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Founded 1972

Engineering in KENYA

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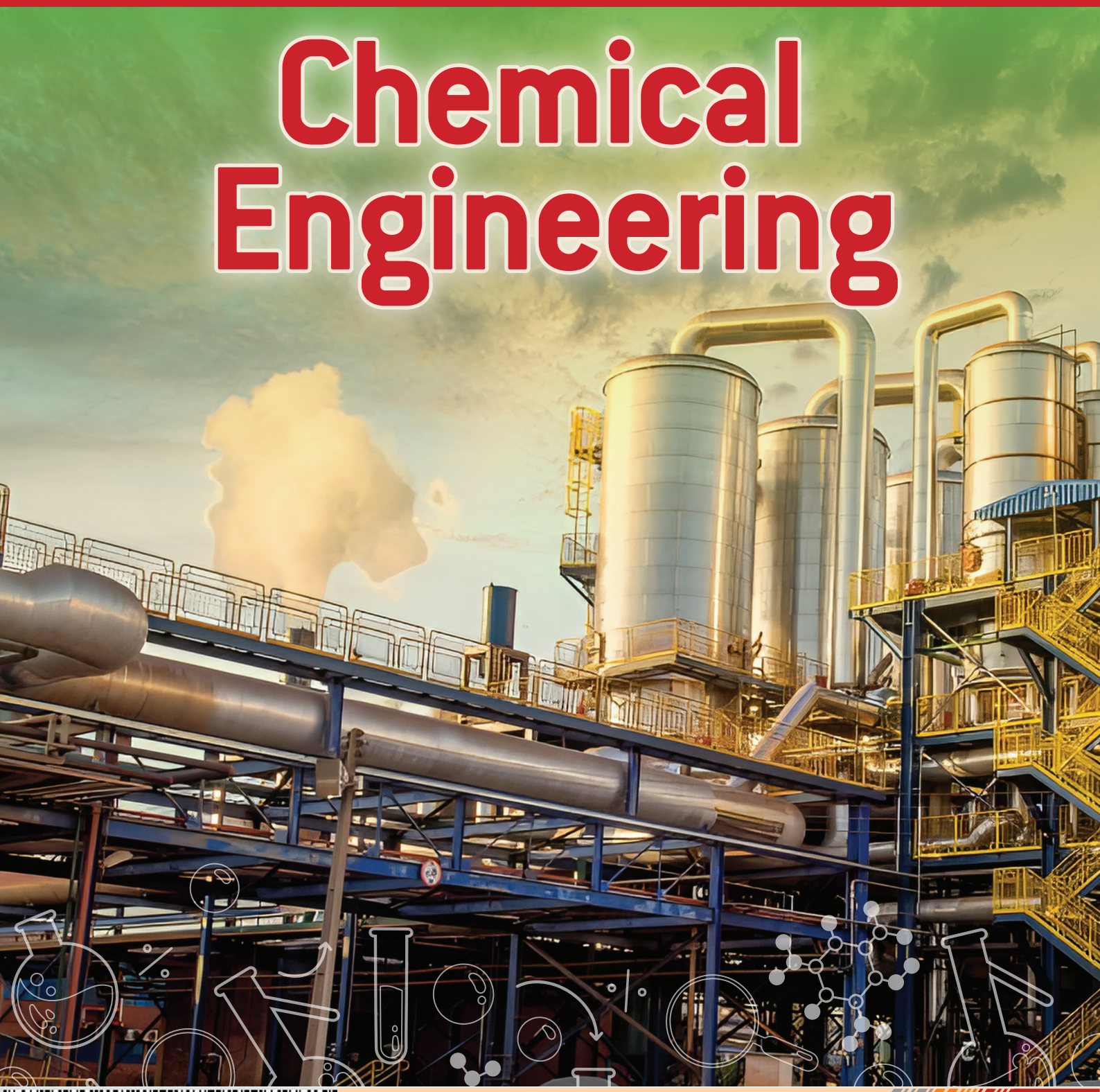
Chemical Engineering



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Engineering in KENYA

Call for Papers

Engineering in Kenya Magazine - Issue 014

The Institution of Engineers of Kenya (IEK) publishes Engineering in Kenya magazine, whose target audience includes engineering professionals, practitioners, policymakers, researchers, educators and other stakeholders in engineering and related fields. The publication is distributed to its target readers free of charge through hard and soft copies.

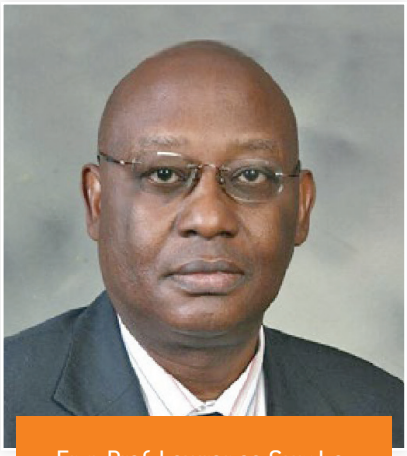
IEK invites you to contribute articles for our next and future editions. Articles should reach the Editor not later than 20th September, 2023 for our next issue, whose theme shall be "Engineering Our Water Resources" and related sub-themes, across all engineering disciplines. An article can range from engineering projects to processes, machinery, management, innovation, news and academic research.

The articles must be well researched and written to appeal to our high-end readers in Kenya and beyond. The IEK Editorial Board reserves the right to edit and publish all articles submitted, in line with standing editorial policy. All articles should be in Word document format, 500-700 words, font type Times New Roman and font size 12.

Send your article today, and get a chance to feature in the magazine!

Send your article to:
editor@iekenya.org and
info@adcentricpr.com

Message from the Editor



Eng. Prof. Lawrence Gumbe

Chemical engineering has played a very important role in human progress and impacts all aspects of modern life. Chemical engineers turn raw materials into useful products. They play a critical role in all goods that are manufactured on a large scale, from chemicals, fuels, fertilizers, foods, pharmaceuticals, biologicals, medical devices, surgical tools, personal protective equipment, to packaging materials, cars, trucks and ships, electronic devices, appliances, clothing, furniture, buildings, clean water and energy.

Chemical engineering is central to all manufacturing, from the traditional chemical, energy and oil industries to biotechnology, pharmaceuticals, food production, electronic materials and device fabrication, and environmental engineering.

Chemical Engineers develop, design and oversee processes that produce, transform, and transport chemicals, biochemicals, materials and energy. The unique training and expertise of chemical engineers is essential to modern technologies.

Many chemical engineers work in manufacturing, designing machines and plants, and ensuring that the processes run smoothly and in the most economical manner possible.

They design processes and equipment for large-scale manufacturing, plan and test production methods and byproducts treatment, and direct facility operations of a wide range of products, such as plastics, paper, dyes, pharmaceuticals, polymers, fertilizers, petrochemicals, and many foods, often through computer-programmed process simulations and artificial intelligence.

Chemical engineers also work in the area of environmental engineering which includes process sustainability, pollution prevention, and safe disposal and recycling of toxic waste. Chemical engineers also work in the areas of biotechnology, pharmaceuticals and nanotechnology.

Chemical engineers improve our well-being by enabling the manufacturing of goods on a large scale, making the processes to do so more sustainable, and providing a healthier, cleaner world. The development of smaller, faster computer chips, innovations in recycling, treating disease, cleaning water and generating energy are all processes that chemical engineers have helped create and make more efficient.

Chemical engineers work on safer, more powerful batteries to boost the mileage of electric cars. They design pipelines that convey chemicals over distances ranging from tens to thousands of meters. They develop successor technologies and new materials that turn climate-damaging carbon dioxide into useful chemicals. They create polymers for use as plastics, rubber, vinyl siding, pipes, personal protective equipment to keep health-care workers safe, and myriad other items of everyday life. They simulate blood flow through arteries to predict and prevent stroke. They harness their knowledge, skills, and expertise to create sustainable solutions that can protect and improve our environment. Chemical engineers even figure out new ways to combine the ingredients of breakfast cereals or pasta sauce.

Chemical engineers apply research in the basic sciences, mathematics, chemistry, physics, and biology, to convert raw materials into valuable products and find solutions to global problems.

The Kenya Government recognises that the manufacturing sector, in line with Vision 2030, is a key driver for economic growth and development. Industrial activities create jobs, increase GDP and contribute to wealth accumulation. As such, Kenya aims to have a robust, diversified, and competitive manufacturing sector. In addition, the sector is projected support the country's social development. The manufacturing sector's contribution to Gross Domestic Product (GDP) has stagnated at about 10 per cent in the last few decades. The growth of the sector has been below the annual target, and Kenya's exports have remained predominantly primary commodities with low value addition.

Chemical engineering will play a key role in the vision above.

This issue of Engineering in Kenya is devoted the Chemical Engineering. We hope that you will find its articles informative, educative and entertaining.

Message from the President

Eng. Erick Ohaga, CE, FIEK, MKIM, AMCIARB (UK)

I hope this message finds you well. As we delve into the thirteenth edition of the Engineering in Kenya Magazine, I am thrilled to address you on the successful conclusion of the Engineering Partnerships Convention (EPC), a remarkable event hosted by the Engineers Board of Kenya (EBK). The convention provided a platform for fruitful collaborations, exchange of knowledge, and fostering stronger ties among engineering professionals, academia, and industry leaders. I extend my heartfelt appreciation to all participants and contributors who made this convention a resounding success.

In the spirit of celebration, I extend my warmest congratulations to our counterparts in Nigeria for their momentous achievement - being admitted to the prestigious Washington accord as a provisional member. This milestone reflects the dedication, competence, and unwavering commitment of Nigerian engineers to uphold high standards in engineering education and practice. Kenya under the lead of EBK, is on its way to similar recognition, and this accomplishment by our Nigerian colleagues serves as an inspiration to propel us further on our journey towards international accreditation.

In this edition of the magazine, I would like to shine a spotlight on Chemical Engineering, a field of great importance to our nation's growth and sustainable development. The progress made in this domain is commendable, as chemical engineers continue to play a vital role across multiple sectors, including manufacturing, pharmaceuticals, energy, agriculture, and environmental preservation.

However, it is crucial to acknowledge the existing gaps and challenges in the practice of Chemical Engineering in Kenya. One notable gap lies in the need for stronger collaboration between academia and industry. By fostering closer ties between educational institutions and the private sector, we can better align the curricula with industry demands, ensuring that graduates are equipped with the practical skills required to excel in the workforce.

Furthermore, investments in research and development are key towards addressing the challenges faced by chemical engineers. By encouraging innovation and providing support for cutting-edge research, we can tackle issues such as waste management, environmental sustainability, and the development of more efficient and eco-friendly processes.

Additionally, there is a need to intensify efforts to create awareness about the importance of chemical engineering and its role in transforming society. By engaging with the public and policymakers, we can advocate for the recognition of the profession's significance and garner support for initiatives that advance the field.

While we celebrate the achievements of our profession, let us not forget the challenges that lie ahead. As the Institution of Engineers of Kenya, we must continue to foster a culture of continuous learning, professional development, and collaboration. Together, we can overcome obstacles and position ourselves as key drivers of progress in Kenya's industrial and technological landscape.

I extend my heartfelt appreciation to all Chemical Engineers in Kenya for their dedication and contribution to the nation's prosperity. I also urge you to seize opportunities to innovate, collaborate, and lead the way in tackling challenges that lie ahead. Thank you for your commitment to excellence, and I wish you all insightful reading in this issue of Engineering in Kenya edition 13.

Message from the Honorary Secretary

Eng. Shammah Kiteme, CE, MIEK

This issue 13 is both evidence of Engineers resilience and a testimony of our capacity to keep moving no matter what. Having been privileged to witness the re-birth of the Engineers magazine it gives me great pride that the Editorial Board under the able leadership of Eng. Prof. Lawrence Gumbe has kept the consistency of this publication after every two months.

Similarly, Engineers have made progress in the last couple of months. We all are aware that the Engineers Scale of Fees was finally operationalized. We also have seen an increase in engagement between IEK and government both at the National and County levels. IEK has also improved outreach to various players in private sector. This has led to a number of MoUs that spell out our engagement with the industry at large for the benefit of members. Engineering in Kenya magazine has been central in these engagements.

It is therefore very important that this issue has focused on Chemical Engineering. This is in keeping with the tradition of focusing on one specialisation in Engineering for every issue. This is such an important branch of Engineering right now because the country under the agenda of increasing the share of manufacturing to the GDP requires heavy input of Chemical Engineers. Chemical Engineers will be required to design and implement various types of industrial plants to offer products that will meet demand for consumers. The petrochemical industries, edible oil industry, soaps and detergents industry, fertilizer and other solvents required to make soaps etc. will heavily depend on the input of Chemical Engineers.

Another important development is the acquisition of Kenya Petroleum Refineries Limited by Kenya Pipeline Company Limited. This is aimed at synergy and efficiency in the petroleum supply chain. This industry presents a big opportunity for Chemical Engineers.

It is expected that the country will now aim at self-sufficiency in many areas including food and other commodities. This means opportunities for Chemical Engineers. It is important that Engineers embrace entrepreneurship so that creation of industries is also part of our focus.

Yet very few Engineers have registered under the chemical and process engineering specialisation. They may be hardly thirty in the register but they also have a great opportunity to influence the students in high school to consider a career in Chemical Engineering. IEK has offered these opportunities through the Membership and Future Leaders committees. These sessions target students in High School and encourage them to consider STEM and more specifically study to become Engineers.

It is expected that as IEK launches the new strategic plan, after the current one has served its term, more focus will be on the membership growth that covers all areas of specialisation. And this is where the institution will contribute in growing the number of Engineers in the country. The current ratio of one Professional Engineer into 16000 people is way out of the expected ratio for countries to witness rapid industrial growth like this country aspires. Developed countries have managed to reduce this ratio to as low as 1:200

More opportunities have also opened up with the Mutual Recognition Agreements and Trade in Services plank of the Africa Continental Free Trade Area (AfCFTA). This means that the space for Engineers to practice has grown to be continental and an opportunity we all should jump in.

As part of advocacy, IEK has continued to robustly engage with the media in order to create the awareness of the important role of the Engineers in development. These engagements will continue and the Engineer will be placed in his rightful place in the industry. It is expected as the regulator EBK continues to roll out various measures to streamline the industry, we as Engineers in our individual space will charge our fees professionally, we will avoid undercutting and we will be part of the efforts of protecting the integrity of the profession.

Overall, the profession has a bright future. This is what all of us must take part in building in our different ways.

There are recent developments in the industry where a bill has been proposed to regulate construction project management through Construction Project Managers and Construction Managers Bill 2023. While it is proposed and has not yet been tabled in parliament, there has been intense engagements on the content and the intention of the bill. The bill seeks to limit construction management practice to those who have construction management degree. This is obviously a challenge to Engineers who have practiced as project engineers, resident engineers and project managers of various engineering projects. It is inconceivable that they would have to go back to the university to acquire a new degree in construction management to be able to manage these projects. It is for this reason that IEK has taken the position that the bill is not good in its current form and structure. We have asked members for comments on the bill and we will ensure their views are considered if the bill is to proceed to the next stages.

I now invite you to enjoy reading this 13th Issue of Engineering in Kenya Magazine.

Revolutionising the Water Storage Sector in Kenya

SBS® Tanks is revolutionising the water storage sector in East Africa. As part of The SBS Group, SBS® Solutions East Africa services the East African region from offices in Nairobi, Kenya, delivering ISO 9001:2015 and ISO 45001:2008 accredited water storage tanks. Established in 1998 in Durban, South Africa, SBS Tanks has extensive global experience collaborating with engineers and professionals and has become renowned as the leading manufacturer in Africa for steel panel water storage tanks fitted with a liner.

A Trusted Brand With a Legacy of Excellence

Over the past 25+ years, with over 3000 tank installations in more than 23 countries globally, SBS Tanks has earned the reputation as a trusted global brand that delivers exceptional quality and reliability. Design Engineers, consultants and clients have over 500 tank sizes to choose from with capacities from 12000 to 4.2 million litres across a number of ranges designed to suit application, weather and regional site and project specific requirements. From rainwater harvesting to bulk water, effluent wastewater or recycled water storage, mine water systems, backup or fire suppression water storage, SBS Tanks has developed liquid storage tanks to meet the needs of a wide range industries and standards.

Why choose SBS® Tanks?

- ***Global standards for local conditions:*** SBS Tanks is internationally certified to the highest industry standards for quality, ISO 9001:2015, health and safety and management, ISO45001:2018. All designs, developed by in-house engineers, are certified by external engineers.
- ***Proven reliability of a trusted brand:*** For 25+ years SBS Tanks has worked with engineers and professionals to deliver quality water storage tank solutions across the globe.
- **Innovative, environmentally friendly modular design:** Tanks from SBS Tanks are easy to transport, can be extended to increase storage capacity or dismantled and re-located.
- ***Wide range of capacities:*** Over 500 sizes available with capacities from 12,000 liters (12m3) to up to 4.2 million liters (4,212m3). Installation or build flexibility based on the site footprint and capacity requirements.
- ***Weather and application specific options:*** Designed to suit a wide range of application, weather and regional site and project specific requirements, SBS tanks can be used for bulk water storage, rainwater harvesting, effluent wastewater or recycled water storage, mine water systems, backup or fire suppression water storage.
- ***Rapid on-site construction:*** Modular design allows for quick installation (24 days for 4,212m3 tank) and immediate commissioning for operational use.
- ***Durable and smart design features:*** Manufactured from high-quality steel, coated with a specialised corrosion resistant alloy, Zincalume®, SBS Tanks are fitted with a leak proof internal PVC liquid storage liner. This prevents contamination of the liquid and further reduces the risk of corrosion.
- ***Extended Lifespan:*** SBS Tanks have an expected 65+ year lifespan with low maintenance requirements and a 10-year No Leak Warranty.

Designed for Local Conditions

Challenges such as limited site footprint can be overcome with the Engineered Solutions range utilising a vertical build design of up to 11 metres in height. Bulk water storage requirements can be accommodated vertically or horizontally with tank diameters of up to 24 metres. Multiple tank configurations, either for bulk requirements or for process application, provide the option to isolate tanks individually for maintenance and prevent water supply interruption. The SBS Tanks Elevated Range offers increased water pressure delivery and reduces the risk of sabotage or contamination. For regions that experience extreme weather conditions, the Cyclonic Range offers wind rating of up to 67 metres per second or 240km per hour, while the Standard Range – suited for most applications – can withstand winds of up to 43 metres per second or 140km per hour.

Professional, Qualified In-Country Support

With engineering professionals based in Nairobi, Kenya, SBS is able to offer local engineering design and compliance support and on-site project management expertise.

"Africa requires access to water storage solutions that are quick to install, cost-effective and that have a lower carbon footprint than alternative solutions such as concrete reservoirs," says Eng. Robert Tunje, General Manager, SBS Solutions East Africa Limited. "It is no secret that water is essential for economic and social development. Engineers have a huge role to play to ensure speedy and equitable delivery of this resource. SBS Tanks offers an excellent solution for bulk water storage, at a fraction of the cost and time, revolutionising service delivery and driving an economically bright future for the region."

Considering the Environment

Durability, quality and longevity all have an impact on the sustainability of a product and the environmental impact of a project. Modular water storage tanks from SBS Tanks, designed by the in-house SBS engineering team, are lightweight, facilitating ease of transportation and installation and resulting in only 2% of the carbon footprint of the equivalent concrete reservoir. Manufactured using high-quality steel, coated with a specialised Zincalume® coating for added corrosion protection, and fitted with an internal liquid storage liner, tanks from SBS have an expected 65+ year lifespan.

Whether it is a bulk water or sanitation project, closed circuit mine water solution, fire protection water storage, rainwater, borehole or potable water storage tank you require, we have the expertise and the product to meet your needs.

SBS® Tanks are the trusted, cost-effective solution in the manufacture, delivery and installation of premium quality water storage solutions with high resistance to corrosion and no leakages.

SBS® Tanks are suited for use in a variety of sectors including the storage of water for fire suppression. Designed, manufactured and installed to exacting standards, SBS Tanks is ISO 9001:2015 certified for quality and ISO 45001:2018 for health and safety.

From bulk water municipal water storage to effluent wastewater processing or recycled water storage, rainwater harvesting, raw seawater storage as part of a desalination plant process, to fire suppression water storage, SBS® Tanks are available in capacities from 12000 litres to 4.2 million litres.

Steel panel storage tanks from SBS® Tanks can be installed at elevated heights on engineer designed tank stands. In-house engineers work with clients to determine the design specifics based on the tank application and location.

IEK President Eng. Erick Ohaga, Cabinet Secretary for Roads and Transport Hon. Kipchumba Murkomen, IEK Honorary Secretary Eng. Shammah Kiteme on June 2023

IEK President Eng. Erick Ohaga presenting the EiK magazine and the AJERI to the Vice President of Energya Cables International Coperation at the Africa Future Energy Convention held in Johannesburg

IEK Council members during the council strategic plan retreat held on 31st March - 1st April 2023 at the Lake Naivasha Resort.

IEK President Eng. Erick Ohaga at the University of Nairobi's recognition Awards held on May 2023

Tree planting by the capital Branch in commemoration of World Environment Day on June 2023 at the University of Nairobi Graduation Square.

IEK and ACEK Meeting with the Jordan Ambassador to Kenya

ENGINEERING PARTNERSHIPS CONVENTION (EPC) 2023

EXECUTIVE SUMMARY

The Engineering Partnerships Convention 2023, held under the theme "Transforming Kenya's Economy - Engineers' Contribution to Development," brought together industry leaders, experts, and stakeholders to discuss and explore avenues for collaboration and innovation in the engineering sector. The event featured His Excellency the President of the Republic of Kenya, Dr. William Ruto as the keynote speaker, highlighting the crucial role of engineers in shaping Kenya's future.

In his address, President Ruto underscored the government's commitment to supporting engineering initiatives and emphasized the importance of strategic partnerships between the public and private sectors. He acknowledged the significance of infrastructure development in propelling economic growth and called for collaborative efforts to address the country's infrastructure gaps. The president emphasized the need for technology integration, sustainable engineering practices, and job creation through engineering endeavors.

President Ruto's speech set the tone for the convention, focusing on the government's commitment to facilitating a conducive environment for engineers to thrive. The president highlighted the role of engineers as catalysts for economic growth and emphasized the need for collaboration, innovation, and knowledge sharing to address Kenya's infrastructure challenges effectively.

The convention provided a platform for participants to delve into various areas critical to Kenya's economic development. Discussions centered around key issues, including the liberalization of professional engineering services, addressing legal, regulatory, and operational gaps, developing engineering capabilities, affordable housing, food security through water, irrigation, and the blue economy, engineering research and academia, and acceding to the Washington Accord.

Affordable housing emerged as a central theme during panel sessions and breakaway sessions. Participants explored innovative engineering solutions and financing models to tackle the housing shortage in Kenya. Strategies to streamline the construction process, leverage technology, and create sustainable housing developments were discussed, aligning with the government's vision of job creation and sustainable engineering practices.

Food security through water, irrigation, and the blue economy was another critical area addressed at the convention. Experts highlighted engineering interventions to ensure a reliable water supply for agriculture, optimize irrigation systems, and promote sustainable practices in the blue economy. These discussions aligned with the government's emphasis on technology integration and sustainable engineering practices to drive economic growth and address Kenya's food security challenges.

Engineering research and academia were prominent topics, emphasizing the importance of research, innovation, and collaboration between academia and industry. Participants discussed strategies to enhance research funding, develop a robust engineering curriculum, and promote lifelong learning for engineers.

Acceding to the Washington Accord was given a significant focus, aligning with the government's vision of collaboration and integration with international standards. The benefits of membership in the Washington Accord were emphasized, including mutual recognition of engineering qualifications and improved global competitiveness for Kenyan engineers. Aligning engineering education and accreditation standards with international benchmarks was highlighted as a crucial step in fostering knowledge exchange and supporting the growth of the engineering sector.

The Engineering Partnerships Convention 2023 facilitated valuable discussions and collaboration among industry professionals, policymakers, and academia in line with the government's agenda for engineering development. The convention provided a platform to address key issues, such as infrastructure gaps, affordable housing, food security, research, and international collaboration. By embracing innovation, sustainable practices, and strategic partnerships, Kenya's engineering sector can contribute significantly to the country's economic growth, job creation, and overall prosperity. The outcomes and resolutions from the convention will guide stakeholders in implementing measures to leverage engineering partnerships and transform Kenya's economy. The Engineering Partnerships Convention 2023 served as a catalyst for action, empowering participants to drive positive change and shape the future of the engineering sector in Kenya.

SPEECH BY **H.E. DR. WILLIAM RUTO, CGH**

As the government pursues sustainable development for shared prosperity through the Bottom-Up Economic Transformation Agenda, we remain constantly mindful of the need to identify and engage every stakeholder whose vision, mandate, and intervention are like-minded. To deliver the best outcomes under the agenda for radical transformation and rapid growth, a coalition of able and willing actors, ready to make impactful contributions, is indispensable.

For us to have any meaningful chance of staying in control of our development and remaining on top of the complex and dynamic challenges, which threaten to wipe out the fruit of our struggles, we must have clarity about the needs of our moment in history: How we will make progress in increasing well-being and for the most people by expanding opportunities, minimizing threats, increasing wealth and employment and reducing poverty and inequality.

Accordingly, we have resolved to focus our attention and strategic investment on the core pillars of the bottom-up economic transformation in a radical plan that takes due account of our national commitments to the realization of sustainable development goals, the actualization of Agenda 2063, and the implementation of Vision 2030.

It is highly encouraging to learn about the activities of dedicated professionals who are independently engaged in progressive endeavours that are nonetheless aligned with the Bottom-Up Economic Transformation Agenda. I must emphasize this: The Engineers Board of Kenya holding this convention for the fourth year is impressive, appropriate, and commendable.

It is important that Kenyan professionals meet periodically to reflect on professional standards and quality, service, impact, and their greater socio-economic institutional role. As they do so, it is essential for them to deliberate on their role and contribution to the national transformation agenda because Kenyans rightly expect it of them.

As for you, our engineers, there is no better time to be contemplating essential professional matters than now. The reason is that our Agenda creates opportunities for substantial inputs from the engineering profession. There is definitely a fundamental role for engineers and engineering in the actualisation of important dimensions of the Plan.

We have a target to enhance the contribution of industry to the national GDP by 20 percent by 2030. To do this, we shall have to engage in competitive manufacturing on a large scale. Agro-industrial manufacturing for value addition, in particular, is the most viable means of growing our manufactured exports. This, in turn, requires a robust capacity to support rising efficiency in every industrial process or, in other words, engineering and engineers.

> *"I must emphasize this: The Engineers Board of Kenya holding this convention for the fourth year is impressive, appropriate, and commendable."*

Modern medical technology has given rise to medical engineering as a profession, and the universal health coverage will require greater investment in state-of-the-art equipment, technologies, and innovations. The affordable housing plan and general infrastructure development have traditionally been synonymous with the engineering domain. Our commitments in ICT and the digital superhighway pillar intervene in a sector that employs a variety of engineering professionals.

Not only do we need engineering professionals to guide the implementation of programmes and projects under the Bottom-Up Economic Transformation Agenda, but we also have to go deeper. Competitive efficiency is essential for transformation and calls for constant innovation. The Low Volume Sealed Roads Standard, for example, is a creative approach to road construction that has enabled Kenya to build 10,000km of roads, 6,000 of which are already completed. Similarly, our engineers at KenGen, who effectively benefited from technology transfers in the important area of clean and green geothermal power production, are now extending Kenya's pioneering footprints in our region by leading projects in Ethiopia and Djibouti.

These are the most recent instances of encouraging leadership from our engineers. I challenge this esteemed fraternity to go further and implement energy-efficient innovations in transport and further improve e-mobility innovations.

I also believe that there is a tremendous opportunity for Kenya through its engineering professionals to take leadership of the African and global energy transition by producing innovations for green energy production and efficient technologies for sustainable industrial processing of raw materials. The vision of a young, clean, and green continent has you in mind, and you have no choice but to rise to the occasion. These, and many other weighty matters, must occupy your minds and anchor your deliberations as you strategise on ways and means of facilitating members of your profession to exploit emerging opportunities for innovation and make their contribution to national socio-economic transformation.

Therefore, even as you consider your agenda, it is important for you to reinforce your critical mandate in education and training by supporting the design, improvement, and implementation of the most appropriate national STEM curriculum for our present and future productive and competitive needs.

> *"Not only do we need engineering professionals to guide the implementation of programmes and projects under the Bottom-Up Economic Transformation Agenda, but we also have to go deeper"*

You are also vested with the immense mandate of using innovation as a professional value and entrenching it deeply in Kenya's engineering culture in all sectors, especially in education, research, and practice.

I make this call for a very considered reason: Engineering is vital for national economic growth and development. The strong relationship between a nation's engineering capacity and its economic development is well established. We are committed to developing an optimal national engineering capacity to support the transformation of our country.

It is, therefore, very urgent for us to use every opportunity to impart necessary skills and competencies to learners from an early age and, in fact, all the way from pre-primary to the tertiary level of education. In that connection, I am delighted to commission the 4th cohort of the Graduate Engineers Internship Programme today. The programme is designed to accelerate professional training and cut the time required to qualify as an engineer from 7-12 years to only 3 years. In recognition of the needs of a transforming economy, the government is going to scale up the programme, from its current enrolment of 120 to 500 trainees in the next financial year.

I am also delighted to have witnessed the signing of a memorandum of understanding between the Engineers Board of Kenya and the Korean Professional Engineering Association to promote collaboration on a broad range of capacity-building projects.

The Government is also committed to the delivery of high-quality engineering capacity by establishing a Kenya School of Engineering. We shall, therefore, support the Engineers Board of Kenya in this endeavour.

Through the Board, we are facilitating total compliance with the highest standards of engineering by building contractors and developers. It should no longer be possible for projects to employ unqualified people or to proceed without employing an engineer altogether. Qualified engineers must supervise building works from the commencement to completion. A zero-tolerance policy for non-compliant structures must be employed in order to take action against people responsible for collapsing buildings.

I approve and support Kenya's bid to accede to the Washington Accord under the International Engineering Alliance and to promote international recognition of Kenyan engineering programmes and qualifications. I also support the enhancement of the global mobility of Kenyan engineers. Such initiatives, including the recent admission of the Engineers Board of Kenya as an affiliate of the World Federation of Engineering Organizations, bring our sector to international standards and expose our professionals to international best practices. This is good for Kenyan engineering and, therefore, good for our development agenda.

There should be no doubt about the government's commitment to the promotion and development of Kenyan engineering as a decisive component of our development. I encourage you to use this convention to define a clear road map for raising the overall engineering standard and capacity and making a catalytic contribution to the Bottom-Up Economic Transformation Agenda. There is so much for you to do, and you must quickly get ready to start the work.

SPEECH BY CS MINISTRY OF ROADS AND TRANSPORT, **HON. ONESMUS KIPCHUMBA MURKOMEN**

Assembled today, are policymakers, industry experts, academicians, researchers, service users, and Kenyan engineers to discuss how engineering capacity can be built to create sustainable economic development for Kenya, the region, and indeed the continent. This is an extremely important event that sets the tone and agenda for how the profession will collaborate with its stakeholders. We are immensely grateful that the President of the Republic of Kenya has been able to find time out of his very busy schedule to grace this occasion.

This year's edition comes at a time when the future holds exciting possibilities in the technology field. We see the fourth industrial revolution gathering pace and the world moving towards a more automated and interconnected future, with advances in artificial intelligence and robotics. Further, there are alternatives to the internal combustion engine emerging locally and several other technological trends. I believe the local engineering profession holds the keys to unlocking and unleashing the potential of these emerging technologies so that they become a reality for the benefit of Kenyans.

The Ministry of Roads and Transport has moved with speed to align its policies and programs with sector targets including Sustainable Development Goals, Agenda 2063, Vision 2030, the Fourth Medium Term Plan (MTP IV), and most crucially the Bottom–Up Economic Transformation Agenda (BETA). Projects and operations at seaports such as Lamu and Mombasa as well as ports on Lake Victoria are being aligned with the value chain approach. Construction of Berth 1 at Dongo Kundu will commence later this year.

In the aviation sector, a modernized National Air Traffic Management System and disaster recovery centre is currently under implementation and will be completed in 2026. A new control tower for Kisumu is ongoing and this will significantly enhance the operational abilities of this airport once it is opened in 2025. Ukunda Airstrip is receiving a 200m runway extension aimed at boosting the South Coast tourism value proposition. Construction of Angama Airstrip (1.3km) in Masai Mara is ongoing while Lanet Airstrip is being rehabilitated and a new terminal building is under construction. The Wajir terminal building is also being rehabilitated. The East Africa School of Aviation within this financial year has installed advanced equipment to train young people and in-service personnel in essential competencies which also happen to be marketable and transferable to other parts of the world.

The Kenya Railways has made significant progress in rehabilitating Meter Gauge Railway (MGR) lines, aiming to provide an alternative and cost-effective transportation mode for various value chains. Currently, the Gilgil – Nyahururu line (78km), Leseru – Kitale line (65km), and Kisumu – Butere line (69km) are undergoing rehabilitation at different stages. Additionally, efforts are underway to rehabilitate 31 MGR locomotives. Previously, the Thika – Nanyuki line, Longonot – Malaba line, and Naivasha ICD to Longonot Station MGR link (23km) have been completed and are already in operation.

In the Roads Subsector, there is an ongoing project portfolio valued at Ksh 700 billion and this portfolio, as it is progressively completed, will change the game in terms of reduction in the cost and duration of travel while also enhancing the predictability of movement for passengers and goods. These benefits translate into strengthening numerous value chains across the economy. In light of the dire economic conditions, the Ministry is actively seeking to scale up the use of Public-Private Partnerships financing for commercially viable projects such as the Lamu Port, some berths in Mombasa, and sections of the Northern Corridor.

A nation's competitiveness depends on the capacity of its industry to innovate and upgrade manufacturing and infrastructure. The estimated UNESCO ratio of professional engineers to a middle-income country's population is 1:5,000 persons. Going by this measure, Kenya has a shortage of over 7,000 professional engineers and this shortage cuts across the various engineering disciplines. One effect of this shortage is that despite large investments in national infrastructure projects, the participation of local engineers in these projects and programs has unfortunately been constrained by limited training and exposure to specific skills. This has necessitated the mobilization of foreign engineers to fill the gaps. The underlying contributors to the skills gaps include inadequate policies on skills development and transfer, limited formal employment opportunities, limited access to long-term training such as post-graduate programs, and inadequate resource allocations for capacity building. In Kenya, the adequacy of post-graduation training of a person to render professional engineering services to the public is tested and certified by the EBK using clearly documented and widely publicised criteria.

The shortage of engineering skills is further manifested in the limited number of engineers being able to meet the specified certification criteria in a given year. To ensure the skills shortage is dealt with decisively, the Ministry is currently implementing

the Graduate Engineers Internship Programme (GEIP). The Programme is structured to impart professional engineering competencies to recently graduated engineers within a period of 3 years. Currently, 120 graduate engineers are sponsored under EBK using Government funds with another 2000 undergoing structured training under various Government Agencies partnering with EBK. We are greatly privileged that the 4th Cohort of the program will be commissioned during this convention. The Ministry plans to continue to upscale the GEIP programme to have an annual intake of 1,000 Graduate Engineers within the next two years.

The State Department of Roads has developed a collaborative framework between Road Agencies and Academia. The framework will strengthen academia and industry linkages for applied research by offering attachments to students, supporting lecturers to gain industry experience, and supporting the equipping of university laboratories. Additionally, the Ministry through the Engineers Board of Kenya will establish the Kenya School of Engineering to help bridge the existing engineering skills gaps. The school will be a regional center for excellence in engineering.

> *The estimated UNESCO ratio of professional engineers to a middle-income country's population is 1:5,000 persons. Going by this measure, Kenya has a shortage of over 7,000 professional engineers and this shortage cuts across the various engineering disciplines.*

Kenya is pursuing signatory status in the Washington Accord under the mentorship of the Board of Engineers, Malaysia, and the Pakistan Engineering Council. The Washington Accord is an international accreditation agreement for professional engineering degrees that is widely recognized. Once the signatory status is attained, our engineering programmes and graduates will be recognized globally and will enjoy global mobility. This initiative will unlock international access for our vibrant young engineering professionals and graduates.

To enhance the regulation of engineering services, I am glad that the Board will roll out the Engineers Registration Portal and Project Registration Portal. The two portals will form the basis of the issuance of project information stickers and site instruction booklets. I want to urge developers, investors, County Governments, contractors, and the public to engage professionals at all levels of the infrastructure provision value chain. I wish to thank the Current President of the Republic of Kenya for recognizing the need to bring together the Engineers Board of Kenya (EBK) and the Kenya Engineering Technology Registration Board (KETRB) which are now both housed in the Ministry of Roads and Transport and not in separate ministries like before. The Ministry of Roads will soon gazette a Task Force to harmonize engineering regulatory frameworks including education, skills recognition, career pathways, and review of engineering Schemes of Service.

Finally, the liberalization of professional services at the regional, continental, and global levels has continued to grow. There are continuous trade talks at the African Continental Free Trade Area (AfCFTA) and the East African Community (EAC) for liberalized engineering services. The Ministry of Roads and Transport will deliberately develop capacity-building initiatives on Trade In-Service (TIS) to ensure an understanding of opportunities, threats, and strengths of the liberalization of professional services. The Ministry will further support the enhancement of the Mutual Recognition Agreements (MRAs).

The President of the Republic of Kenya, Dr. William Ruto, PhD (3rd Right) / CS, Ministry of Roads & Transport, Hon. Kipchumba Murkomen (3rd Left) / Governer, Nakuru County, Hon. Susan Kihika (2nd Left) / Senator, Nakuru County, Hon. Tabitha Karanja (1st Left) / Chairman EBK, Eng. Erastus Mwongera (2nd Right) / Registrar EBK, Eng. Margaret Ogai (1st Right), during EPC 2023 held on 14th - 16th June 2023 at Sawela Logdes, in Naivasha, Nakuru County

SPEECH BY GOVERNOR OF NAKURU COUNTY
H.E SUSAN KIHIKA

I am honored to welcome all of you to Nakuru County for the 4th Engineering Partnerships Convention, which focuses on the theme of "Transforming Kenya's Economy - Engineers' Contribution to Development." Engineering plays a vital role in the development of any nation and is the driving force behind economic transformation. Our aspirations, as outlined in Agenda 2063 for the African continent, Kenya Vision 2030, and the Kenya Kwanza Plan, emphasize infrastructure development to stimulate economic growth, generate employment, and enhance the quality of life for our citizens.

The world's economic powerhouses have relied on engineering to develop and grow their economies. History has shown that countries need to be self-reliant in producing their own goods and products to withstand external shocks. Therefore, it is imperative for our country to build and strengthen our engineering capabilities to meet our own needs.

Furthermore, this conference aims to explore avenues for liberalizing engineering services within the East African Community and the African Free Continental Trade Area. This noble agenda recognizes that the per capita number of engineering professionals in Africa is lower compared to other regions of the world. It is crucial for the African continent to share engineering skills to foster economic growth within our regions. Africa's potential as the next big thing is contingent upon advancing our engineering sector for economic development.

Another objective of this conference is to address the legal, regulatory, and operational gaps that exist in ensuring safe, efficient, and effective infrastructure. While we have laws and regulations in place to govern the construction industry, there are still loopholes that allow for unscrupulous practices. It is high time we curbed this menace. I urge the relevant bodies, particularly the National Construction Authority and the Engineers Board of Kenya, to explore ways of enhancing compliance with laws and regulations.

I have observed that the topics and submissions to be covered during this conference are highly relevant to all participants. I am confident that by the end of the conference, attendees will have gained valuable insights into advancing the engineering profession in our country and the broader African region. The lessons learned and experiences shared will be pivotal in our journey toward achieving our economic aspirations.

Thank you all for your presence and participation in this important convention. Together, let us pave the way for a prosperous future through the advancement of engineering.

The President of the Republic of Kenya, Dr. William Ruto, PhD (Centre) / CS, Ministry of Roads & Transport, Hon. Kipchumba Murkomen (Left) / Governer, Nakuru County, Hon. Susan Kihika (Right), during EPC 2023 held on 14th - 16th June 2023 at Sawela Logdes, in Naivasha, Nakuru County

SPEECH BY PRINCIPAL SECRETARY STATE DEPARTMENT OF ROADS, **ENG. JOSEPH M. MBUGUA, PE, MBS**

I am pleased to join you and be part of this 4th Engineering Partnership Convention. Engineers contribute immensely to the remarkable transformation of our country. The Convention has come at time of global economic slowdown and persistent supply chain disruptions and the drought effects that have created urgency on food security and climate change effects.

This Convention provides a platform to deliberate on mitigation and adaptation strategies that can enhance our quality of life, development and transformation of our Country's physical infrastructure, technology, and systems. I am glad that there are tailored-made sessions on the Kenya Kwanza Plan priorities such as Digital Transformation, Affordable Housing, Food security and Climate Acton Plans. It presents an excellent opportunity for engineers and the engineering practice to rise to the occasion.

Collective expertise of engineers, architects, quantity surveyors, contractors, and other actors in built environments are critical in delivering solutions in food security, housing, transport, digital economy through development of enterprises that produce local products hence creating jobs, wealth and transform lives of ordinary Kenyans.

Engineers are the driving force behind national projects, and their expertise and ingenuity are instrumental in shaping our nation. We will deliberately invest in their training, skills development, and knowledge enhancement to ensure that they are equipped to face the challenges of the 21st century.

The growth of liberalization of professional services can now not be overemphasized. This will be on promoting the mobility of engineers and harmonizing professional standards across borders. Furthermore, it is imperative that we create a robust framework that ensures compliance with quality standards, promotes transparency, and minimizes corruption.

As I conclude, let me take this opportunity to congratulate the Board on its various impactful initiatives and programs such as:

a. Successful independent reviews of engineering programs to ensure our Kenyan universities offer the required standards of engineering education and clearing backlog on registration of Graduate Engineers Applications;

b. Embarking on Washington Accord in earnest through appointment and training of assessors who will be responsible for assessing local engineering programs for Outcome Based Education among other duties; and

c. Signed MoU with Korean Professionals Engineering Association (KPEA) whose aim is to enhance capacity of our local engineers and enable them secure employment in Korea. I challenge EBK to fully implement the MoU so that Kenyan engineers reap its full benefits.

I take note of the Board's effort to provide a platform and opportunity for learning, professional exposure, and skills acquisition through the establishment of the Kenya School of Engineering (KSE) and commit my support.

Finally, I would like to reiterate our commitment in supporting the Board to fulfil its mandate intended to guarantee safety and welfare of the public, which is critical in the realization of a sustainable National Development Agenda.

I therefore, challenge all the sector regulators to finalize the MoU and implement it as it is critical to ensuring infrastructural integrity and for posterity.

PS Roads (5th right), EBK Chairman (5th left), EBK Registra/CEO (4th right) and IEK President (4th left) IEK 1st V. President (3rd left), IEK 2nd V. President (1st right), IEK Hon. Secretary (2nd right), ACEK Hon. Secretary (3rd right), IEK Council Member (1st left) & ACEK Hon. Treasurer (2nd left)- during EPC 2023

REMARKS BY CHAIRMAN OF ENGINEERS BOARD OF KENYA, **ENG. ERASTUS MWONGERA, CE, FIEK, CBS**

The Engineers Board of Kenya held the 4th Engineering Partnerships Convention, with the honor of having the sitting president: His Excellency the President, Hon. William Samoei Ruto, PhD., C.G.H., address a gathering of engineers for the first time since independence.

Expansion of Graduate Engineers Internship Programme (GEIP)

The Board has set a bold vision of registering 10,000 professional engineers by 2027, and we have taken concrete steps toward achieving this goal. To provide fresh graduate engineers with a platform to enhance their professional competencies, we have established the Graduate Engineers Internship Program (GEIP). This three-year program is specifically designed to empower young engineers like those in our esteemed Cohorts 1, 2, and 3. I am pleased to announce that we have engaged 290 graduate engineers across these cohorts, and their progress has been remarkable. Six of our interns have successfully transitioned into the prestigious title of Professional Engineer after completing their internship, a testament to the effectiveness of the program. I must express my gratitude to the Government's invaluable budgetary support, which has enabled us to further expand our program.

This year, we have increased the number of participating graduate engineers from 100 to 120, providing even more opportunities for graduate engineers to benefit from the GEIP. Today, we gather to mark a significant milestone as Cohort 4, comprising 120 graduates, commences their internship journey. We are confident that this group of graduate engineers will make the most of this transformative experience, and we look forward to witnessing their growth and development. journey.

Journey Towards Acceding to the Washington Accord

The Board began its journey to accede to the Washington Accord in 2019 with mentorship from the Board of Engineers Malaysia and Pakistan Engineering Council. Joining the accord would globally recognize our Engineering Programs, attract foreign students, and increase mobility for our engineers. Kenya aspires to become the third African country, after South Africa and Nigeria, to accede to the accord, demonstrating our commitment to excellence and international recognition in engineering education and engineering capabilities.

Kenya School of Engineering

The Engineers Board of Kenya is mandated under the Act to establish the Kenya School of Engineering (KSoE). The school will deliver practical knowledge, holistic learning, and support long-term manpower needs. This school will also fill the gap for challenges experienced in accreditation from several institutions. The Board recognizes the Government's commitment to supporting the establishment of this school.

Partnerships and Collaborations

The Board recently established a significant strategic partnership with the Korean Professional Engineering Association by signing a Memorandum of Understanding (MoU). This partnership aims to foster collaboration between Korea and Kenya in various areas, including industrial project development, capacity building, and cultural exchange. Furthermore, the Board has been actively involved in the East African Community (EAC) Mutual Recognition Agreement (MRA), which currently includes Kenya, Tanzania, Uganda, and Rwanda. Efforts are underway to support South Sudan, Burundi, and the Democratic Republic of the Congo in joining the MRA, promoting trade and mobility of engineers across the East Africa region. Additionally, discussions are ongoing for the African Continental Free Trade Area (AfCFTA), which holds the potential for further opportunities and collaborations.

EBK Chairman (centre), EBK Registra/CEO (1st left) and IEK President (2nd right) KoTDA Representative (2nd left), Data Commissioner(3rd left) & Microsoft Kenya CEO (3rd right)- during EPC 2023

ADDRESS BY THE PRESIDENT - ELECT OF THE WORLD FEDERATION OF ENGINEERING ORGANIZATIONS (WFEO), **ENGR. MUSTAFA B. SHEHU**

Let me start by thanking the Chairman EBK, Eng. Erastus Mwongera for inviting me to participate in the 4th Engineering Partnership Convention taking place Naivasha, Nakuru County. My initial intention is to be there physically, but due the International Engineering Alliance meeting taking place at Taichung Taiwan, that made it only possible ton participate online. I am also glad that this convention is honored by the esteem presence of the President of Republic of Kenya, His Excellency Dr. William Ruto, clearly indicating your intention in working closely with engineers in order to deliver on your manifesto, which is centered on infrastructural development. Let me use this privilege to congratulate you on your election victory and peaceful taking over the leadership of Kenya. Personally, I have been following with keen interest your exemplary leadership style in trying to make Kenya and the African continent take their appropriate place socially and economically. In this respect I congratulate you for the promotion of fair trading within the African continent through WTO and AfCFTA as well as the bottom-up economic transformation Agenda on food security, housing, etc. which are all people centered. Your Excellency, the engineering community is very much with you and willing to partner with your government in this journey towards making Africa great and by extension, Kenya.

In brief, the WFEO is the global body of engineers founded in 1968 under the auspices of UNESCO with Secretariat located at the UNESCO Headquarters in Paris. It is a non-governmental and non-profit organization with its membership comprising of over 100 countries representing over thirty million engineers. It is recognized at UNESCO as a strategic partner with Associate status and co-organizes the UNESCO World Engineering Day for Sustainable Development on 4th March of each year. WFEO is a member of the United Nations Economic and Social Council (ECOSOC) and co-leads the UN Science and Technology Major Group. The role and responsibility of engineers in addressing the challenges facing society is more recognized and acknowledged worldwide. Through its activities, WFEO engages with governments, policy makers and United Nations leadership to present the engineering perspective on issues affecting the global community.

It will be of interest to intimate His Excellency that Kenyan engineers and African engineers in general are participating actively in the affairs of WFEO and other global engineering organisations especially in the last 12 years. As at now we have 6 out of 26-member Executive Council of WFEO from Africa (that includes a Kenyan in the person of Eng. Nathaniel Matalanga). Also for the first time in WFEO history, we are going to have from Sub-saharan Africa the President of WFEO who will take over in October this year. This is achieved through a lot hard work and co-operation between the African Engineering Institutions in the last couple of years. This also serves as a pointer to our countries that as we are trusted at global stage, we should be trusted at our home countries for any level of technical and leadership responsibility.

Another milestone which the engineering institutions in Africa are achieving is regarding the ability of the engineers qualification to be accepted in other parts of the world, which is only done through registration with International Engineering Alliance to become signatories to Washington Accord. Nigeria, Kenya, Mauritius, Rwanda and Zambia had started the process. It is gladdening to note that just this morning Nigeria has been admitted into the Washington Accord, while Kenya, Mauritius, Zambia will hopefully be admitted next year. WFEO will ensure that other countries like Ghana, Zimbabwe, Uganda, Malawi, Tanzania will follow subsequently.

Distinguished ladies and gentlemen, it is sad but factual to note that Africa is the most under developed continent with huge infrastrucure deficit and lags behind in all Human Development Indices. While this may look disturbing, our leaderships should see it as an opportunity to develop the capacities of our engineering personnel to be used to meet these challenges. This can be done through deliberate policies of government in looking inwards by engaging our indigeneous practitioners and firms in achieving all projects carried out in our respective countries. Sustainable development can only be achieved if we determine to develop Africa by Africans.

While looking forward for the Comminique that will generated at the end of this convention, on behalf of the WFEO, I congratulate EBK and IEK for the successful organization of this program.

IEK President - during EPC 2023

The President of the Republic of Kenya, Dr. William Ruto with the CS Roads & Transport, Nakuru County Governor and Senator, & EBK Chairman and Registrar/ CEO - during EPC 2023

EBK Chairman (right), IEK President (centre)and IEK 1st Vice President (left) - during EPC 2023

PS Roads (Centre), EBK Chairman (5th left), IEK President (4th left) EBK Registrar/CEO (5th right) and EBK board members/IEK Council Members/ACEK council members - during EPC 2023

The President of the Republic of Kenya, Dr. William Ruto with the CS Roads & Transport, Nakuru County Governor and Senator, & EBK Registrar/CEO - visiting exhibition booths during EPC 2023

The President of the Republic of Kenya, Dr. William Ruto with the CS Roads & Transport, Nakuru County Governor, PS Roads, & EBK Registrar/CEO - with foreign delegates during EPC 2023

EBK Chairman (left), IEK President (centre)and EBK Registrar/CEO (right) - during EPC 2023

IEK 1st Vice President with delegates - during EPC 2023

Mandatory Registration of Building Projects on the Engineers Projects Registration Portal (EPRP) of the Engineers Board of Kenya

To All Civil/Structural Engineers, Consulting Engineering Firms!

This is to bring to your attention that the Board has developed an on line Projects Registration Portal (EPRP), which was officially launched by His Excellency, the President, Dr. William Ruto, on 14th June during the recently concluded Engineering Partnerships Convention held in Naivasha.

The EPRP system is hosted by EBK within the Engineers Portal and is a vital initiative introduced by the Board to address the challenges faced in the construction sector, particularly with regard to the collapse of buildings. It aims to strengthen the regulatory framework and ensure that engineering projects meet the highest standards of safety and ethical standards through adherence to regulations.

As a Civil/structural engineer or firm that plays a crucial role in the construction process, you are required to activate your account in the EPRP and register all your ongoing projects by uploading relevant information onto the platform. This will enable the EBK to effectively monitor and evaluate engineering projects, ensuring their compliance and minimizing the risks associated with substandard constructions.

We Would Like to Highlight the Following Key Points:

1. Project Registration and Registration Deadline: All civil/structural engineers, and consulting firms with active building projects already approved by the counties and registered on the NCA portal to register all their projects on the EBK EPRP system by the 15th of July 2023. This includes stalled projects.

2. Design and Submission of New Projects: Going forward, all engineers/firms involved in designing and submitting new building projects must register them on the EPRP system. This will ensure that the EBK can effectively monitor compliance and maintain a comprehensive record of engineering projects across the country.

3. Support and Assistance: We understand that adapting to new systems and processes may have its challenges. Therefore, we are committed to providing continuous support and assistance throughout the registration process. Should you encounter any difficulties or have any questions, please do not hesitate to contact our dedicated support team via email address: ***info@ebk.go.ke*** or using phone numbers: ***TEL: +254-20-2719974; CELL: +254-735-330744, or +254-722-509972*** (must be official lines only)

You are invited to register your projects on the EPRP system as soon as possible before the above deadline. Kindly be advised that the Board, in collaboration with other agencies such as NCA and county governments will validate the accuracy and completeness of information provided.

We appreciate your cooperation and commitment to upholding the highest professional standards. Your active participation in the EPRP system will not only enhance your professional profile but also contribute to the safety and reputation of the engineering profession in Kenya.

Attached with this letter is a guideline procedure on how to register a project on the EPRP system.

The Board looks forward to your prompt registration of projects on the EBK EPRP system.

Procedure For Registering A Project In The EBK Engineers' Projects Registration Portal (EPRP)

To register a project on the EBK Engineers' Projects Registration Portal (EPRP), please follow the steps outlined below:

1. **Visit the EBK website: https://www.ebk.go.ke.**
2. **Click on the "Engineers Portal" tab.**
3. **Activate your account by following the prompts for account activation.**
4. **Once successfully logged in, click on the "My Projects" tab located on the left side of your screen.**
5. **Use the "Add a Project" tab to initiate the registration process for a new project on the portal.**

Note: Ensure that you are in good standing, as you cannot proceed beyond this step unless you are in good standing.

6. **Enter the project site's plot number and click the submit button to validate it.**
7. **Project Details Page: Prepare the following mandatory information to fill out the project details page:**

- Project name
- Nature of the project/usage
- Developer details: Name, email address, phone number, and address
- Physical location details: County, sub-county, geographical coordinates (latitude and longitude)
- If a consulting firm is involved, enter the name of the consulting firm
- Enter the project description, including storeys and type of construction
- Upload a contract agreement form for the supervision contract
- Submit and continue.

8. **Design Stage: Have the following information ready to fill out the Design information:**

- Architect's Name and Registration number
- Copies of structural engineering drawings
- Copies of architectural drawings
- Copy of the geotechnical report for the site
- Submit and continue.

9. **Approval Stage:**

- Attach a copy of the approved structural drawings
- Enter the County approval number
- Submit and continue.

10. **Development Stage: Prepare the following information to fill out this page:**

- NCA approval Number
- Development Commencement date
- Contractor Details: Contractor name, representative's name on-site, contractor's phone number, and email address
- Provide any other contractor's details
- Enter information about other consultants involved at the bottom of the page.

Note: On this page, the supervision engineer will update monthly site progress reports and photos. The engineer can use the (+) tab to continuously upload future reports until the project is completed and then proceed to the project closure stage.

11. **Project Closure:**

- Once the project is successfully completed, the engineer can proceed to the closure stage and submit a certificate of completion to close the project.

Please follow these steps carefully to ensure the smooth registration of your project on the EBK Engineers' Projects Registration Portal (EPRP).

Performance of Agricultural Waste as Partial Replacement for Cement in Rigid Pavement Construction

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1. Introduction

Sustainable development is the ability of a society "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs". There are three components of sustainability: the environmental component, the economical component and the societal component; of these three components, the environmental components appear to have eclipsed and assumed primacy over the other two and has become the focus of political, industrial and academic leaders all over the world. The focus understandably is driven by the spectre of the survival of the earth as a result of the depletion of ozone layer by greenhouse gases. It is estimated that 800kg of green house gases, carbon dioxide (CO_2) is emitted into the ecosystem when manufacturing one ton of cement. Therefore, sustainable, alternative and recycled materials should be taken into consideration.The humankind concern about environmental degradation and greenhouse gas emissions stressed the significance of research in finding new sustainable development to some products, among them Portland cement (OPC). It is well known that pozzolans improve the mechanical performance and durability of cementitious matrices by acting chemically and physically. Environmental benefits of essential supplementary materials include the diversion of recyclable waste from landfills for useful operations; utilization of these agricultural wastes brings about reduction in cost efficiency of cement used for concrete mix and the corresponding emission of greenhouse gases reduction in the use of energy for cement production. Cement is the most expensive component in a cubic metre of concrete; its qualities have the greatest impact on its properties. Many waste products, such as fly-ash and ashes made from various agricultural wastes such as palm oil waste, rice husk ash, and millet husk ash, have been attempted as pozzolan or secondary cementing materials over the years. When added to Portland cement, supplementary cementing materials affect the pore structure of the concrete, reducing its permeability and enhancing its resistance to water penetration and water-related deterioration such as reinforcing corrosion, sulphate and acid assault.

Supplementary Cementitious Materials (SCMs) are materials that add to the qualities of hardened concrete through hydraulic or pozzolanic action, according to the Portland Cement Association (PCA). They are commonly used in concrete to make it more cost-effective, reduce permeability, boost strength, or alter other attributes. Akhionbare (2013) investigated the use of agro-waste as a partial substitute for cement in construction projects. His results showed that bone powder ash had the highest tricalcium silicate (C_3S) composition and compressive strength; optimum strength was achieved at 10% replacement.

The application of these agricultural wastes in rigid pavement substantially improved the modulus of rupture of concrete, hence, making it resilient and more resistive to distresses. Its application in road pavement concrete construction was noted to improve the abrasion resistance of the pavement.

Researchers have demonstrated the importance of agro-waste ash by partially substituting agro-wastes for 10–30% of cement in order to generate high-strength concrete (Ismail and Waliuddin, 1996). Several researches throughout the world have confirmed the importance of agro-wastes; however, their effectiveness with high-strength concrete and under seawater curing circumstances is unknown. As a result, the focus of this research is on the potential use of rice husk ash (RHA), snail shell powder (SSP), cow bone ash (CBA) and pulverized cow bone (PCB) in high-strength concrete, as well as their performance in seawater.

2. Materials and Methodology

Ordinary Portland cement	Rice Husk Ash (RHA)	Snail Shell Powder (SSP)	Pulverized Cow Bone	Cow Bone Ash	Fine and Coarse Aggregates
The Dangote 3X Portland cement was used as a binder and was sourced locally.	The Rice Husk used passed through B. S sieve of 75 microns.	The collected shells were washed, cleaned, dried and crushed before it was blended into fine powder using commercial milling machine. It also passed through B. S sieve of 75 microns.	Pulverized Cow Bone Ash (PCB) was obtained from grounding cow bones. The cow bones, after careful removal of adhering flesh and tissues, were cleaned, sun-dried and then grounded. The passed through the B. S sieve of 75 microns.	The cow bones, after careful removal of adhering flesh and tissues, were cleaned, sun-dried, before burning passed through B. S sieve of 75 microns.	The sand used as fine aggregate was washed to remove any impurities and dried, and for this study, 20 mm maximum nominal size granite aggregate was used as coarse aggregate.

The laboratory tests conducted are presented in Table 1

Table 1: Laboratory tests conducted

Material/ Combination	Laboratory Test
Cement, Sand, RHA, SSP, CBA, PCB and Coarse Aggregate	• Sieve Analysis (Sand only). • Chemical Analysis (OPC, RHA, SSP, CBA and PCB). • Specific Gravity
Control Sample	• Workability (Slump test) • Compressive Strength, cube tests (28days, 90 days and 120days; fresh and sea water cured). • Flexural Strength test (7 and 28 days).
Modified concrete with partial substitution of cement with 0, 5, 10, 15, 20 and 30% variation of the agricultural wastes.	• Workability (Slump test) • Compressive Strength, cube tests (28days, 90 days and 120days; fresh and sea water cured). • Flexural Strength test (7 and 28 days).

In this research, 324 cubes and 216 beams were casted. Concrete was prepared by replacing cement with RHA,

SSP, CBA and PCB. The casted concrete was cured in fresh, and then sea water to induce Alkali-silica reaction (ASR) in the concrete. A Grade 40 concrete using mix ratio of 1:0.9:2.8 by weight were adopted with water/cement ratio of 0.35.

3. Results and Discussion

Specific Gravity

Thespecific gravity test result is summarized in Table 2.

Table 2: Specific gravity test results

Material	Cement	Sand	RHA	SSP	CBA	PCB	Coarse Aggregate
Specific Gravity	3.07	2.65	2.65	3.04	2.05	2.22	2.70

Chemical Analysis

The chemical composition of OPC, RHA, SSP, CBA and PCB was determined using. X-Ray Fluorescence Spectrometry (XRF Fused Bead Test). The result of the chemical analysis is presented in Table 3.

Table 3: Chemical analysis result

Compound	OPC	RHA	SSP	CBA	PCB
SiO_2	20.8	72.18	0.78	3.30	9.37
Al203	5.37	6.06	2.02	3.99	3.05
Fe203	3.41	4.21	0.78	1.48	1.47
CaO	60.38	3.12	67.19	77.31	70.87
MgO	2.68	1.16	0.93	2.22	3.89
Na_2O	0.42	1.15	1.44	1.31	2.98
K_2O	0.63	2.31	0.17	1.25	1.82
SO_3	1.81	0.31	0.24	-	2.55
Na_2Oe	-	2.47	-	-	-
C	-	2.91	-	-	-
P205	-	-	0.21	6.59	-
TiO_2	-	-	0.03	-	-
MnO				1.10	1.34
Cl	-	-	0.04	-	-
LOI	2.02	4.12	26.14	1.37	2.45

Workability (Slump Test)

The slump test result obtained is expressed in Table 4

Table 4: Slump value of fresh concrete for the different samples

Sample ID	S0	S5R	S10R	S15R	S20R	S30R	S5S	S10S	S15S	S20S	S30S
Slump (mm)	0	0	0	0	0	0	0	5	7	10	15
Sample ID	S5C	S10C	S15C	S20C	S30C	S5P	S10P	S15P	S20P	S30P	
Slump (mm)	40	70	80	85	100	0	5	7	10	15	

The result showed no improvement in the workability of concrete with the addition of RHA. It was however observed that with increase in RHA, the fresh concrete was increasingly difficult to work which confirms the findings of other researchers that RHA reduces workability which could be a result of the high water demand characteristics of RHA caused by its high pozzolanic activity. Increase in SSP content resulted in increase in workability. This may be attributed to the creation of large numbers of very tiny air bubbles, which get distributed throughout the mass of the concrete, thereby increasing workability. CBA and PCB also showed increase in slump values with increasing contents. CBA, however, showed a more significant increase in slump value compared to PCB. This may be attributed to the higher fineness of CBA compared to PCB.

Compressive Strength

Figs 1 and 2 show the compressive strength at 28days when samples are cured in fresh and sea water respectively. Under fresh water curing conditions, compressive strength increased steadily with increase in RHA and SSP up to 20% while compressive strength decreased steadily with increase in CBA and PCB contents. This same trend was observed under sea water curing conditions, except for RHA which gave optimum result at 15% partial replacement.

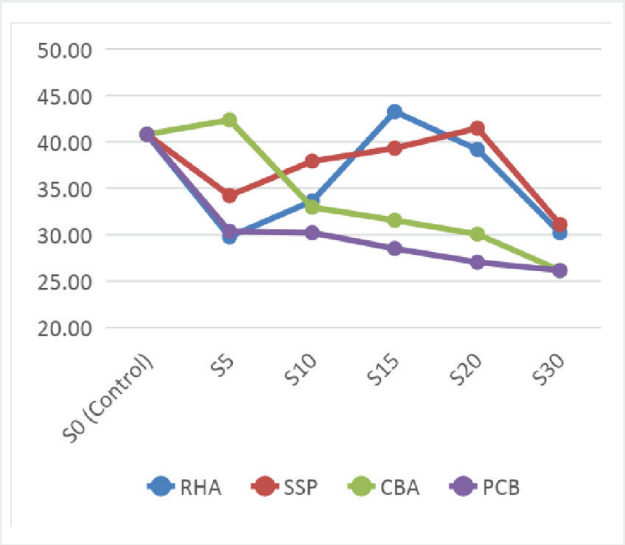

Fig 1: 28th day compressive strength under fresh water

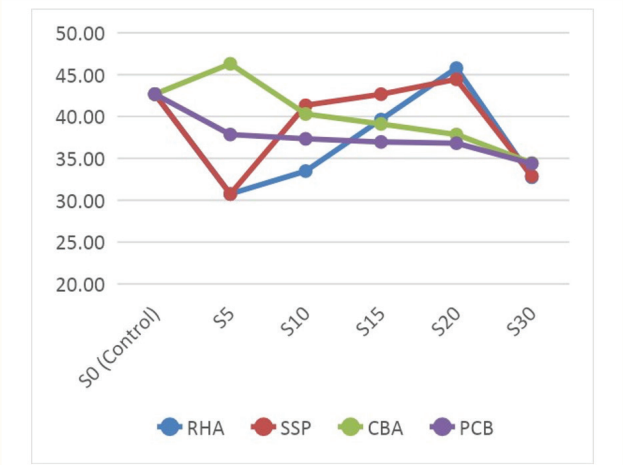

Fig 2: 28th day compressive strength under sea water conditions

From the result, RHA at 15% gave the most satisfactory result under sea water curing conditions; this can be attributed to the high pozzolanic effect of RHA which replaces the more expansive silica fume in concrete.

At 90, from Figs 3 and 4, SSP gave the highest results under both fresh and sea water curing conditions at 5% partial replacement. This may be due to the balance between quantity of cement required for CSH production and the amount of CaO present in the 5% SSP; which resulted in a much higher production of CSH which translated to a higher compressive strength. Beyond 5% content, this balance is lost and then a steady decrease in compressive strength is noticed.

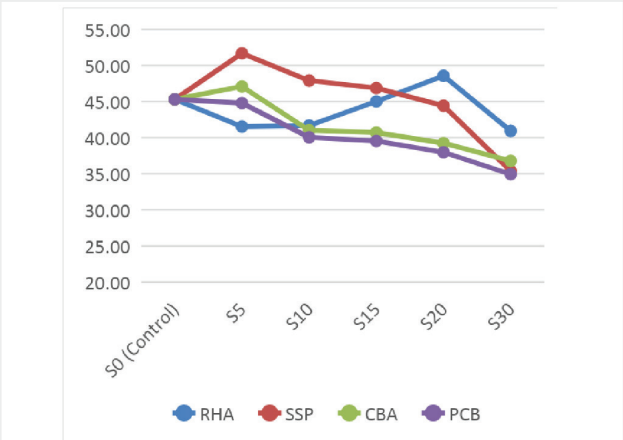

Fig 3: 90th day compressive strength under fresh water

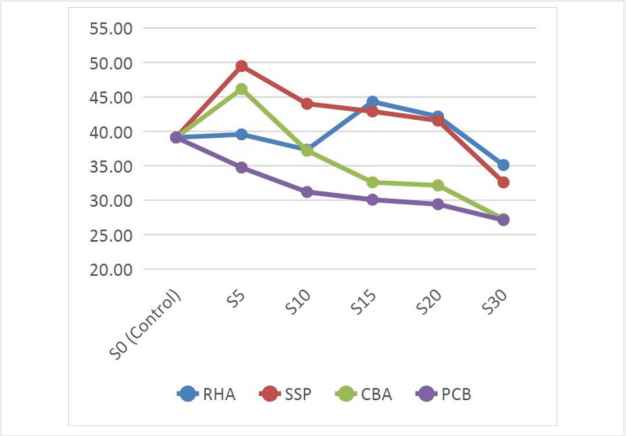

Fig 4: 90th day compressive strength under sea water conditions

Flexural Strength

The flexural strength obtained for the different SCMs and percentage replacements were higher than that of the control samples, under fresh and sea water curing conditions. At 28days, as presented in Fig 5 and 6, under fresh water curing conditions, flexural strength increased with increase in CBA up to 20%, other SCMs had optimum values at 5% partial replacement. Under sea water curing conditions, SSP and CBA gave the highest values at 5% and 20% partial replacement respectively. This considerable gain in flexural strength as observed for SSP and CBA may be due to the CaO content present in the mix producing better bonding between paste and aggregate.

4. Conclusions

The following conclusions were made from the tests and results obtained:

i. The slump result showed no improvements in workability with increase in RHA content. However, SSP, CBA and PCB did improve workability as their contents in the concrete matrix increased.

ii. Replacement of cement with Rice Husk Ash up to 20% under fresh water curing conditions increases the compressive strength of concrete, much higher than that obtained with conventional concrete at 28days, and 90days. Under sea water curing conditions, concrete containing 15% RHA had the most satisfactory result at 28days and 90days. The compressive strength of SSP-blended concrete showed satisfactory results for both fresh and sea water cured samples at 5%-20% SSP content, with most recommended values obtained at 20% SSP content as it satisfies all the curing days. Although increase in CBA and PCB led to decrease in compressive strength, 5% CBA content showed promise.

iii. RHA, SSP, CBA and PCB significantly improved the flexural strength of concrete under both fresh water and sea water curing conditions. Optimum values were observed at 5% partial replacement for RHA, SSP and PCB. 15% was optimum for CBA.

Role of Nuclear Power in Combating Climate Change

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1 Introduction

Climate change is one of the most critical environmental issues the world is facing today. According to the Intergovernmental Panel on Climate Change (IPCC), the change in climate has led to the increased magnitude and frequency of extreme weather events. In Kenya during the past 50 years, surface temperatures in Nairobi have demonstrated a warming trend of more than 2.5 ^{0}C (Government of Kenya, 2018). Globally, nearly half of the increase in greenhouse gas emissions since 1990 came from increased electricity demand (International Atomic Energy Agency, 2022). In Kenya, the emissions from the energy supply (electricity generation) sector are projected to increase significantly and be the highest of all sectors from 2015 to 2030, this is largely due to projected growth in energy demand from 8,554 gigawatt-hours in 2020 to 32,914 gigawatt-hours in 2040 as development plans such as Vision 2030 are implemented (Government of Kenya, 2018). Kenya aims to achieve Vision 2030 through a low carbon, climate resilient development pathway.

Kenya is party to the Paris Agreement which intends to keep global warming below 2°C and has developed the Nationally Determined Contribution (NDC) in reducing global greenhouse gas emissions. Initially, Kenya set the NDC to 30% relative to the Business As Usual scenario by 2030. This was updated in 2020 to a target of 32% by 2030 relative to the Business As Usual scenario (Government of Kenya, 2022). The country is also developing the mid-century (2050) Long-Term Strategy for a low carbon development pathway under the Paris Agreement. In order to track and manage the national contribution to reducing global greenhouse gas emissions, the National Climate Change Action Plan (NCCAP) 2018-2022 has been developed and it aims to reduce greenhouse gas emissions from the electricity generation sector by 21.72%. The mitigation actions include increasing the share of renewables in the energy mix, majorly the geothermal sources (Government of Kenya, 2018). Currently, renewable energy sources account for approximately 75% of the country's installed capacity.

There is a need to complement the existing renewable energy sources to meet the projected energy demand while achieving low carbon development, through alternative low carbon sources such as nuclear energy. Nuclear energy reduced acceleration of global climate warming in the past four decades by preventing the release of over 60Gt CO_2 after 1970. Currently, it is estimated that nuclear energy is preventing annual release of 1.2-2.4Gt CO_2 emissions globally (International Atomic Energy Agency, 2022). Nuclear energy can make a significant contribution to reducing greenhouse gas emissions worldwide, and, at the same time, fulfil the increasing energy demands of a growing world population to support global sustainable development.

Nuclear energy has been identified as one of the sources to meet Kenya's future electricity demand. This offers a great opportunity for Kenya to meet its emission reduction target as it is one of the energy sources with minimal GHG emissions. Adoption of nuclear power generation not only contributes to meeting emission reduction targets in

Kenya but also offers a reliable source of baseload electricity that is also resilient to climate change. The IPCC recognises that nuclear power has potential to decarbonise the global energy industry specifically in electricity generation. However, in order for nuclear energy to be expanded as a global response to climate change mitigation, there is need for greater efforts to address the safety, economics, uranium utilization, waste management, and proliferation concerns of nuclear energy use (Fischedick, 2014).

2 Methodology

The Low Emissions Analysis Platform (LEAP) is a software/ tool used for energy policy analysis and climate change mitigation assessment. The tool was used in this study to characterize national emissions of greenhouse gases and explore alternative emission reduction scenarios in Kenya's electricity supply sector. Data that was fed into the tool was obtained from the Least Cost Power Development Plan 2020 – 2040. This includes data on energy demand and generation candidates namely: hydro, biomass/biogas, wind, solar, geothermal, coal, imports, nuclear and liquefied natural gas. The study period was 20 years with the base year taken to be 2020 and optimization done from 2021 to 2040. The study period 2020 – 2040 was adopted in line with the Least Cost Power Development Plan 2020 – 2040. Three scenarios were created, all of which were compared in terms of deviation from the business as usual (BAU) case.

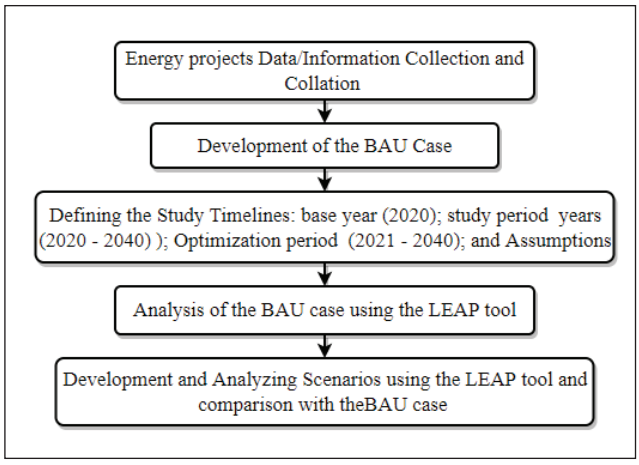

Figure 1: Summary of the methodology

The scenarios are as follows:

Table 1: Study Scenarios

SCENARIO	DESCRIPTION
1	Emissions as adapted from BAU case Versus emissions resulting from exclusion of all planned fossil-based electricity generation (coal and natural gas)
2	Emissions as adapted from BAU case Versus Emissions resulting from exclusion of planned coal-based electricity in the generation mix
3	Emissions as adapted from BAU case Versus Emissions resulting from exclusion of planned natural gas-based electricity in the generation mix

3 Results and Discussion

In the BAU case, which is the reference long term electricity generation plan, the total 20-year emissions are 17.35 million tonnes CO_2 equivalent ($MtCO_2e$). The growth in emissions is indicated in Figure 2 below.

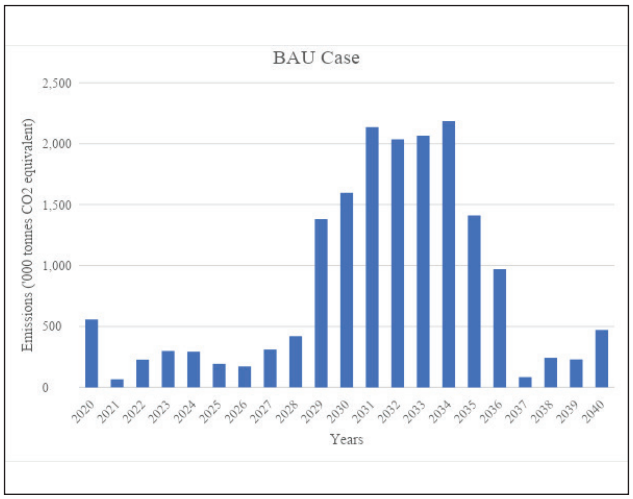

Figure 2: Business As Usual Case emission scenario

Scenario 1

The total emissions in this case are 1.76 $MtCO_2e$, which is an emission reduction of 89.87% when compared to the BAU situation. This is attributed to the removal of coal, which in the BAU model is the main source of C02 emissions. Figure 3 below illustrates the comparative examination of emissions growth.

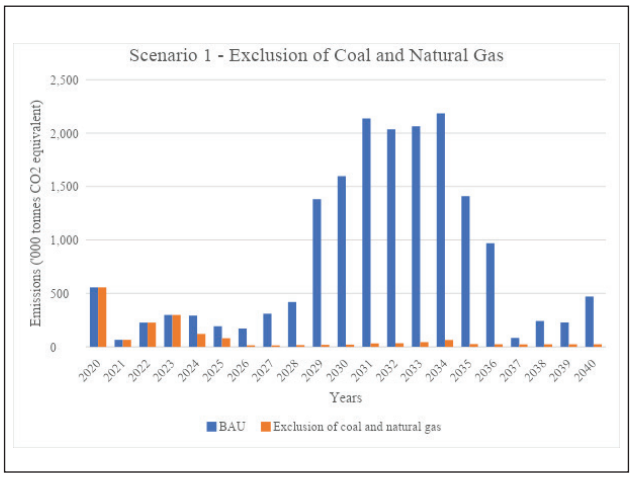

Figure 3: Scenario 1; Exclusion of Coal & Natural gas

The results also indicated that for a low carbon energy system with the removal of 981 MW of coal and 1,050 MW of natural gas, the capacity is replaced by 350 MWe of geothermal, 200 MWe of Wind, 450 MW of hydro, 160 MW of biomass and 246MWe of Solar. The total nuclear capacity is unchanged at 873.9 MW, but a capacity of 224.94 MW is brought online in 2038, instead of 2039 as in the BAU.

Scenario 2

The total emissions are 4.04 $MtCO_2e$. This is a 76.74 % emissions reduction in comparison with the BAU as illustrated in Figure 4 below. The emissions observed here are from planned natural gas generation.

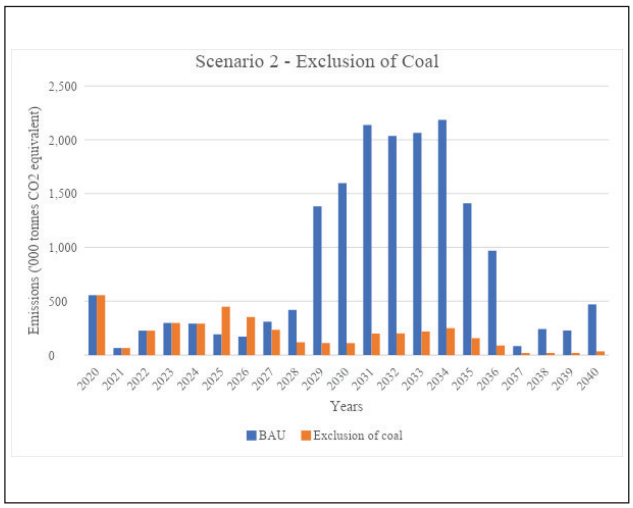

Figure 4: Scenario 2; Exclusion of Coal

Scenario 3

In this scenario the total emissions are 14.06 $MtCO_2e$. This is a 18.95% reduction in emissions growth. Compared to the BAU case this is an insignificant difference on emissions growth. This further confirms that inclusion of coal in the energy mix contributes to a significant percentage of GHG emission compared to natural gas. The growth in emissions is indicated in Figure 5.

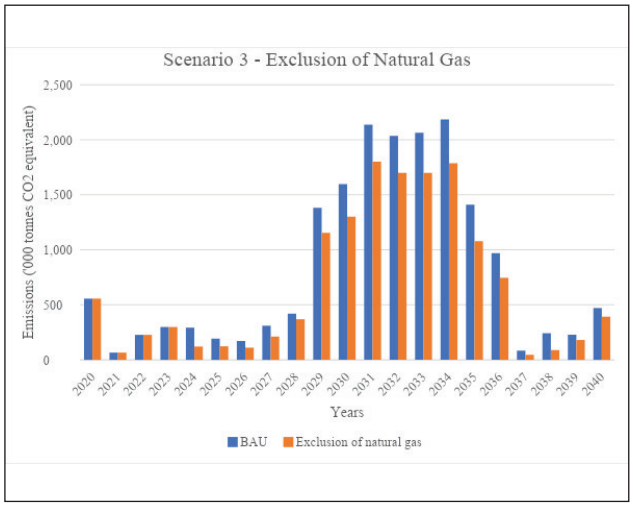

Figure 5: Scenario 3; Exclusion of Natural Gas

4 Conclusion

The assessment using the Low Emissions Analysis Platform indicates that in the future, nuclear electricity generation will play a significant role in combination with renewable sources in order to achieve a reduction in emissions in the energy sector. It is worth noting from the ongoing reactor technology assessment that, based on the forecasted nuclear generation requirements, the emerging Small Modular Reactor (SMR) technologies are expected to play a critical role. They are particularly appealing due to their novel design and desirable deployment characteristics, including: scalability, adaptability for smaller grids, modularization, suitability for cogeneration, small plant footprint, site flexibility, and load following capability. In order for nuclear energy to contribute to GHG emissions reduction in Kenya, it should be included as one of the mitigation actions in the energy sector in climate change action planning. This calls for fast-tracking the implementation of the nuclear power programme by developing the requisite infrastructure (institutional framework, human resource development, stakeholder engagement, legal and regulatory framework, research and development, technology assessment, etc.). Promotion of the coexistence of nuclear and renewable energy among the relevant stakeholders is also key, especially in research and development and policy development matters.

Acknowledgement

We take this opportunity to express our sincere gratitude to N*u*PEA which supported us throughout the course of this study. Of special mention are the members of the N*u*PEA Environmental Protection Technical Working Group for their effort. We also wish to thank the CEO, N*u*PEA for the moral and infrastructural support.

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Picture Courtesy

What is Chemical Engineering?

"The founding of the American Institute of Chemical Engineers represented the beginning of American technological dominance in the 20th century." Nicholas A. Peppas

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From contributing to research in nanomaterials and composites and developments in the energy sector, to the traditional roles in engineering design and management or process development and transport materials, a degree in Chemical Engineering, qualifies one to influence numerous areas of technology and development. Chemical engineering is the branch of engineering that applies scientific and mathematical principles to design, develop, and optimize processes for the production of consumer goods, the transformation of raw material into value-added products and utilization of chemicals and materials. The discipline studies the fundamental properties and behaviors of chemicals and materials, and the interactions between different elements and compounds, to create efficient and sustainable processes.

Birth of Chemical Engineering

During the Industrial Revolution in Europe and the United States in the 18th and 19th century, subject chemistry as a specialty flourished as new industrial processes and technological innovation became the widespread. Seminal inventions and innovations in the energy and agricultural sectors were vital for all sectors of human development and led to the creation of creating many new industries. The concept of unit operations, a method of engineering analysis in the design of plant for process industries, was a key milestone in the history of Chemical Engineering, was introduced by George E. Davis and became a fundamental principle in establishing new processes and innovations. Unit operations involves mass, energy and momentum transfer, and refer to distinct physical processes, such as filtration, distillation, and adsorption critical to various industrial processes. Davis's work laid the foundation for systematic analysis and optimization of the processes. Consequently, rising sociopolitical changes in the mid-1800s resulted in attempts to revise industrial processes with an emphasis on safer and more efficient methods. These circumstances were the basis from which the field of chemical engineering emerged.

The rapid growth of industries such as textiles, metallurgy, and food processing in the 19th century, led to a demand for engineers who could optimize manufacturing processes and improve efficiency. The early 20th century witnessed the striking rise of the petrochemical industry, driven by the discovery and exploitation of vast petroleum reserves and the knowledge of unit operations. The early practitioners of chemical engineering were primarily concerned with practical applications rather than theoretical aspects. By the end of the 19th century, competition among Great Britain, Germany, and the United States for industrial chemicals had become rather fierce, and chemical engineering expertise was in high demand. This period witnessed the establishment of chemical engineering as a distinct discipline within academia.

The textile industry was a major development in the 19th century

Formalization of Chemical Engineering as a program of study began in the 1880s, when the University College, London in 1882 introduced studies in "*Chemical Technology*", followed by the introduction of a course in *Chemical Engineering* at the Central College, later the Imperial College, London, in 1885. In 1888, Lewis M. Norton was credited with starting a new four-year curriculum in Chemical Engineering at the Massachusetts Institute of Technology (MIT). Other universities followed-suit: the University of Pennsylvania (1894), Tulane University (1894), the University of Michigan (1898), and Tufts University (1898). Each of these four-year programs in chemical engineering were housed within the chemistry department.

The first degrees in Bachelor of Science in Chemical Engineering were awarded in 1889 by Rose Polytechnic Institute and in 1891 by MIT. A year later (1892), a bachelor's program in Chemical Engineering was established at the University of Pennsylvania. Oliver Patterson Watts is recognized as being the first recipient of a PhD in Chemical Engineering in 1905 from the University of Wisconsin. In 1903 a specialized magazine The Chemical Engineer was published. It included practical articles written by practicing industrial chemists and engineers. By 1905 this magazine had a circulation of more than 1,600, including about 570 chemical engineers.

In an era where growth and development of nations were being driven by industrial innovation, the young field of chemical engineering thrived. Other pioneers in the Chemical Engineering field included Arthur A. Noyes (1866–1936) and later William H. Walker (1869–1934) contributing to the discipline achieving its prestigious position within the engineering curriculum. In England Davis, who was responsible for coining the term "*chemical engineering*" to describe this new engineering area that addressed problems of the chemical industry, published his ***Handbook of Chemical Engineering*** (1901). Although the notion of "*unit operations*" was not coined until 1915 by Arthur D. Little at MIT, Davis's textbook introduced the notion of "unit operations". Frank H. Thorpe (1864– 1932), an MIT graduate who had earned a doctorate from the University of Heidelberg, is accredited to having published the first textbook on chemical engineering, entitled *Outlines of Industrial Chemistry*.

From an Engineering Discipline to a Profession

By 1904 there was much discord among members at American Chemical Society (ACS) about the relationship between chemistry and newly emerged chemical engineering field. Milton C. Whitaker, a professor of chemistry at Columbia University, argued that a chemist was "*generally not the man who is capable of transmitting from a laboratory to a factory the ideas which he has developed*" because he lacks education "in the engineering branches." The controversy gave rise to the Committee of a Six, a group of 6 chemists and engineers, who explored the "*possibility of forming a chemical engineering organization*." After some time and much deliberation, the Committee of Six, joined by 15 other chemists and chemical engineers, in a meeting in January 1908 formed a new organization dedicated to chemical engineering. On 22 June 1908 the first meeting of the American Institute of Chemical Engineers (AIChE) convened at the Engineer's Club of Philadelphia. According to minutes recorded by William Meade, "*enthusiasm ran high*" among the 40 men in attendance. As the profession continued to grow, the UK Institution of Chemical Engineers (IChemE) was established in 1922.

Throughout the early 1900s, there was exponential growth in industrial production and the need for large-scale chemical manufacturing. Chemical engineers made significant contributions to the development of synthetic rubber, explosives, and pharmaceuticals. . Oil and energy had become indispensable resources, and chemical engineers were central in the refining process, developing processes for the production of synthetic materials such as Teflon® and Kevlar® and the advancement in subject areas such as thermodynamics and heat transfer. The unique training of the chemical engineer was essential in these areas where processes involve the chemical or physical transformation of matter.

Over the course of the 20th century, chemical engineering gradually developed a specific disciplinary identity, with greater focus on unit operations in conjunction with applied thermodynamics, chemical-reaction engineering, applied mathematics, and computer science. By mid-1970s, researchers realized that chemical engineering was not focused solely on the classical areas of the 19th century, but that the curricula meant that trained chemical engineers were equipped to make strides in interdisciplinary areas such as the biochemical and biomedical sciences and materials science.

Chemical Engineering in the 21st Century

Polymerization, isomerization and other unit operations have been ineluctable reasons chemical engineers have been at the forefront of development contributing in areas such as biotechnology, pharmaceutical technology, electronic device fabrication, and environmental engineering Chemical engineers have been instrumental in sustainability management; research in nanotechnology and high-performance materials; as well as electronics manufacturing. Developments in information technology and internet based system has resulted in advancements in process control and simulation techniques – enabling engineers to optimize processes, reduce costs, and minimize environmental impacts.

Chemical Engineering in the 21st century and beyond.

Recognizing the limited natural resources, the negative impact of developments from the industrial revolution on the environment and a need to secure a viable future for the next generations, engineering focus in the 21st century has shifted to a more global perspective; addressing climate change, energy transition, sustainability, the creation of a circular economy and a zero waste approach to development. Through technological advancements in the energy value chain coupled with a life cycle approach to energy management, chemical engineers have been effecting the systems-level thinking necessary to balance the economic and environmental trade-offs necessary for transition to a low-carbon energy system. From a sustainable approach, chemical engineers can play a part in the development of novel and new materials, complex fluids and soft matter as well as material processes, both at molecular and macroscopic scales. For example, research in polymer science and recent drives to identify more environmentally friendly plastics are areas being explored using chemical engineering principles through the application of theory - molecular-level, thermodynamic and transport concepts - modeling, simulation, experiment, and machine learning. Application of these principles may lead not only to the discovery, design, and innovation of new materials but also new materials processes. Resources such as water and agriculture (food, fertilizer and the nitrogen cycle) have been points of focus. Integrate Water Resource Management systems,

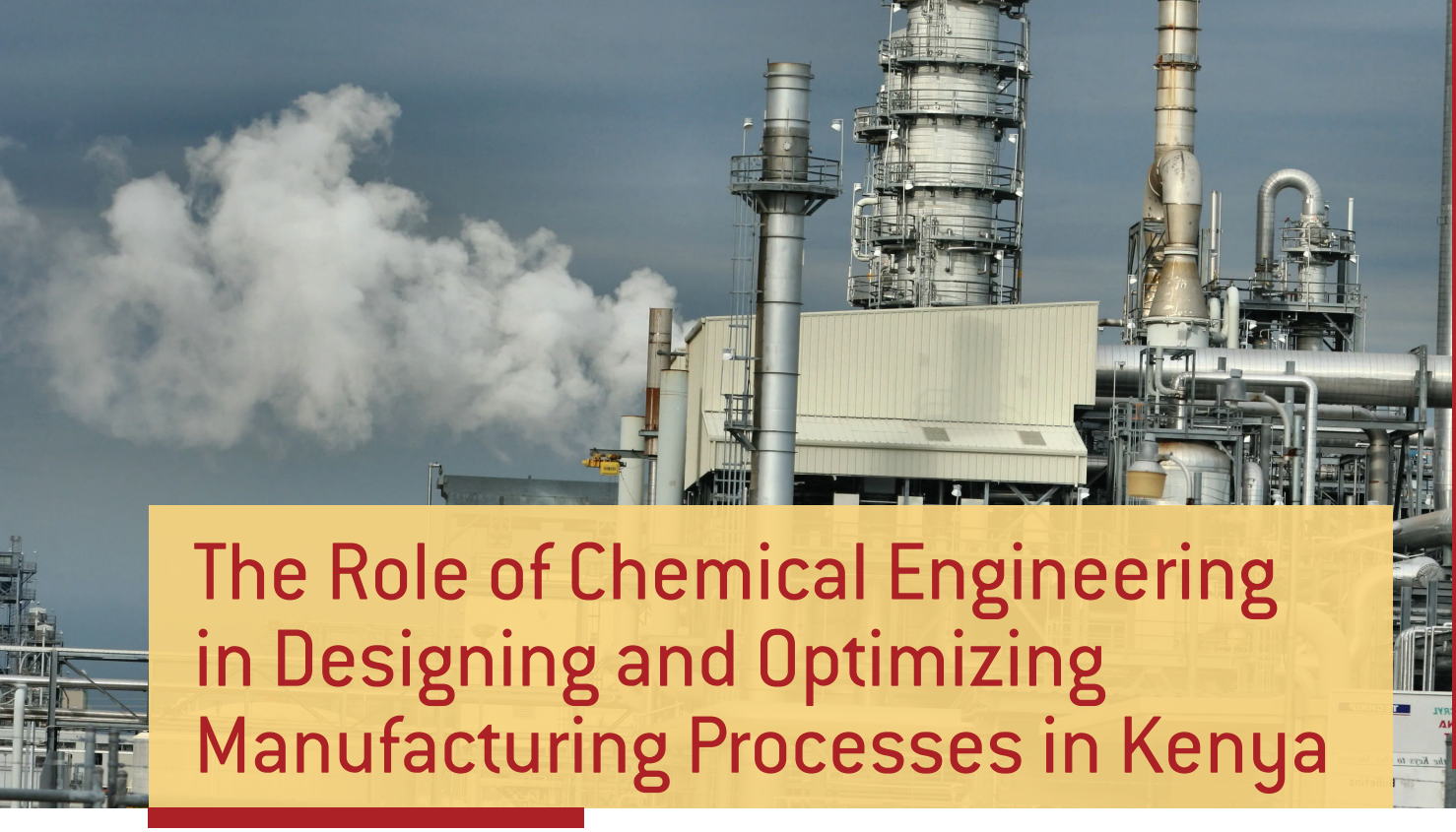
Integrated Waste Management and Integrated Resource and Resilience Plans are interdisciplinary, and cross-sector collaborations where chemical engineers play a critical role in sustainability. Improvements in distributed manufacturing and process intensification from a process design perspective, are also areas where the know-how from chemical engineers will be needed.

Additionally, subject areas such as reactor design and separations, allows chemical engineers through a systems-level approach, from the molecular level to manufacturing facilities, concomitant with other disciplines, to be central to cell engineering, formulations and various aspects of drug manufacturing. Opportunities to apply quantitative chemical engineering skills to immunology include cancer immunotherapies, vaccine design, and therapeutic treatments for infectious diseases and autoimmune disorders. The development of completely noninvasive methods for drug delivery represents an exciting frontier of device- and materials-based strategies. Chemical engineers are also well positioned to advance work with sustained-release depots and targeted delivery of therapeutics.

> *Over the course of the 20th century, chemical engineering gradually developed a specific disciplinary identity, with greater focus on unit operations in conjunction with applied thermodynamics, chemical-reaction engineering, applied mathematics, and computer science.*

Chemical engineers will continue to be in high demand in the foreseeable future. The engineering discipline cuts across most professions and job levels, and provides an excellent foundation for many career paths. Ensuring that chemical engineering curriculum is suited to preparing students for the wide variety of industrial roles is critical. Creating an environment for research, recognizing the nexus between academia, industry and research, as well as reviewing funding and opportunities, are all elemental features required for national and global development. Hilda Derrick became the first student member of IChemE in 1942, nevertheless, women and members of historically excluded groups remain underrepresented relative to their numbers in the general population. Diversifying the profession will bring valuable new perspectives, and is essential to the field's continued contribution to mankind's sustainability and development.

Factory Production Process



The Role of Chemical Engineering in Designing and Optimizing Manufacturing Processes in Kenya

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There is a common saying that Kenya needs to stop reliance on primary products exports to catch up with once on par Asian Tiger Economies. Unfortunately, the good debate usually ends there. This is exactly where chemical & process engineering begins. The only way to earn more from our export is to do value addition of our primary resources which include agricultural products and minerals. Value addition is what chemical & process is all about. It has nothing to do with too much chemistry or hazardous compounds as it is sometimes misconstrued to be.

Chemicals engineer develop processes in the laboratory and translates them into practical application for manufacturing of commercial products or for value addition of primary resources. They also oversee these processes and work to improve their performance. A chemical engineer applies engineering foundations of physics, mathematics, chemistry and biology to achieve the above objectives. In the industry, the tasks which may lay in purview of a chemical engineer may include but not limited to; designing and planning equipment layout, optimization of the performance of production processes, monitoring and continuous process improvements through research, ensuring compliance with health, safety, quality and environment regulations, incorporating safety in operation processes and managing production costs. Optimization of manufacturing process which is a key role of a chemical engineer entails; maximizing yield and productivity, energy efficiency, product quality, process safety while minimizing production costs, wastage, energy consumption, water usage, effluent's volumes, impurities released and environmentally harmful emissions. A chemical engineer maintains and improves processes and equipment through analyzing data, trouble shooting and testing.

The contribution of chemical & process engineering in the Kenya's manufacturing sector has steadily increased from lows of 1990s when the role of chemical engineers was rarely understood in our market. Today, chemical engineers work in various sectors including food manufacture (food here includes soft drinks, tea, water, sugar, flour, salt, coffee, canned foods, candies, bread, cooking oil, milk etc), petroleum sector, body care products, cement, pharmaceutical, chemical manufacture, environment, energy, mining, and consultancy among others. Well trained chemical engineers join these sectors as management trainees, production supervisors, quality management officers, product development officers, manufacturing engineers, material engineers, energy managers, water engineers, mining engineers, environment engineers, process auditors and technical sales engineers to mention but a few.

> *"Today, chemical engineers work in various sectors including food manufacture (food here includes soft drinks, tea, water, sugar, flour, salt, coffee, canned foods, candies, bread, cooking oil, milk etc), petroleum sector, body care products, cement, pharmaceutical, chemical manufacture, environment, energy, mining, and consultancy among others"*

As our country gears up to establish itself as a middle income economy, manufacturing sector will play a pivotal role in turning around the GDP and job creation. More investors are required to propel the contribution of manufacturing sector from current 7.2% to 20% GDP as per KAM's vision for 2030. The remarks by industrialization PS, Dr. Juma Mukhawana to the effect that Kenya was making a blue print on ease of manufacturing to support investors is a sign of good things for the manufacturing sector and chemical & process engineering profession. This is in line with the priority themes of the Industrialization ministry which includes; promoting agro-processing, value addition, promotion of pharmaceutical manufacture and increase of production and processing of edible oil among others.

Furthermore, in March 2023, Kenya Government and American pharmaceutical & Biotechnology Company, Moderna Inc signed an agreement to establish their first African plant for mRNA manufacturing in Kenya. As the country plans to promote manufacturing sector, the value that comes with capacity development by attracting such investments should not be forgotten. The expertise that the country shall create by locals working with these advanced technology will be instrumental in establishing the country as the top regional manufacturing hub. This is exemplified by the KenGen Company which after successful capacity building and work experience in Kenya got consultancy contracts in neighboring countries, Ethiopia and Djibouti to drill for them geo-thermal energy in 2019. This is what the country urgently requires, capacity development for value addition through promotion of investments in manufacturing sector. It can't be that a region whose entire food come from fortified ugali and chapatti flour, its entire thousands of tonnes of flour fortificants (minerals & vitamins) should be imported from South, Asia, Europe and America. Due to lack of value addition of coconuts and other farm products, farming is abandoned in parts of coast region and some farms have since become fertile grounds for breeding religious cults while the country spends billions annually on coconut oil imports from Far East and West Africa. It shouldn't be that a country full of avocados imports all avocado oil from Far East for its food and body care products after exporting avocados and most of the rest going to the dogs, literally. Such mixing tank manufacturing and repackaging value additions cannot enable the sector to achieve the desired objectives. That's why the efforts to secure UK investors partnership in April 2023 to set up an avocado oil factory in Kisii County though coming many years late should be lauded loudly and emulated.

New Developments in Chemical Engineering

Application of Artificial Intelligence (AI) in Chemical & Process Engineering.

The conventional method of solving problems in manufacturing entails use of mechanistic models and white box principle. The approach presumes that the processes follow a certain linear or predictable manner. However, most Chemical Engineering problems involve non-linear behavior which makes the classical methods of solving them difficult, time-consuming and sometimes impossible. In classical approach, the old scientific expressions "All other factors constant" and "assuming ideal case" are commonly used to escape the complexity of real problems in engineering practice. The reality is that for chemical processes, all factors are rarely constant (if so very momentarily) and ideal conditions hardly exist in real practice on this planet. Most chemical processes are complex with many variables and non-ideals. Furthermore, application of classical methods that are designed to rigidly work in a certain way, in chemical processes has limitations in that their solutions are not easily adaptable to changes in design.

Smart manufacturing is one of the advanced techniques that applies Artificial Intelligent (AI) to solve the inherent limitations of classical methods in relation to manufacturing problems. The AI approach uses black box approach, requires big data and data analytics but brings in robustness, flexibility, adaptability, simple implementation and the ease in designing of complex chemical processes. Some of the algorithms that are applied in chemical processes include; Artificial Neural Network (ANN), Fuzzy Logic, Genetic Algorithms, Expert Systems and Hybrid Systems. Artificial Intelligence can be applied in several operations of chemical manufacturing processes such as; process control, modelling, fault detection and classification which are briefly explained below.

Process optimization aims to get the best operating variables that minimizes or maximizes a desired objective in a process. This may include maximizing yields and productivity, energy efficiency, profitability and safety or minimizing wastes, costs or undesired outputs like greenhouse emissions. Due to complexities of most chemical processes, getting the optimization solution through classical mechanistic processes is very difficult. Application of AI approach like Genetic Algorithm or Particle Swam has the solution to such complex problems.

In a chemical manufacturing, process control helps to improve process performance, reduce wastes, ensure safety, improve quality and reduce environmental pollution. The classical approach utilizes conventional controllers which are limited due to parameter uncertainty and non-linear dynamics. However, the controllers based on AI can effectively control these complex processes. Some of the operations where neural network has been applied in process control include; purification processes, separation processes, reaction and thermal processes. The Inverse Model Control is one of the neural networks applied to control chemical processes.

A fault in chemical process is evident by deviation of an observable variable to unacceptable range. Faults may be caused by uncertain parameters, disturbances and instrument failure. The process of fault detection should be quick and robust. In complex processes where, there might occur several faults with some sharing fault's symptoms, the task of identifying the faults is daunting. Application of neural networks like Fuzzy Diagnoser which relates symptoms with the corresponding faults makes the work much lighter. For complex process involving many faults and symptoms, large database is required to effect the diagnosis.

Application of classical approach in chemical process modelling leads to models that are not robust for application in process design. The use of AI approach in process modelling has gained enormous interest in chemical engineering. The process requires less detailed knowledge of the process and can incorporate qualitative data of input parameters. Some of the AI algorithms that are applied in process modelling include ANN, Fuzzy Logic and Adaptive Network based Fuzzy Inference System (ANFIS).

Take-home: Things too complex to solve, change the way to solve them.

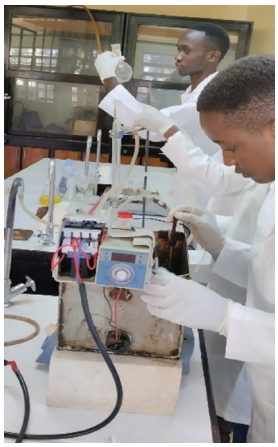
Training of Chemical & Process Engineers at Moi University

Moi University is the longest trainer of chemical & process engineers in the country. Her first cohort graduated in 1997. The department has competent professors and lecturers trained locally and abroad. Our undergraduate program is accredited by EBK and CUE as per the regulations. In addition we have a Master's program in Chemical engineering and a PhD program in Chemical & Environmental Engineering. The training of chemical & process engineers is quite costly because it requires expensive equipment, software, and laboratory material for practical work. The department has some good laboratory facilities, thanks to its industrious staff who write proposals which equip our laboratories. The university has also supported us by acquiring some useful pieces of equipment to supplement our efforts.

The School of Engineering, Moi University believes in hands on training. That's why every engineering student must undergo compulsory workshop practice after second year of study and compulsory industrial attachments after third and fourth years of study. The attachments serves to introduce the students to solving real challenges at work environment. They learn by observing and doing under guidance of industrial supervisor. It is a fact, the contribution of our industrial players in training of our students through their mentorship and facilities which no university can afford is to us of immense value, and we sincerely salute you.

Chemical & Process engineering entails conceptualizing processes, making models and scaling them up for large commercial processes. Some of the data for making the models and designs come from laboratory tests. The same way, some data for optimization may be gotten from laboratory models. That's why our training at Chemical & Process Engineering (CPE) Department is tailored to have much laboratory work. The students are taught research skills, data collection, analysis and making deductions from the same. A separate laboratory course in every semester for third and fourth years points to the seriousness of the practical work in our programs. Furthermore, the final year students are required to carry out two projects. The research project entails laboratory hands-on project. The students identify practical problem, develop a methodology for solving that problem, execute the project methodology, analyze the data and make deductions, write a report and present the work before a panel of examiners. The second is a design project that requires the students to apply all the principles learnt in entire study period in the design a process for large commercial processing.

The CPE department is in process of modernization its programs through curriculum review to incorporate aspects currently required by our customers, the industry. Looking forward as a department, we seek to establish closer collaboration with our industrial and other partners as envisaged in SDG 17, Partnership for Goals. Through these collaborations, more projects undertaken by the students and staff will be geared towards solving problems in the industry. The partnerships will also serve more to enhance our practical training so that our products remain the top cream in the region.



Chemical and Process Engineering Students in Laboratory at Moi University

Hon. Millie Odhiambo during the International women in Engineering Day Dinner held on 26th May 2023 at the Crowne Plaza hotel in Nairobi

Women Engineers Committee chair Eng. Florah Kamanja (3rd right) is joined by EBK Registrar Eng. Margaret Ogai (3rd Left) 1st VP Eng. Grace Kagondu (4th left) ,Eng. Rosemary Odhiambo (2nd Right) and others during the International Women in Engineering Day Celebrations at Daystar University.

International Women in Engineering Day (INWED) Celebrations

Mentorship Session at the Limuru Girls High school organized by the IEK Women Engineers Committee and the Engineers Board of Kenya held on 7th and 8th July 2023.

International Women in Engineering Day (INWED) Celebrations

Desalination of Water for Sustainable Development: A Non-Conservative Alternative For Conserving Scarce Water Resources

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Introduction

There is a need for good quality water for domestic, agricultural and industrial purposes all over the world. Traditional sources of water such as groundwater and water from rivers and lakes are unable to fulfil the water requirements of communities. The population of African countries is growing and the water needs of our people is increasing. So, there is a need to consider non-traditional sources of water such as sea water or recycled or reused water.

Desalination Basics

Desalination refers to the removal of dissolved inorganic solids (salts) from a solution such as water to make it free of dissolved salts (Linkov, 2002). Desalination is carried out to remove ionic contaminants such as Mg2+, Ca2+, Cu2+ and Cl- from boiler water for nuclear and fossil-fuelled power plants so as to prevent pitting, stress corrosion cracking and scaling of heat exchanger surfaces (Linkov, 2002). There are many processes of desalination. These can be classified as either processes that separate water from the solution or those that separate salt from the solution as presented below:

Classification of Saline-Water Conversion Processes (Gillam & McCoy, 1966)

1. **Processes that separate water from the solution**
    a. Distillation or evaporation
        i. Multiple-effect long-tube vertical
        ii. Multistage flash
        iii. Vapour compression
        iv. Humidification (solar)
    b. Crystallisation or freezing
        i. Direct freezing
        ii. Indirect freezing
        iii. Hydrates
    c. Reverse osmosis
    d. Solvent extraction

2. **Processes that separate salt from the solution**
    a. Electrodialysis
    b. Osmionisis
    c. Adsorption
    d. Liquid extraction
    e. Ion exchange
    f. Controlled diffusion
    g. Biological systems

According to El-Sayed (2012), the leading methods of desalting with respect to the minimisation of the cost of water production are multistage flash distillation, vapour compression and freezing. Desalination processes can also be classified in terms of method of heat transfer. Here, the major processes are membrane based and thermally driven (Ng & Shahzad, 2018). The major membrane-based process is reverse osmosis while the major thermally driven processes are based on either of evaporation or condensation (Ng & Shahzad, 2018).

As at the time of publication by Ng & Shahzad (2018), more than 150 countries produce 38 billion m3 of water by desalination per year by operating 18000 desalination plants. The desalination share (percentage) in the world as at 2018 are presented in Figure 1 below:

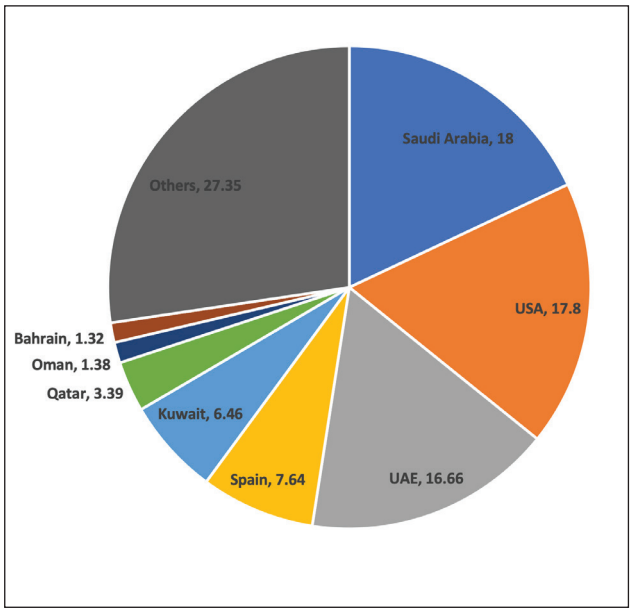

Figure 1: Desalination share in the world as at 2018 (Adapted from (Ng & Shahzad, 2018))

Sustainable Development

Sustainable development refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

Traditional approaches to the design of desalination plants paid little attention to fuel consumption but no concern for the environment or to waste management (El-Sayed, 2012). The aim is now to lower cost and improve efficiency and to design a system as a whole rather than as a sum of components.

The following research directions are recommended (El-Sayed, 2012):

1. Avoiding carbon dioxide emissions

- Desalination plants should be powered by renewable energy if carbon dioxide emission is to be avoided.
- High efficiency desalting is obtained by employing reverse osmosis desalters while lower salt content sources can be desalted by electrodialysis.

2. Reducing carbon dioxide emissions

- If fossil fuels (coal, natural gas or oil) have to be used, the solution to lowering carbon dioxide emissions is to develop higher efficiency energy conversion devices.

3. Desalination of zero liquid discharge

- Membrane desalting is a highly efficient and cost-effective process because it does not require a phase change of water – hence vast savings in energy costs.
- Vapour compression desalting has high energy costs due to a phase change in water. However, the process can be conducted using low pressure and there are less problems of clogging.

A non-conservative alternative for conserving scarce water resources

Ocean thermocline energy (also ocean thermal energy conversion) has been suggested as a means to achieve sustainable desalination to produce fresh water (Ng & Shahzad, 2018). This process uses the ocean thermal gradient between cooler deep and warmer shallow or surface seawaters to run a heat engine and produce useful work or desalination. The abundant availability of thermocline energy between warm surface water at 28 – 30 oC and deep cold water at 4 – 10 oC can be harnessed to operate low temperature multi-effect desalination to produce fresh water without a global warming impact (Ng & Shahzad, 2018). Thermocline energy projects are operational in Hawaii, Japan, India, China and South Korea but the reported amounts of freshwater produced per day are small scale, e.g., 100 m3 per day of fresh water by the National Institute of Ocean Technology of India for Kavaratti Island (Ng & Shahzad, 2018). For comparison, it was reported by Njagi (2018) that Nairobi used 500000 m3 of water per day then.

Conclusion

A number of desalination options are available. Considerations as to what type of process to select will depend on the following:

- Required capacity – a solution such as ocean thermocline energy is only able to meet small-scale desalination demands
- Plant location – it may be possible that setting up a desalination plant by a coastal site will be more economically feasible than obtaining fresh water from a dam, say, 100 km away. In the latter instance, the cost of providing pipes and pumping the water may be more expensive.
- Input – it has been observed that reverse osmosis works well for concentrated seawater while electrodialysis is suitable for dilute seawater.
- Energy cost – If energy cost is not a factor then distillation would be appropriate. Where energy cost is considered expensive, then options such as reverse osmosis would be preferable.
- Environmental impact – the various products of the desalination process need to be assessed, for example, how the resultant brine will be disposed. Also, coastal sites sometimes have sensitive environmental habitats. It may be that constructing a desalination plant in such a site could cause disruption. An environmental impact assessment may be necessary before construction work begins so that possible environmental impacts are considered and that measures of mitigation are proposed.

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Building Chemical Engineers

Author: **Prof. Nancy Wangechi Karuri, PhD**
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Role of Chemical Engineers in Solving Real-World Problems and Improving Environmental Sustainability.

The chemical engineering discipline is crucial in the evolution undergoing in the process industry as it addresses the challenges of the future. Chemical engineers are well equipped to solve the problem of scale-up; that is how new products and processes from laboratory inventions are brought to large scale production for general use. Chemical engineers are essential in the development, implementation and use of existing and new technologies that address climate change, as well as, the development of new sustainable materials, safer, affordable and effective pharmaceuticals and greener forms of energy. For example, during the COVID-19 pandemic, one of the significant challenges faced was the ease of manufacture and distribution of vaccines once successful candidates where identified. This and other questions related to scale-up were addressed by chemical engineers.

How Dekut is Preparing Chemical Engineering Students for the Industry

DeKUT's mission is to be the premier university in Kenya. Kenya's Vision 2030 manifesto envisions a rapid acceleration in Kenya to being a highly industrialized country. Worldwide, the proportion of chemical engineers positively correlates with the level of industrialization as well as rate of production of technological advancements. Solutions to global challenges require diverse sources, including the youthful and innovative manpower of countries such as Kenya. Thus, DeKUT identified a need for chemical engineers who are able to think critically and creatively in addressing national developmental goals. DeKUT consulted with stakeholders from industry and academia, both nationally and internationally, in formulating its undergraduate chemical engineering program. It also benchmarked with undergraduate chemical engineering programs worldwide.

The need for hands-on learning, creative problem solving and engagement with industry was clear from these activities. These needs were met by providing an undergraduate program with more laboratory engagement in the undergraduate courses. For example, there is a strong emphasis on reactor design and DeKUT has pilot plant reactors for laboratory studies to support classroom learning. Additionally, students are required to undergo two-12 week industrial attachment periods as part of the program. The students also undertake a two-semester capstone process design project that involves process simulation and optimization. Finally, the fifth-year project, is modeled as research problem. Students have the opportunity to learn about important aspects of research such as experimental design, the need for controls, statistical analysis as well as addressing issues of sustainability and efficiency while problem solving. For example, one of our final year projects involved development of a cost-effective protocol for isolating chitosan from tilapia scales. Chitosan is a biodegradable polymer with a number of applications in human health. This was followed by a project on producing nanofibers of chitosan through electrospinning and characterizing them.

Latest Technologies and Techniques Being Used to Ease Learning.

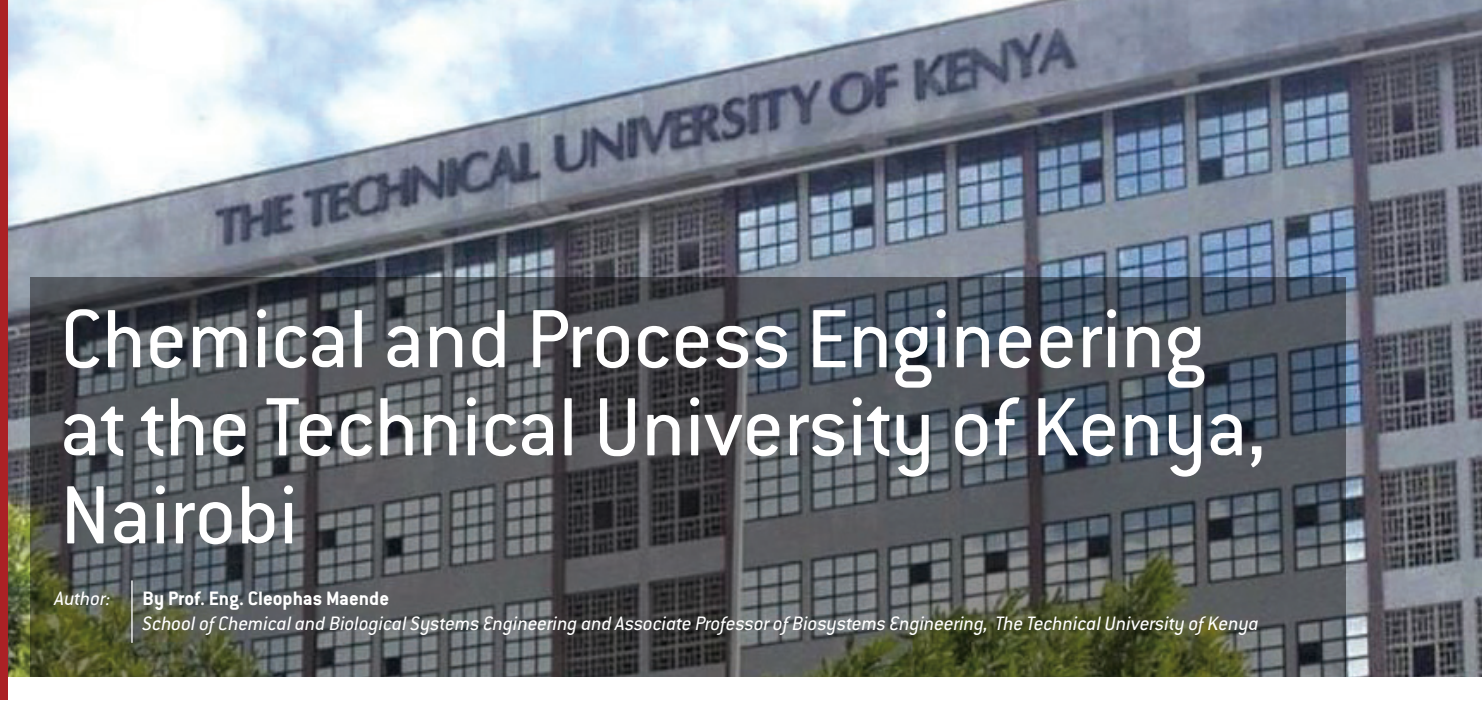
The chemical engineering program is versatile and involves blended learning; that is, both face-to-face and virtual learning. The Covid pandemic taught us that virtual learning is an important tool in learning. There is a Chemical Engineering Club at DeKUT. It offers opportunities for peer mentoring and networking. It has also been used as a platform for industrial site visits. In addition to a reactor laboratory, chemical engineering also shares a well-equipped thermodynamics and fluid mechanics laboratory.

Various Opportunities Available for Chemical Engineers in the Country and Beyond

There are opportunities for chemical engineers in the rapidly evolving industries of food processing and in the pharmaceutical industry. Furthermore, there are a number of opportunities for chemical engineers, especially in biotechnology and agricultural processing fields. These same areas also present opportunities for self-employment for new graduates. There are also opportunities for graduate level research fellowships at the MSc and PhD levels, both nationally and internationally

Challenges Faced By The Students As They Transition To The Industry And How To Navigate

The biggest challenge that students face is that the number of jobs available locally does not match the number of graduates produced. This challenge can be addressed by the students extending their job search to regional countries that value the quality of education in Kenya. Another challenge, specific for chemical engineers, is that most employers in Kenya are not aware what chemical engineers do. In Kenya, the required skill set of chemical engineers is currently being met met with a combination of mechanical engineering and industrial chemistry skill sets. This was the situation about 80 years ago in developed countries but is no more. It is possible that in the next few years, as Kenya tries to reach its industrial goals, chemical engineers will find their rightful place and make significant contributions to the national economy.



Chemical and Process Engineering at the Technical University of Kenya, Nairobi

Author: **By Prof. Eng. Cleophas Maende**
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Chemical and process engineering involves the production and manufacturing of products through chemical processes. This includes designing equipment, systems, and processes for refining raw materials and for mixing, compounding, and processing chemicals. At Technical University of Kenya (TUK), training in this profession is offered at three levels - engineer, technologist, and technician levels. The difference in these levels for all engineering professions is predominantly in what each is expected to do in the real world. The engineer is a dreamer who visualizes and dreams of designs in the relevant engineering field; the technologist is a doer who converts these dreams into reality; and the technician is a fixer who maintains engineering systems. TUK carefully equips these dreamers, doers and fixers with the right theoretical knowledge and practical skills to live up to the expectation of the profession and the demands of the industry.

The programme at TUK has three specialization areas: food processing and pharmaceutical technology; energy and the environment; and polymer technology. This article will concentrate only on a part of what the programme offers – food processing. Food Processing is the process of transforming food items into a useable form. Raw materials are processed into food via different physical and chemical processes such as mincing, cooking, canning, liquefaction, pickling, macerating and emulsification. Chemical engineering professionals who work in food processing industries deal with several processes that have been created to ensure that the food that they produce is as safe as possible. These include pasteurization, packaging, additives, purification, and dehydration.

The Future of Food Processing Industry.

Global crop production has changed dramatically in recent decades. The amount of food we grow has increased rapidly as a result of several factors: the amount of land we use for agriculture has expanded; a rapid rise in crop yields; and the diversity of diets has also increased in many countries around the world. Cereals, roots, and other staple crops once made up the majority of agricultural produce but now that has expanded into legumes, fruits, vegetables, nuts, seeds, and other foods. This trend is quite similar for Kenya as well. For example, in Kenya, food production has been growing by an average of 1.2% each year since 1966. In 2021, food production was recorded as $12.3 billion. This is set to reach $13 billion by 2026.

This increased food production requires expansion in existing industries and creation of new industries so as to cope with the increase. Also changes in diets call for modification of the processes these industries adopt. The future of the food processing industry is therefore quite bright. In this regard, the job market for chemical engineering is expanding. But the employer is always looking for that extra skill that a professional brings to the organization. At TUK, we endeavor to give that extra skill. From mathematics and basic sciences through engineering sciences and design we give sufficient complimentary units such as engineering economic analysis, industrial organization and management, culture and society, law for engineers etc and plenty of practical skills to produce a well-rounded professional ready for the job market.

Use of Automation and Robotics in Food Processing.

Technology has advanced in all spheres of our lives. Automation and robotics in the food industry are used by manufacturers to make and package food. Technology has drastically improved food packaging and this has had a direct benefit of prolonging shelf life and improving food safety. Automated packaging has also had a positive impact of the costs of production. The areas where automation and robotics play a major role is in the use of robotic arms; automated packaging systems; automated labeling systems; automated sorting systems; automated inspection systems; automated guided vehicles (AGVs); collaborative robots (cobots). Although most of these are not a direct concern of the chemical engineering professional they form part of food production practices and play a role in improving in the savings in the overall food production process. However, one which is quite unique in chemical engineering is the use of cobots. These are robots designed to work alongside humans in a manufacturing facility. Cobots can be programmed

to perform tasks that are difficult or unsafe for humans to perform, reducing the risk of injury and improving efficiency. In chemical engineering hazardous chemicals are plenty.

Increasing Efficiency in Food Production.

Any form of production relies on several aspects popularly termed as factors of production – land, capital, workforce and entrepreneurship. As a measure of how well a factor of production is utilised, efficiency in food production is increased by critically appraising these factors of production. This fact is impressed upon our students that a good design has to go beyond the aesthetics of the product and go beyond the effectiveness. It has to convert the inputs to outputs in higher ratios. Once land and capital are settled, the concentration in increasing efficiency shifts to utilising better the workforce (automate routine operations) and employs innovative ways of production (be more entrepreneurial). TUK introduces a course in entrepreneurship quite early in the training so as to equip the learners with these ideas in their learning process.

Improving Food Safety and Quality.

Packaging is one of the most effective forms of preserving food products. It improves the safety of the food by isolating the food from contamination and thereby preserving its quality. Consumers, media, regulators and industry tend to focus on the product and not on the safety of its packaging, but packaging is a critical component in the overall food safety process. Contamination and mislabeling risks at the packaging manufacturing stage are often overlooked because the emphasis on food safety usually lies in the preparation of the food itself. Our learners get to know this through a useful unit on safety and risk management.

In Conclusion

Chemical engineering professionals are in demand. All the advancements that are being made in every industry, whether the manufacturing or processing of products, heavily rely on chemical engineering to play a role. We are happy to be part of this journey at Technical University of Kenya. We are training for the real world.


Picture Courtesy

Exploring Career Options for Chemical and Process Engineers in Breweries

Author: | **By Correspondent**

The field of brewing has experienced remarkable growth and innovation in recent years, fueled by the craft beer revolution and an increasing consumer demand for unique and high-quality brews. As the brewing industry continues to expand, so do the opportunities for professionals in various disciplines. There are exciting career options available to chemical and process engineers within breweries. With their expertise in optimizing processes, ensuring quality control, and driving efficiency, chemical and process engineers play a vital role in the success of breweries. These opportunities are as expounded below:

Brewing Process Optimization:

Chemical and process engineers can contribute significantly to the optimization of brewing processes. They analyze and improve brewing techniques, ensuring consistency, efficiency, and scalability of production. By applying their knowledge of heat transfer, fluid dynamics, and reaction kinetics, these engineers enhance the mashing, boiling, fermentation, and filtration processes. They work closely with brewmasters and other experts to streamline operations, reduce waste, and enhance product quality.

Quality Control and Assurance:

Maintaining consistent quality is paramount in the brewing industry. Chemical and process engineers play a pivotal role in quality control and assurance by developing and implementing robust quality management systems. They design and monitor analytical methods to assess key parameters like pH, alcohol content, specific gravity, and flavor profiles. They also collaborate with microbiologists to prevent contamination and implement stringent hygiene practices. Furthermore, engineers contribute to the development of sensory evaluation techniques to ensure the beer meets the desired flavor and aroma characteristics.

Environmental Sustainability:

In today's world, breweries are increasingly focusing on sustainable practices. Chemical and process engineers bring their expertise to the table by developing and implementing eco-friendly solutions. They work on optimizing energy consumption, reducing water usage, and managing waste streams effectively. Engineers explore renewable energy sources, implement efficient heat recovery systems, and design wastewater treatment processes to minimize environmental impact. Their contributions help breweries achieve their sustainability goals while maintaining profitability.

Brewery Automation and Digitalization:

The rise of automation and digitalization has transformed the brewing industry. Chemical and process engineers leverage their knowledge of process control systems and data analysis to implement advanced technologies. They design automated systems to monitor and control temperature, pressure, and flow rates throughout the brewing process. Engineers also develop data-driven models to optimize brewing parameters, ensuring consistent product quality. By embracing digital tools and automation, breweries can enhance productivity, reduce costs, and improve overall efficiency.

Research and Development:

Chemical and process engineers are integral to the research and development (R&D) efforts of breweries. They collaborate with brewmasters and flavor scientists to develop new recipes, ingredients, and brewing techniques. Engineers conduct experiments, analyze data, and refine processes to create innovative and unique brews. They also explore novel raw materials and evaluate their impact on flavor, aroma, and brewing efficiency. Through their R&D endeavors, engineers contribute to the continuous growth and diversification of the brewery's product portfolio.

In conclusion, the expanding brewing industry offers exciting and rewarding career opportunities for chemical and process engineers. Their expertise in process optimization, quality control, sustainability, automation, and research and development is highly valued in breweries. As the demand for craft beers and specialized brews continues to rise, chemical and process engineers have a crucial role to play in ensuring the efficiency, quality, and innovation that define the brewing industry's success. By embracing these opportunities, engineers can contribute to the growth and advancement of this vibrant and dynamic field.


Picture Courtesy

Diageo is a global leader in alcohol beverage with an outstanding collection of brands across spirits and beer. It operates as a market-based business, with each market being accountable for its own performance and driving growth. It has a presence in 180 countries and has 132 production sites, employs over 27,000 people, and boasts a portfolio of over 200 brands. It is a major distributor of Scotch whisky and other spirits. Distilleries owned by Diageo, produce 40% of all Scotch whisky with over 24 brands, such as Johnnie Walker, J&B and Vat 69. Its leading brands include Johnnie Walker, Guinness, Smirnoff, Baileys liqueur, Captain Morgan rum and Tanqueray and Gordon's gin.

Diageo has a primary listing on the London Stock Exchange and is a constituent of the FTSE 100 Index. It has a secondary listing on the New York Stock Exchange.

History

Diageo was founded in 1997 as a merger between Grand metropolitan and Guinness, but its brands date back far earlier – some as far back as the 17th century.

In 2000, Diageo acquired majority control of East African Breweries PLC (EABL) and in the following year the group cross-listed its share on the Uganda Securities Exchange. EABL is a constituent company of the NSE 20 Share Index.

EABL is East Africa's leading branded alcohol beverage business with an outstanding collection of brands that range from beer, spirits and adult non-alcoholic drinks (ANADs) reaffirming our standing as a total adult beverage (TAB) company.

Established in 1922, EABL's extensive network of breweries, distillers, and distribution network spans across the six markets within which we operate in Eastern Africa, especially concentrated in the three core markets of Kenya, Uganda, and Tanzania. Our group's diversity is an important factor in delivering the highest quality brands to East African consumers and long-term value to East African investors. Despite operating in these key East African markets, our unique products can be found in more than 10 countries across Africa and beyond.

EABL's diversity as a robust regional company is revealed in its subsidiaries, which are: Kenya Breweries Limited, Uganda Breweries Limited, International Distillers Uganda Limited, Serengeti Breweries Limited, UDV (K) Ltd and East African Maltings Limited.

Our business model is cantered on country-specific strategies, which allow us the agility to identify and shape consumer trends, as well as respond to market dynamics to support growth. We are a proud grain to-glass business and remain steadfastly focused on:

- Producing quality beer, spirits, and adult non-alcoholic beverages (ANADs).
- Investing in responsible marketing to build aspirations for high-quality brands.
- Continuously innovating to unlock new opportunities and deliver new offerings that meet changing consumer demands.
- Transforming sales execution and extending our reach to ensure our consumers can access and enjoy our brands every day, everywhere.
- Sourcing and producing locally where viable to support local communities.
- Playing a positive role in society and delivering value to our stakeholders and shareholders.

EABL's vision is to be the most celebrated business in every market in East Africa. Its ambition is to create the best performing, most trusted and respected consumer products company in Africa.

With breweries, distilleries, support industries and a distribution network across the region, the group's diversity is an important factor in delivering the highest quality brands to East African consumers and long-term value to East African investors.

As a consumer-driven business, EABL takes time to study the market and understand consumer needs and wants as well as how best to satisfy them. That is why we constantly invest in innovating and renovating our brands to stay on par with dynamic consumer trends. This goes hand in hand with our Vision to be the most celebrated business in Eastern Africa.

Chemical Engineering in Water Treatment Operations

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The objective of water treatment processes is to reduce the relevant contaminants in raw water to the levels required for various uses, e.g., drinking, domestic and industrial uses. Chemical engineering has played a vital role in the evolution of water treatment processes over the years through the development and optimization of various techniques aimed at water treatment.

The current water treatment processes are conventional and revolve around the following key steps:

a. Coagulation and Flocculation – This is often the first step in water treatment processes whose aim is to remove suspended solids from water. Chemical engineering is applied as coagulants such as polyaluminium chloride is used to group together small particles suspended in water in order to form larger particles called flocs in a process called flocculation. These flocs settle and are removed through sedimentation. This process reduces turbidity of water and eliminates various physical contaminants including organic matter and dissolved substances.

b. Filtration – Coagulation and flocculation is followed by filtration whose purpose is to remove fine particles that may still be present in water. Different filtration methods are be employed depending on various factors and the most common method of filtration is rapid sand filters. This filtration method is utilized in AWWDA's plants i.e. Karimenu II Dam and the Kigoro Water Treatment Plants. This system of filtration is employed primarily due to its ease of operations and readily available sand material for use.

   Chemical engineering has improved filtration techniques for water treatment by development of advanced technologies such as activated carbon and membranes, to remove contaminants like organic compounds, microorganisms, and even bacteria in some cases.

c. Disinfection – Disinfection is primarily for killing pathogenic microorganisms and chemical engineering has played a key role in developing effective disinfection methods. Different disinfectants such as chlorine, ozone, and UV treatment are utilized to disinfect water. In Kenya, chlorination is the most common method used in water treatment process, e.g., in Ng'ethu and Karimenu II Dam Water Treatment Plants. AWWDA has utilized dual disinfection methods in its modern water treatment facility in Kigoro Water Treatment Plant, which includes both UV disinfection and chlorination.

Modern Applications Of Chemical Engineering in Water Treatment Processes in AWWDA Projects

Water treatment processes continue to grow with the development and adaptation of modern water treatment technologies with AWWDA at the forefront of embracing these modern technologies to improve its mandate.

Modern applications of chemical engineering incorporated in existing projects include:

a. Reverse Osmosis

A key example is seen in the Independent Water Projects constructed during the COVID-19 pandemic that improved water supply to curb the spread of the virus. Through funds provided by the Government of Kenya, AWWDA provided clean water to informal settlements within the Nairobi Metropolitan area.. Following the assessment of the water quality of each of the boreholes, AWWDA was able to employ reverse osmosis treatment processes within sites with poor quality water. Reverse osmosis was selected as the most suitable treatment process is its ease of installation as it is typically compact, and can be scaled down or up based on specific needs, hence making it suitable for small-scale application.

b. Membrane Water Treatment Technology

AWWDA has partnered with a research and development engineering company, Jiangsu Nollet Intelligent Water Equipment Co. Ltd., to develop a compact water treatment system for the expansion of the Karimenu II Dam Water Treatment Plant. The treatment plant is proposed to be expanded by 20,000m3/day to serve areas in Thika and Gatundu.

At the onset of the project formulation, AWWDA faced the challenge of limited land availability at the existing site as well as a need to seamlessly integrate the proposed new system with the existing system. A solution to this problem was found in the Eco-iGDM equipment, an ultrafiltration membrane water purification technology. The Eco-iGDM is a simple green physical separation technology with an ultrafiltration membrane of pore size between 10-100nm. The advantages of this technology are that it is capable of removing pathogenic microorganisms such as bacteria and viruses. It also utilizes no chemical reagents and occupies limited space.

Conclusions

In summary, chemical engineering has significantly advanced water treatment processes by contributing to the development of new technologies, optimizing existing methods, and providing expertise in areas such as coagulation, filtration, disinfection, water reuse, and process optimization. These advancements have been crucial in ensuring access to safe, clean water for various purposes while minimizing environmental impact. It is for this reason that AWWDA continues to embrace milestones in chemical engineering to improve its service delivery.

Institutional Background

Athi Water Works Development Agency (AWWDA) is one of the nine (9) Water Works Development Agencies (WWDA) established under the Ministry of Water, Sanitation & Irrigation. It was established under the Water Act 2016 vide Legal Notice No. 28 of 26th April 2019.

The Agency is responsible for the development, maintenance and management of water and sewerage infrastructure in the counties of Nairobi, Kiambu and Murang'a Counties covering 5,800.4Km2 with a total population of 9,320,287 people.

Controlling Greenhouse Gases and Pollution Emissions and achieving Carbon Neutrality Towards a Sustainable Future

Author: | **Dr. Sylvia Murunga**

Every year, the negative effects of climate change worsen. Every year, they cause agony and suffering to hundreds of millions of individuals around the world. Every year, they become a bigger annoyance in the present while also foreshadowing severe consequences in the future. Global industrialization, overexploitation of fossil fuels, and inadequate or non-existent waste management have aggravated the situation by increasing greenhouse gas emissions, resulting in a rise in global temperature and contributing to environmental problems. Climate change and its consequences are now a reality that humans must deal with. As a means of combating this global issue, there has been discussion on intergenerational equity and building a sustainable way of life. Because sustainability is a tough idea to grasp, there are numerous viewpoints on what it means to be sustainable.

Carbon neutrality is defined in a variety of ways; the Publicly Available Specification by the British Standards Institution (BSI PAS 2060) defines carbon neutrality as the absence of net GHG emissions during a certain period, while the Carbon Neutral Cities Alliance (CNCA) describes it as a goal of cutting GHG emissions by 80–100% by 2050 or sooner when compared to the baseline year of 1990. The two documents, BSI PAS 2060 and CNCA, are similar in their conclusions in the sense that a city's net GHG emissions should be zero at some point in the future during a predetermined period.

The UNEP's Emissions Gap Report 2022, reveals that the impact on the temperatures for the new and updated Nationally Determined Contributions (NDCs) since the twenty-sixth United Nations Climate Change Conference of the Parties (COP26) in Glasgow in 2021, has not been felt and the situation is projected to be same for by the end of this century. The unconditional NDCs indicate a 2.6°C increase in temperatures by 2100, which exceeds the goals of the Paris Agreement. Existing policies indicate a 2.8°C rise, exposing a disparity between national commitments and the efforts to implement those commitments. The emissions gap for 2030 is defined as the difference between the estimated total global GHG emissions resulting from the full implementation of the NDCs, and the total global GHG emissions from least-cost scenarios that limit global warming to 2°C, 1.8°C or 1.5°C, with varying probabilities. In the best-case scenario, full implementation of conditional NDCs and extra net zero commitments would result in a temperature increase of 1.8°C, a scenario that is currently not credible. However, just 4.5% of countries have reached carbon neutrality, and the majority still intend to do so by 2050–2070.

To achieve the goals of reducing global warming to below 2.0°C and 1.5°C, global greenhouse gas GHG emissions must be lowered by 30 and 45 percent, respectively, relative to current policy predictions. The requirement for a system-wide transformation is necessitated by the necessity for increased and hastened action if global warming is to be limited to far below 2°C. There is a need for reform in the management of several sectors, such as electrical supply, industry, transportation, buildings, and food systems. Financial system reforms are also required to finance these critical developments adequately.

The climate crisis is a component of the triple global crises of climate change, pollution, and loss of biodiversity. The world's accumulating energy, food, and cost of living challenges, exacerbated by the conflict in Ukraine, are inflicting great human misery. Degradation of the environment and global warming are the most significant ecological and environmental issues facing humanity today. Without strong international actions, legislation, and other measures, the deteriorating ecological environment will continue to impact future generations. To initiate and advance the transformation, it is necessary to avoid the lock-in of new fossil fuel-intensive infrastructure, to advance zero-carbon technologies, market structures and plans for a just transformation, and to apply zero-emissions technologies and promote behavioral change to sustain and deepen emissions reductions until they reach zero.

Food systems contribute significantly not only to climate change, but also to land-use change and biodiversity loss, freshwater depletion, and pollution of marine and terrestrial ecosystems. The food system now accounts for roughly one-third of total GHG emissions, with agricultural output, including the production of inputs such as fertilizers, contributing the most, followed by changes in land use and supply chain activities (retail, transport, consumption, fuel production, waste management, industrial processes and packaging). Adopting a food systems lens necessitates a cross-sectoral strategy that connects the supply and demand sides, as well as all actors in the food supply chain. It makes it easier to find synergies and trade-offs across interconnected environmental, health, and economic factors, but the inclusion of numerous sectors complicates emissions computation and increases the danger of duplicate counting. Shifting diets, safeguarding natural ecosystems,

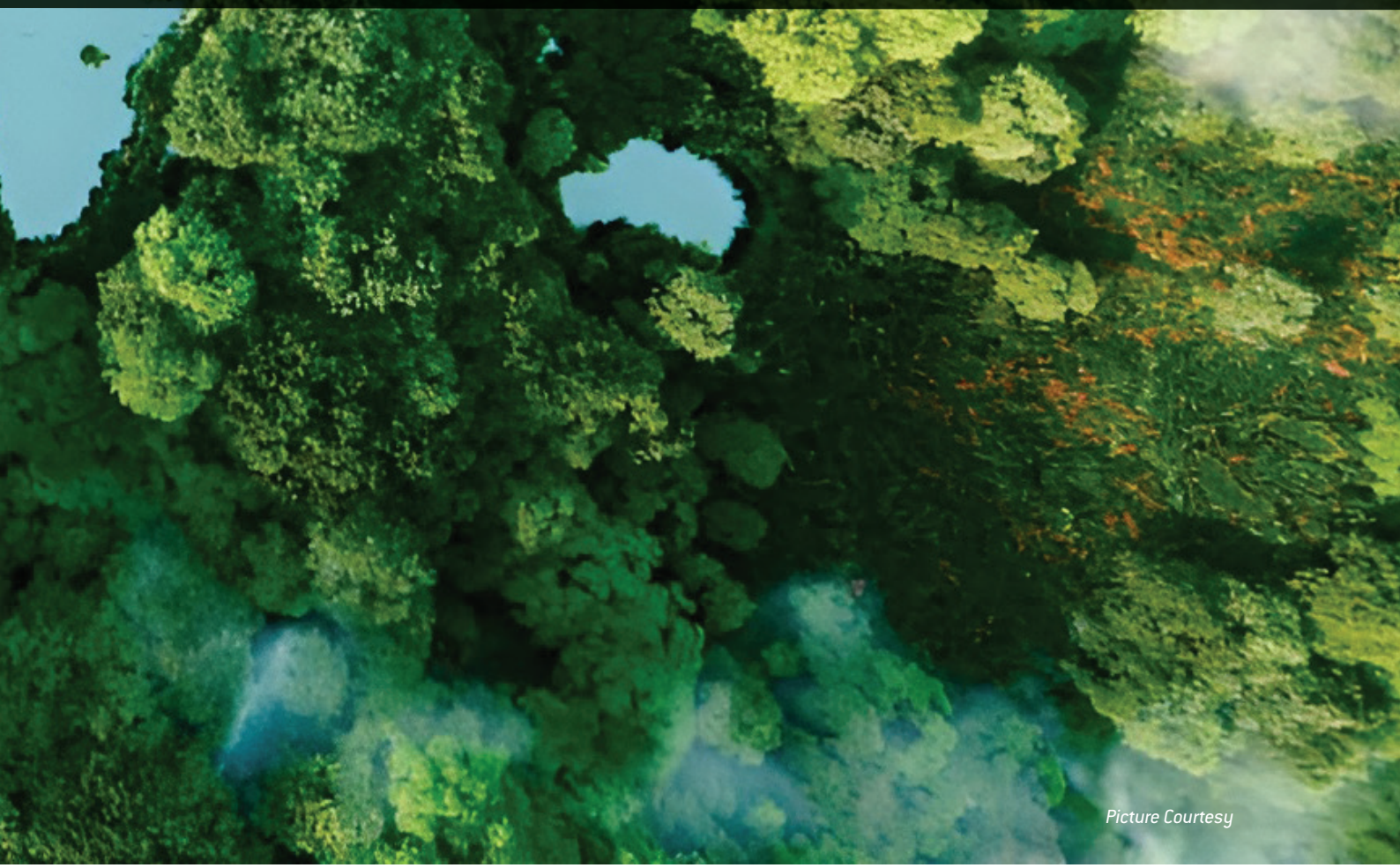
enhancing food production, and decarbonizing the food value chain are all examples of required food sector reforms, and each transformation topic contains many mitigation actions. Food system transformation is critical not only for tackling climate change and environmental degradation, but also for ensuring healthy diets and food security for all.

Realignment of the financial system is a critical enabler of the transformations needed. The financial system is a network of private and public institutions such as academic and research institutions, banks, institutional investors and public institutions that regulate the safety and soundness of the system, but also co-lend or finance directly.

Universities and other institutions of higher learning can play a significant role in shaping responses to climate change and bringing about a more sustainable future by, among other things, teaching, undertaking cutting edge research, pledging to use renewable energy and implementing climate change adaptation and mitigation strategies on campus. Achieving carbon neutrality has significant educational benefits because projects like these give tomorrow's citizens and climate leaders practical experience. Jomo Kenyatta University of Agriculture and Technology (JKUAT) takes a novel approach to carbon neutrality and sustainability by prioritizing the creation, growth, and dissemination of knowledge and the promotion of continual learning, which is clearly demonstrated through her initiatives and policies like the development of curricula and pedagogical approaches to educate the students and the society. As such, JKUAT plays her role in educating future environmental auditors, community organizers, corporate managers, engineers, practitioners, technical professionals, policymakers and, most significantly, the community about the imperatives of carbon neutrality and actions that can be taken to mitigate and adapt to climate change, while concurrently propagating social and governance measures. Over time, the cumulative build-up of societal awareness pervades and influences the practices of the corporate sector, community stakeholders, and local and national governments on how to better manage climate change mitigation and adaptation in their diverse spheres of influence, including advocacy, daily behaviors, and professional careers.

JKUAT's newly recognized Bachelor of Science in Chemical Engineering program by Engineers Board of Kenya (EBK) is meant to develop chemical engineers capable of dealing with environmental concerns. The Bachelor program is intended to produce graduates capable of developing advanced technologies, monitoring devices, modelling techniques, and operating strategies that reduce the volume and toxicity of pollutants allowed to enter the air, waterways, and soil; significantly reducing the negative environmental impact of industrial facilities, power plants, and transportation vehicles; and allowing for greater reuse of post-consumer and post-industrial waste streams.

All actors have roles to play in initiating and accelerating the transformation, including in the removal of barriers that stand in the way of progress. Actions made individually may not be enough to effect systemic change, but when combined, they can have a far greater impact.



Picture Courtesy

Tea Processing in Kenya

Author: **Dr. Nickson Kipng'etich Lang'at**
Head of the Department of Research & Development, KTDA MS Limited

1 Tea Production Overview

Tea was first introduced in Kenya in 1903 by G.W.L. Caine by and was planted in present-day Limuru. Commercialization of tea started in 1924 by Malcolm Fyers Bell, who was sent out by Brooke Bonds to start the first commercial estates. Since then the nation has become a major producer of black tea. Currently Kenya is ranked third after China and Indian in tea exports in the world. Kenyan tea is unique in many ways, one being that planting materials released to growers are carefully selected by Kenyan scientists to ensure only high quality, high yielding and pest and disease resistant elite clones are planted. The result is that Kenya tea is natural and pure as no pesticides or other chemicals are used. Kenyan tea has also consistently been certified as meeting the highest standards set by various world bodies. Kenya prides itself as the producer of the best quality black tea in the world. This is because only the choicest of the upper two leaves and a bud are hand-plucked, followed by skillful manufacture under stringent conditions at source, to ensure maximum quality and cuppage. In order to meet growing global consumer demand for black CTC (crush, tear and curl) teas, Kenya has specialized in black tea processing and has developed a wealth of expertise to satisfy these needs. Consumers recognize that tea made by the CTC method has more infusion giving surfaces and brews stronger, thicker, brighter and brisk teas, which ensures maximum cuppage per unit weight. Apart from being the world's largest exporter of black tea, Kenya also manufactures limited amounts of green and orthodox tea.

Tea growing regions in Kenya are found in the Great Rift Valley - a spectacular natural geographical wonder that divides the country almost asymmetrically. In the East of the Rift are the cool Aberdare highlands, the home to the snow capped Mt. Kenya and the panoramic Nyabene hills. In the West of the Rift defined by the Mau escarpment are the Nandi Hills, highlands and around Kericho, Mt. Elgon and the Kisii highlands. It is on the slopes of these highlands within the altitudes of between 1500, to 2700, above sea level that tea is grown. These regions are endowed with an ideal climate for tea growing. The tropical, volcanic soils rich in nutrients give the tea a unique flavour and character. The rainfall ranges between 1200mm and 2700 mm annually (Mwangi, 2013).

Currently, about 62% of the total crop in the country is produced by the smallholder growers who process and market their crop through their own management agency, Kenya Tea Development Agency (KTDA) Ltd., which is the largest single producer of tea in the world. The balance of 38% is produced by the large scale estates, which are managed by major multinational firms associated with tea in the world. The leading counties in production include Kericho, Bomet, Kiambu and Nyeri. Traditionally Kenyan tea has been sold to the market in bulk form and is much sought after by leading tea companies to blend and add taste to the most respected tea brands in the world. However, encouraged by Tea Board of Kenya, there is emerging a vibrant value-added sub-sector, led by the Tea Packers Association, which aims to provide consumers worldwide with pure Kenyan branded teas, blended at source. The main buyers of Kenyan tea are Pakistan who import about 23% of the total exports followed by the United Kingdom, Egypt and Yemen. Tea Board of Kenya in conjunction with other players in the industry are planning to roll out a strategy to win new tea markets and cut reliance on a few markets. The move is aimed at rescuing farmers from low prices.

Picture Courtesy

Tea Processing

2. Types of Made Tea

According to Tea Board of Kenya, the following are the types processed in Kenya

2.1 Black Tea

Black tea is the most popular type of tea in the world. Approximately 90% of the tea consumed worldwide is black. Like most teas, black tea is derived from the leaves and buds of the Camellia Sinensis plant. The leaves undergo full oxidization giving them the black colour. It therefore is the most processed tea.

2.1.1 Benefits of Black Tea

(i) Black tea contains antioxidants called polyphenols which help prevent DNA damage of body cells.

(ii) Caffeine in black tea increases mental alertness by mildly stimulating the brain.

(iii) Polyphenols found in black tea can help prevent carcinogenic cells hence preventing certain forms of cancer such as ovarian cancer and prostate cancer.

(iv) It contains compounds such as flavonols that prevent heart diseases.

(v) Chemicals and tannins contained in black tea help in improving body digestion.

2.2 Orthodox teas

Orthodox tea refers to loose-leaf tea that is produced using traditional (or orthodox) methods of tea production, which involve plucking, withering, rolling, oxidation and fermentation

2.2.1 Benefits of Orthodox Tea

(i) It is high in Antioxidants as compared to CTC which looses its antioxidant quality comparatively due to machine processing.

(ii) Antioxidants helps to neutralize damaged cells which help us to look and feel better.

(iii) Helps prevent Cardiovascular Disease

(iv) Loose leaf Tea has been shown to have a calming effect on the body and especially helps boost mental clarity.

(v) Loose leaf teas retain the Authentic Taste and are comparatively more rich in flavour and colour.

(vi) Loose leaf teas are organically processed thus giving it an advantage over the other in terms of quality.

2.3 Green Tea

Green tea is a type of tea derived from the leaves, buds and shoots of the Camellia Sinensis plant. Unlike black tea, it is not fermented. It has gained popularity around the world due to its many health benefits.

2.3.1 Health benefits of green tea

(i) Polyphenols found in green tea guard against the Alzheimer's disease, thus protecting the brain, especially as one gets older.

(ii) Green tea helps in weight loss. This is by increasing the rate of metabolism which leads to burning of body fats.

(iii) Catechins contained in green tea have been proven to guard against cardiovascular diseases.

(iv) Studies suggest that catechins could prevent certain forms of cancer such as stomach cancer, prostate cancer and breast cancer by preventing formation of cancerous tumors.

(v) Green tea lowers cholesterol levels in the body which in turn reduces the risks of high blood pressure.

2.4 White Tea

White Tea is derived from the leaves and buds of the Camellia Sinensis plant. It is mainly harvested once a year, before the tea leaves are fully opened. At this stage, the buds are wrapped in white hairs. The most expensive and pure of all teas, white tea is also the least processes type of tea, only undergoing withering and drying after plucking. As a result, it contains a large amount of antioxidants. White tea has a floral and delicate taste.

2.4.1 Benefits of White Tea

(i) White tea contains more anti-oxidants than any other tea which help in boosting the immune system and fighting free radicals in the body.

(ii) White tea has anti-ageing components that help in reducing wrinkles and improving the skin texture.

(iii) White tea helps in weight loss. It boosts the metabolism rate, leading to weight loss.

(iv) White tea contains compounds that may help in the fight against cancer.

2.5 Yellow Tea

Yellow tea is a type of tea derived from the leaves, buds and shoots of the camellia sinensis plant species. Yellow tea is sweet and pleasant.

2.5.1 Benefits of Yellow tea

(i) Yellow tea is rich in antioxidants which are essential in guarding against heart problems, immune system deficiencies and also protect the stomach, kidney and liver.

(ii) Yellow teas also boost the rate of metabolism which helps in weight loss and preventing obesity.

(iii) They help prevent cancer as the antioxidants and polyphenols contained in yellow tea help rid the body of cancerous cells.

(iv) It lowers cholesterol levels in the body.

(v) It helps in reducing the aging process, again due to its antioxidants and high nutrients.

2.6 Oolong Tea

Oolong tea is a type of tea derived from the leaves, shoots and buds of the Camellia Sinensis plant. It is partially oxidized. It contains a significant amount of caffeine and has a sweet flavor.

2.6.1 Benefits of Oolong Tea

(i) Oolong tea enhances mental and brain alertness mainly due to its caffeine component.
(ii) Oolong tea may protect against ovarian cancer.
(iii) It boosts the rate of metabolism, leading to weight loss.
(iv) It reduces the risk of heart diseases as it reduces cholesterol levels.
(v) It reduces the risk of high blood pressure.

3 Processing of Black CTC Teas

3.1 Harvesting or Plucking

Plucking operation is a significant step in the final quality of the tea. Usually, tender and uniform terminal bud and two shooting leaves or only shoots with three tender leaves are picked from the tea plant twice or thrice a week. Manual picking is done for high quality tea and it highly depends on the skill of the picker. Mechanical plucking of tea leaves is also practiced but it results in large quantities of broken leaves and partial flushes. However, mechanical harvesting at right time can yield high quality teas. To attain high quality standards plucking of coarse leaves is strictly avoided.

3.2 Withering

The plucked tea leaves are subjected to withering for initial removal of moisture content. Two methods of withering are generally practiced. Natural and artificial withering. In natural method, the freshly picked tea leaves are spread out in very thin layers on wire meshed racks that are mounted on troughs. Tea is subjected to drying in natural air for a minimum period of 20 to 24 hours. In artificial Withering, the plucked tea leaves are widely laid in 18 to 20cm layers on a surface/ table with wire meshes that are placed or mounted on a trough in which forced circulation of warm air mixed with fresh air takes place. This method of withering significantly causes a reduced withering time, resulting in approximately 60-62% residual moisture reduction rendering the withered tea leaves suitable for tea processing.

3.3 Breaking Up

Breaking up is the process of rolling and twisting of withered tea leaves which is a pre-preparation step. This is done with the use of a horizontal barrel with a feed hopper at one end and a perforated plate at the other end. Forced through the barrel by a screw – type rotating shaft fitted with vanes at the centre, the leaf is distorted by resistor plates on the inner surface of the barrel and is cut at the end plate, thereby causing the withered leaves placed in the jacket to twist and roll.

3.4 CTC Method (Crushing, Tearing and Curling)

CTC machine comprises of two metal rollers that are separated but placed with small clearance between each other that revolves at unequal speeds. This movement cuts, tears and twists the withered and broken up tea leaves. As a result, the juice from the tea leaves are pressed to the surface of the leaves, which initiates the fermentation process. The crushed leaf is called *dhool.*

3.5 Fermentation

Fermentation commences when leaf cells are broken during CTC operation and continues when the leaf is spread on the fermentation trays under controlled conditions of temperature, humidity, and aeration. The actual process is a series of chemical reactions. The most important is the oxidation by polyphenol oxidase of some polyphenols into compounds that combine with other polyphenols to form orange-red compounds

called theaflavins. The theaflavins react with more units to form the thearubigins, which are responsible for the transformation of the leaf to a dark brown or coppery colour. The thearubigins also react with amino acids and sugars to form flavour compounds that may be partly lost if fermentation is prolonged. In general, theaflavin is associated with the brightness and brisk taste of brewed tea, while thearubigin is associated with strength and colour. Larger boxes are used in trough fermentation, and in continuous fermentation the leaf is spread on trays on a conveyor system. In all of these fermentation systems the leaf is aerated by forced air (oxygen being necessary for the action of the enzymes), and it is brought by automated conveyor to the dryer.

3.6 Drying

Drying is an important part of tea manufacture, where enzyme reactions in earlier phases are terminated by heat and moisture loss, and new compounds are produced by the action of heat. The process also makes the tea leaves shelf stable and enhances their flavor. Drying is an energy intensive process in the tea factory. It consumes 3.5–6 kWh of thermal energy per kg of made tea. Oxidized dhool is conveyed into the dryer where it is dried by way of hot air blown through the tea which becomes suspended in the air (fluidized), so as to give rapid and even drying. Fluid bed drying has been recognized as a gentle, uniform drying method capable of drying down to very low moisture content with a high degree of efficiency. The tea takes about 20 minutes to progress through the dryer with average moisture content of 3 to 5%. At the same time, the dryer extracts excess fibre (due to stalks in the green leaf) from the dried tea, as the fibre is lighter than the leaf; the particles of fibre are blown into cyclones situated at the top of the dryer. Fluid Bed is designed to dry tea particles as they float on a cushion of air or gas. The process air is supplied to the bed through a special perforated distributor plate and flows through the bed of solids at a velocity sufficient to support the weight of particles in a fluidized state. Bubbles form and collapse within the fluidized bed of material, promoting intense particle movement. In this state, the solid tea particles behave like a free flowing boiling liquid. Very high heat and mass transfer values are obtained as a result of the intimate contact with the teas and the differential velocities between individual particles and the fluidizing air. For static bed driers, the tea particles effectively dry due to blast of hot air and fluidization process. Vibrating bed drier has its advantage of keeping the material in a live fluidized state during this transitionary phase.

3.7 Sorting and grading

The tea is sorted using a number of machines connected one after another. The first machine consists of a series of rollers that roll over felt to pick up a static charge. This removes all the fiberous material that comes off the tea. These are also fannings but these ones are smaller and are sometimes used to blend into teabag tea. The next machine is a series of vibrating sieves used to remove the small grades known as dust. At the end of this machine the grade that is left is Broken Pekoe. Depending on the grades being targeted, further fine grading may be employed. The teas are then moved into large storage bins before packing into sacks. Along the way there are ferrous magnets positioned along the conveyors to make sure there is no metallic contamination to keep in line with international standards. The teas are tasted every hour for quality control and because the whole process takes two hours they can check on each batch and remove any batches that are defective.

In general, the following are the grades obtained at end of the sorting process:

1. *Primary Tea Grades*
- Broken Pekoe 1(BP1) is the largest size particles. Liquors are light in colour but have an encouraging flavouring characteristic.
- Pekoe Fanning 1(PF1) is made up of black grainy particles slightly smaller than the BP1.
- Pekoe Dust (PD) is often black and finer than the PF1 and has thick liquors and aroma.
- Dust 1(D1) is made up of the smallest particles and characterised by strong liquors.

2. *Secondary Grades*
- Dust (D)-Made up of tiny bits of broken leaf often used to brew strong tea.
- Fannings & Broken Mixed Fanning (BMF)-Fibrous lots with very little trace of black teas.

3.8 Tea Sales and sampling

Although tea sales vary with tea companies, most of the tea is sent to auction in Mombasa, the world's largest tea auction. On average 4kg samples are taken from each batch and sent to agents in Mombasa, where they in turn send out a sample to their prospective buyers. Tasting reports made at the factory and by the agents are compared and used to make sure the quality is good enough. If a buyer likes an invoice they can go to the auction platform to bid on it. The factory may also trade directly at prices that are set on the averages from the auction.

4. Challenges and Opportunities

4.1 Challenges facing tea farming in Kenya:

Despite being a significant agricultural activity, tea farming in Kenya faces several challenges, including:

1. Climate change, which has led to erratic weather patterns, affecting tea yields and quality.
2. Pests and diseases, which can cause significant crop losses if not managed properly.
3. Lack of access to credit and financial services, which limits the ability of small-scale farmers to invest in their farms.
4. Access to modern technology along the tea value cahin
5. Poor infrastructure, which makes it difficult to transport tea from the farms to the markets.
6. Fluctuating tea prices, which can affect the income of tea farmers and the profitability of the industry.
7. Culturally driven land management practices which are rapidly rendering tea farming uneconomical

4.2 Opportunities in tea farming in Kenya:

Despite the challenges, there are several opportunities for tea farming in Kenya, including:

1. Expansion of tea production to new regions and countries, which can increase the global tea supply and demand.
2. Adoption of new technologies such as precision farming, which can improve tea yields and quality.
3. Diversification of tea products, such as flavored and specialty teas, which can increase the value of tea and create new markets.
4. Promotion of sustainable tea farming practices, such as organic and fair trade tea production, which can increase the demand for Kenyan tea in international markets.
5. 5. Improvement of infrastructure, including roads, railways, and ports, which can make it easier and more cost-effective to transport tea from the farms to the markets.
6. Sustainable production of bioenergy fuel wood substitutes (especially sustainably-produced agriculture and forestry residues) to diversify energy supply, reduce pressure on Kenya's forest resources and enhance sustainability credentials for discerning international markets.
7. Introduction of tax breaks and other fiscal incentives to reduce the cost of importing modern, efficient machinery for the processing and conversion of biomass fuels to thermal energy, to promote and ensure the clean and sustainable use of bioenergy in the tea sector, Kenya's largest foreign exchange earner and leading rural employer.

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Picture Courtesy:

STUDENTS' VOICES

Chemical engineering is not only a lucrative profession but also a tool that allows you to actively take part in this constantly evolving world. From new scientific discoveries to emerging grand challenges, nearly every day, there are problems to be solved that require the skills acquired in this field. Chemical engineering equips one with scientific and technological knowledge and practical skills such as analytical thinking and problem-solving that can be used to identify and solve problems and find efficient and durable solutions. With a chemical engineering degree, one can venture into biotechnology, oil and gas, nuclear energy, polymers and plastics, food, environment, and even business among many other careers. It is therefore quite clear that demand for chemical engineers is high and still growing as the world continues to advance to be able to blend into multiple fields and still create meaningful change is the most efficient skill one can have in this era in time if you ask me.

Name: Moses Kiteto Kayanda
Age: 23
Course: Chemical and Processing engineering, Moi University
Year of study: 4th

Chemical engineers play a vital role in developing and improving industrial processes, ensuring their efficiency, safety, and environmental sustainability. They are involved in areas such as process design, equipment selection, process optimization, and development of new materials and products. Chemical engineers also focus on understanding and controlling chemical reactions, heat and mass transfer, fluid flow, and separation techniques.

Chemical engineering offers a diverse range of career opportunities, from research and development to production, project management, and environmental consulting. It requires strong problem-solving skills, analytical thinking, and a solid foundation in mathematics and science. The field continually evolves as new technologies and challenges arise, and chemical engineers are at the forefront of innovation, driving advancements in industries that impact our daily lives. As students the diverse knowledge provides various opportunities to us as we can apply our skills in many different industries. As we prepare for the industry, we are confident that we have adequate skills that when given the opportunity, we shall contribute immensely towards the economic growth of this country.

Name: Shalom Mwendwa
Age: 23
School: The Technical University of Kenya
Course: Chemical & Process Engineering
Year: 4th

My name is Esther Mutheu and I am an undergraduate student at the Technical University of Kenya (TUK) pursuing a Bachelor of Engineering (chemical engineering). I am currently in my fourth year. I would love to specialize in Food Processing and Pharmaceuticals Technology during my final year.

The Technical University of Kenya offers a wide range of opportunities in terms of the study programs it offers. Chemical engineering is one of the disciplines of engineering offered at TUK. The program has three specialization areas: Food processing and pharmaceuticals technology; energy and environment; and finally polymer technology.

Chemical engineering being one of the best courses offered at TUK is at the heart of Kenya's vision 2030. For this dream to be realized, Chemical Engineering must play a key role. The Chemical Engineering program at TUK is designed to enable students develop concepts and discoveries in laboratories. Some of the concepts learned that can be applied to a real-life situation in industries include Industrial Chemical processes, various separation techniques, equipment design, chemical process optimization, Process control, and process simulation.

Name: Esther Mutheu
Age: 23
Course: Bachelor of Engineering (Chemical Engineering)
Year of study: 4th

I'm Tracy Muhonja Munetenyi, a twenty-year-old student from the Technical University of Kenya (TUK), where I just finished my second year in my Bachelor of Technology in chemical engineering degree and progressing to my third year in September 2023. I am eager to continue learning more about my course in the next semester and also engage in more practical work.

I am honored to be studying chemical engineering at TUK as it is one of the best in chemical engineering. The lecturers deliver the course content effectively accompanied by assessments and assignments to ensure complete mastery of the content. Also, the university has a program known as industrial-based learning where we visit workshops and get to even have more knowledge and experiences about my course. The workshops have the necessary equipment that we get to familiarize ourselves with after theoretical concepts in class.

Name: Muhonja Munetenyi
Age: 23
School: The Technical University of Kenya
Course: Chemical & Process Engineering
Year: 2nd

IEK Membership Report

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK council at its 510th,511th and 512th council accepted the following members under various membership categories as shown below;

MEMBERSHIP CLASS	NUMBER ACCEPTED - 510TH COUNCIL	NUMBER ACCEPTED - 511TH COUNCIL	NUMBER ACCEPTED - 512TH COUNCIL
FELLOW	-	1	-
CORPORATE	15	69	45
GRADUATE	401	46	28
GRADUATE ENGINEERING TECHNOLOGIST	2	14	5
GRADUATE ENGINEERING TECHNICIAN	13	10	2
STUDENT	72	40	-
TOTAL	**503**	**180**	**80**

During the period we had 1 member who transferred from the class of Corporate to Fellow member and 129 who transferred from Graduate to Corporate member. In addition we had 475 graduates, 21 graduate engineering technologists, 25 graduate engineering technicians and 112 students were accepted as members.

Gender Data

Class	Male	Female	Percentage (Male)	Percentage (Female)
Fellow	1	-	100%	-
Corporate	114	15	88%	12%
Graduate	374	101	79%	21%
Graduate Engineering Technologist	19	2	90%	10%
Graduate Engineering Technician	23	2	92%	8%
Student	90	22	80%	20%
TOTAL	621	142	81%	19%

Summary

Gender	No	Percentage
Male	621	81.%
Female	142	19%
	780	100%

510TH APPROVAL

CORPORATE

S/N	NAME	MEMBER.NO
1	Amos Onchiri Onchari	M.10832
2	Chepkwony Kiprotich Bore	M.8674
3	Christine Nanjala Mauka	M.4336
4	Dennis Mwenda Kinyua	M.9130
5	Francis Muchiri Nyagah	M.11413

S/N	NAME	MEMBER.NO
6	Fredrick Gijo Haribae	M.5940
7	George Ngugi Ngomi	M.4890
8	Gideon Ashira Ndeti	M.7808
9	Joshua Mboga Oliech	M.3100
10	Kevin Mangula Simiyu	M.8817
11	Nyang'au Bisawa Lynner	M.8155
12	Patrose Sempeyian Leshinka	M.10734
13	Sharon Selein	M.7853
14	Daniel Wanga Odongo	M.6250
15	Noah Sindani Muyundo	M.7489

511TH APPROVAL

FELLOW

S/N	NAME	MEMBER.NO
1	Kung'u Ndung'u Ndung'u	F.1999

CORPORATE

S/N	NAME	MEMBER NO.
1	Kevin Were Owuor	M.11096
2	Elijah Owino Ochieng	M.8621
3	Denis Nicholas Mugendi Mutegi	M.3431
4	Wilson Omondi Odhiambo	M.8724
5	Samuel Mwangi Njigua	M.7972
6	Jacob Manyange Andama	M.9068
7	Alex Maina Kiai	M.6866
8	Abdulaziz Abdullahi Ahmed	M.6766
9	Ferah Ambuka Oputi	M.5625
10	Phoebe Kanini Kimasyu	M.7955
11	Sheila Muthoni Kabiru	M.6742
12	Mathew Ochieng Otieno	M.10435
13	Osuma Aggrey Odiwuor	M.7997
14	Vincent Odhiambo Odhiambo	M.9790
15	Faith Muthee Mutiso	M.7047
16	Michael Mogaka Momanyi	M.6707
17	Brian Odongo Maomond	M.8417
18	Dickson Bengua Mupe	M.6900
19	Sammy Ombogo Mayaka	M.9004
20	Josephat Njoroge Mbugua	M.5041
21	Raymond Kibon Kurgor	M.7390
22	Kelvin Wambugu Ngure	M.9656
23	Rachel Wangoi Kimingi	M.8230
24	Andrew Gitau Gathekia	M.5168
25	Josephat Obwoge Bangi	M.11221
26	Alpesh Vijay Valji	M.9569
27	Edwin Muriithi Mugi	M.7912
28	Kennedy Ochieng Okuku	M.7597
29	Pancras Obiri Abere	M.7128
30	Kate Anne Mukangula	M.8081
31	Hellon G Otieno Ogallo	M.7911
32	Martin Mutoro Wanyama	M.8850
33	John Mwangi Thitai	M.8806
34	Lydia Mugure Nyingi	M.7219
35	Richard Kiptanui Kibet	M.5340
36	Kennedy Mukewa Wafula	M.6626
37	Wycliff Muriuki Mutabari	M.8431
38	Wycliffe Oiroka Onkundi	M.7643
39	Zachariah Karuchiu Chiira	M.9206
40	Kevin Simiyu Wafula	M.5444
41	James Muchivunze Luvonga	M.9393
42	Muge Aaron Otucho	M.9371
43	Abdikafar Mohamed Bulle	M.9233
44	Elvis Njenga Kimani	M.5794
45	Ayora Ondieki Dominic	M.7533
46	Wellington Moses Abwok	M.8031
47	Caroline Mongina Matara	M.7401
48	Joseph Kung'u Muthoni	M.10730
49	Ronald Okabose Ogello	M.7970
50	Onesmus Mutisya Kituku	M.6509
51	Lucas Chego Asoti	M.6243
52	John Karanja Njuguna	M.687
53	Festus Kipkoech N'geno	M.12554
54	Pius Kariuki Ndege	M.6771
55	John Githua Njambi	M.7668
56	Nyamweya David Ondari	M.8312
57	Peter Otieno Opiyo	M.9281
58	Kenneth Kipkorir Cherono	M.8179
59	Christine Chepkirui	M.8079
60	Bartocho Kiptoo Kiplagat Evans	M.5562
61	Martin Kinyua Ngunyi	M.8477
62	Anthony Mwaura Ndungu	M.4319
63	Edna Nyanchama Ongwenyi	M.6765
64	Samuel Mugo Kimani	M.4470
65	Gordon Onyango Onjore	M.5842

S/N	NAME	MEMBER NO.
66	Daniel Okinyi Ouma	M.9836
67	David Muli Saani	M.7870
68	Aaron Mutua Maleve	M.5060
69	Evans Kiptoo Koech	M.4882

512TH APPROVAL

CORPORATE

S/N	NAME	MEMBER NO.
1	Abednego Matui Kyalo	M.7800
2	Thilange Munjuri Acquilino	M.9870
3	Agnes Wangui Wanjiku	M.7400
4	Alex Ngibuini Mwangi	M.7850
5	Allan Anusu Kamaliki	M.9176
6	Anthony Njau Gitau	M.9175
7	Argwings Oyoti	M.2411
8	Beryl Akinyi Sewe	M.7042
9	Caleb Mwangi Chege	M.7797
10	Eliud Kimtai Chepkoech	M.8782
11	Kiplangat Erick Ronoh	M.10442
12	Evans Mayaka Okibori	M.10709
13	Faiza Wambui Mbugua	M.11624
14	Felix Tebangura Ono	M.11412
15	George Muhugu Kamau	M.8138
16	Henry Leslie Muchai	M.7086
17	Hesbon Moriasi Okari	M.7175
18	Hillary Otieno Aseno	M.10941
19	Hussein Dagane Hassan	M.8490
20	Jairus Ngote Waka	M.10981
21	John Wanjihia Karuku	M.11020
22	Josphat Gacheru Kariuki	M.9259
23	Julius Owino Odhiambo	M.8635
24	Kelly Mungai Kigundu	M.8020
25	Kerio Kipkoech Bore	M.8987
26	Kiprotich Joshua Bii	M.7905
27	Magdalene Nafula Otieno	M.8480
28	Marclus Kiranga Nimrod	M.6760
29	Mark Rwigi Kibe	M.6122
30	Maryanne Nduku Munyao	M.8291
31	Michael Kavulya Musyoki	M.7493
32	Michael Mutunga Kilonzo	M.7264
33	Millicent Phyllis Ajiambo	M.7183
34	Philip Osiemo Mogire	M.3703
35	Maurice Wabwile Marango	M.5173
36	Peter Kimeli Too	M.6037
37	Samuel Alal Oketch	M.2023
38	Samuel Ottiah	M.8220
39	Stephen Mutisya Muthui	M.10611
40	Stephen Onyango Ongalo	M.8570
41	Tom Mutugi Namu	M.10072
42	Violet Kavindu Kaswii	M.7123
43	Kennedy Emund Odhiambo Odwaro	M.10481
44	Martin Muthima Githinji	M.8294
45	George Yonah Nyamanga	M.11504

The council invites Engineers and affiliate firms to apply for membership in the various membership classes, kindly follow the link members.iekenya.org to register or scan the QR Code below to apply for membership;

Deceased Members:

1. **Eng. Fanuel Dirack Tsuma**
2. **Eng. Renson Indeche**
3. **Martha Wanjiru Ngochi**

The IEK condoles with family and friends of our members who have passed away in the recent past. May their souls rest in peace.

"Death is not extinguishing the light . It is putting out the lamp because the dawn has come."

SHE For She Engineers program

2ND CALL FOR MENTORS

She For She Engineers program:

1. Network and share job opportunities
2. Assign a coach/ mentor to young women Engineers
3. Drive women engineers membership growth

CLICK HERE TO REGISTER AS A MENTOR

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30TH IEK INTERNATIONAL CONVENTION
Engineering a New World

In Partnership with

ENGINEERS BOARD OF KENYA
Enhancing Professionalism

WCCE
WORLD COUNCIL OF CIVIL ENGINEERS

30TH IEK INTERNATIONAL CONVENTION

Theme:
Engineering a New World

DATE:
14th - 17th November 2023

VENUE:
Pride Inn Paradise Beach Resort Convention Centre and Spa in Mombasa

FULL CONVENTION PACKAGE:

	IEK Member in good standing	IEK Member not in good standing*	IEK Non-Member
Physical Attendance			
Early Registration (before 1st October)	Kshs. 40,000	Kshs. 45,000	Kshs. 45,000
Late Registration (after 1st October)	Kshs. 45,000	Kshs. 50,000	Kshs. 50,000
Virtual Attendance			
Early Registration (before 1st October)	Kshs. 15,000	Kshs. 20,000	Kshs. 20,000
Late Registration (after 1st October)	Kshs. 20,000	Kshs. 25,000	Kshs. 25,000

** By the date of registering for the Convention*

	Foreign Delegate	Undergraduate student
Physical Attendance	USD380	
Virtual Attendance	USD150	Kshs. 3,000

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EARN 25 PDUs

OR SCAN CODE TO REGISTER

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