Nigerian Chemical & Engineering Industry MAGAZINE

A Four-Monthly Publication of Nigerian Society of Chemical Engineers
(A Division Of Nigerian Society Of Engineers)

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Healthcare & Biotechnology

Engr. Anthony Ogheneovo

Communique of 54th International Conference

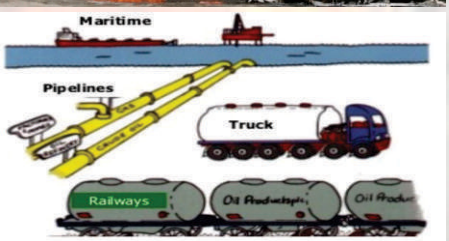
Engr. Anthony Ogbuigwe, *FNSChE*
National President, NSChE

Sustainability & Safety

Engr. AbdulRasheed Babalola, FNSE

CURTAILING

SAFETY INCIDENTS IN PETROLEUM PRODUCTS TRANSPORTATION



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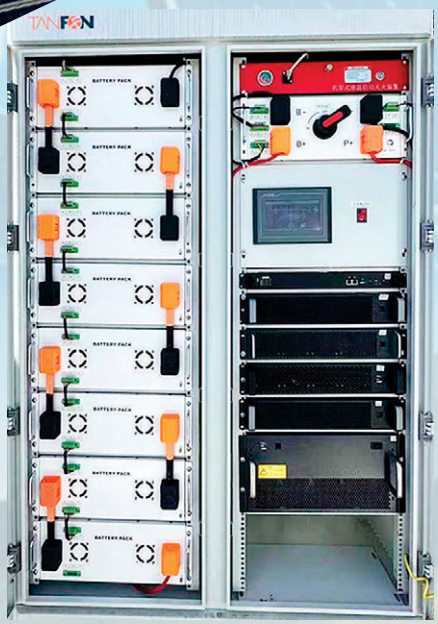

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NSChE VISION

"To be the Center of excellence for the Chemical Engineering Profession in Africa and the Prime Mover of Industrialization in Nigeria".

NSChE MISSION

"To organize the Nigerian Society of Chemical Engineers into a virile professional body capable of promoting the relevance and versatility of the profession, achieving better training and updating of Chemical Engineers through its activities. Fostering of relationships with the academia, research institutes, industries, other professional bodies and government will be the basis for stimulating accelerated industrialization of the country and improving the quality of life of the Nigerian people".

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From The Editorial SUITE

***Engr. Donatus Uweh**, FNSChE*
(Editor-in-Chief)

The world rushes on and here we are in 2025 with the months already counting. The "Nigerian Chemical & Engineering Industry" magazine keeps going too. We continue to make valuable presentations to the teeming readers of NSChE's 1st class magazine. One may ask "Can Nigeria's problems be solved?". The answer is 'Yes'. The definition of faith contains hope, so let there be hope for goodness to evolve in families, communities, states, the nation and the entire economy of our dear country in 2025 and beyond.

Let us now briefly examine what we are sharing with our readers to foster hope for goodness. The first presentation is entitled "The Future of Chemical Engineering in Healthcare & Biotechnology" by Engr. Anthony Ogheneovo, FNSChE.
One of the key virtues of Chemical Engineering is versatility particularly where processing is part of a system. One of the deliverables in this article is that chemists, pharmacists and allied professionals in the pharmaceutical and biotech industries need to adopt the team approach by engaging Chemical Engineers who, by training and practice, can innovatively achieve enhanced effectiveness and efficiency in manufacturing processes.

Another presentation is entitled "Curtailing Petroleum Products Transportation & Handling Incidents in Nigeria" by Mr. Gogomary Oyet, General Manager, Health, Security, Safety & Environment, NNPC Retail. He brings to the fore the various causes of incidents in transportation of petroleum products particularly by road tankers. His experience and research have shaped his treatise which should not be taken lightly. It is the dream of Process Safety Initiative of Nigeria and other key stakeholders on safety matters to see an end to the loss of lives and properties caused by explosion of petroleum products in trucks and vessels due to various causes.
Other articles are:

i. Fundamentals of Codes & Standards in Chemical Engineering Practice by Engr. Olanrewaju Adebayo Bamidele, CEO of Olanab Consulting Limited.
ii. Environmental Sustainability & Safety in Engineering by Engr. Dr. AbdulRasheed Babalola, FNSE, FNSChE, FNISafetyE, Associate Professor of Chemical Engineering, Federal University of Technology, Ikot Abasi (FUTIA), Akwa Ibom State

The Nigerian Society of Chemical Engineers conducted two flagship conferences in 2024. The 32nd Fellows Conference held in October 2024 had the theme "Power Sector Development – The Nexus between Industrialization and Economic Development". The 54th International Conference/ Annual General Meeting was held from 13th to 16th November 2024 on the theme "Value Enhancement in Solid Minerals and Agro-Allied Sectors for Industrial Development". As a responsible professional body, NSChE has unwavering commitment towards the progress of Nigeria. It is expected that the relevant government agencies and stakeholders would implement the recommendations borne out of the two conferences. These recommendations are contained in the communiques published in this edition.

Past Presidents of NSChE are always concerned about the successful operations of the National Secretariat of the Society. In turn, the National Secretariat Staff seek to know the welfare of the Society's Past Presidents. This was well demonstrated in 2024 when the Staff paid courtesy visits to Engr. Anthony Shobo, FNSChE (Past President, 1969 - 1973) and Engr. Ayo Solanke, FNSChE (Past President, 1997 - 1998). The memorable pictures of the visits are in this edition. The Editorial Team wishes them and other living Past Presidents many more years of robust healthy life.

The Editorial Team also uses this opportunity to congratulate Prof. Omodele Eletta on her appointment as the 1st female Director of the National Centre for Hydropower Research & Development.
Finally, we extend our deep appreciation to all those who contributed to the successful publication of this edition.

Relax and enjoy your reading.
Engr. Donatus Uweh, FNSChE
Editor-in-Chief

THE FUTURE OF CHEMICAL ENGINEERING IN HEALTHCARE AND BIOTECHNOLOGY

Engr. Anthony Ogheneovo, *FNSChE, FNSE*
(Executive Secretary, NSChE)

Chemical Engineering is rapidly transforming healthcare and biotechnology, integrating advanced materials, process engineering, and data-driven approaches to develop next-generation medical solutions. From drug manufacturing to regenerative medicine, chemical engineers are at the forefront of groundbreaking innovations that are shaping the future of human health.

1.0 BIOPHARMACEUTICAL PROCESS ENGINEERING:

Scaling Up Life-Saving Drugs

With the increasing demand for biologics, gene therapies, and personalized medicine, chemical engineers are optimizing large-scale bioprocessing to make these treatments accessible and affordable. Innovations in:

i. Cell culture & fermentation for high-yield biopharmaceutical production
ii. Downstream purification techniques for cost-effective drug manufacturing
iii. Continuous manufacturing systems to replace batch processes and reduce waste medications (See Fig. 1)

2.0 SYNTHETIC BIOLOGY & CRISPR:

The Future of Genetic Engineering

Chemical Engineers are enabling synthetic biology and Clustered Regularly Interspace Short Palindromic Repeats (CRISPR) gene editing to create next-gen therapies.

CRISPR-based treatments for genetic disorders like sickle cell disease.

Fig.1: Pharmaceutical factory

Fig. 2: Drug research to production

Engineered microorganisms for producing therapeutic proteins and bio-based drugs (See Fig. 2)
Smart bioreactors to scale synthetic biology applications medicine, gene therapy advancements, and efficient production of complex biological compounds.

3.0 ADVANCED DRUG DELIVERY SYSTEMS & NANOMEDICINE:

Nanotechnology is revolutionizing drug administration, making treatments more precise and effective.
Lipid nanoparticles (LNPs) used in mRNA vaccines (e.g., COVID-19 vaccines).
Nanoengineered drug carriers for targeted cancer therapy.
Smart polymers & hydrogels for sustained-release medications.

4.0 TISSUE ENGINEERING & REGENERATIVE MEDICINE: GROWING ORGANS IN THE LABORATORY

Chemical Engineers are pioneering biomaterials and tissue scaffolds for organ regeneration.

i. 3D bioprinting to fabricate tissues and potentially full organs.
ii. Biodegradable polymers to support cell growth for wound healing.
iii. Stem cell engineering for regenerating damaged tissues.

5.0 LAB-GROWN MEAT & ALTERNATIVE PROTEINS:

Engineering the Future of Food
Cell-cultured meat is a biotechnological breakthrough that chemical engineers are refining for scalability.
Bioreactor design for efficient cell culture growth
Nutrient optimization for sustainable production
Scaffold engineering to mimic real meat texture

6.0 BIOSENSORS & WEARABLE MEDICAL DEVICES:

Real-Time Health Monitoring
Advances in biosensing technology are enabling

"Engineered microorganisms for producing therapeutic proteins and bio-based drugs... Smart bioreactors to scale synthetic biology applications medicine, gene therapy advancements, and efficient production of complex biological compounds."

real-time disease monitoring and early detection (See Fig. 3)

Lab-on-a-chip diagnostics for rapid disease screening
Glucose sensors for diabetes management
Wearable health monitors tracking vitals via nanomaterials

7.0 AI & MACHINE LEARNING IN CHEMICAL ENGINEERING FOR HEALTHCARE

Artificial intelligence (AI) and machine learning (ML) are revolutionizing biopharmaceutical research, diagnostics, and process optimization.

AI-driven drug discovery reducing time for new treatments.
ML-based process control for optimizing pharmaceutical manufacturing
Big data in healthcare analytics for personalized treatment plans

8.0 SUSTAINABLE AND SCALABLE VACCINE PRODUCTION

The COVID-19 pandemic showcased the critical role of chemical engineers in vaccine development. Future advancements include:

- mRNA vaccine production optimization
- Adjuvant formulations to enhance vaccine effectiveness
- Cold chain logistics solutions for global vaccine distribution

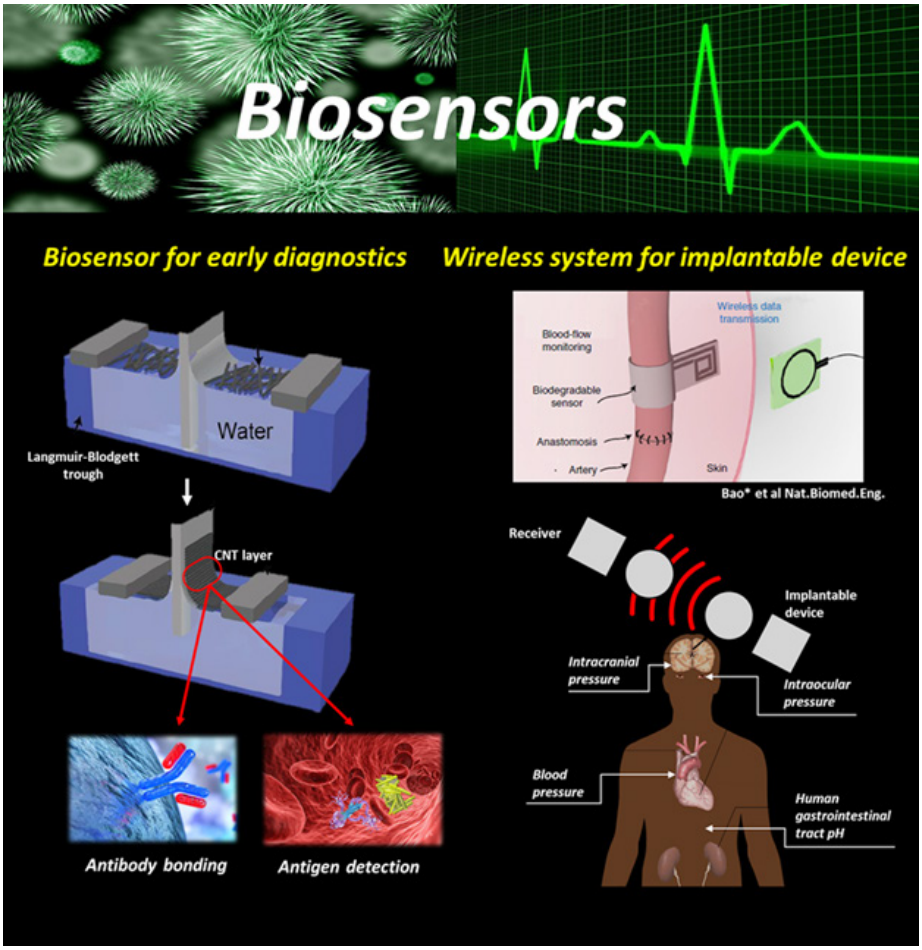

Fig. 3: Biosensor applications

"Chemical Engineers are driving innovation at the intersection of healthcare and biotechnology. Their expertise in process engineering..."

CONCLUSION

This presentation examined the evolving role of chemical engineers in healthcare and biotechnology. Chemical Engineers are driving innovation at the intersection of healthcare and biotechnology. Their expertise in process engineering, nanotechnology, biopharmaceuticals, and AI is shaping the future of medicine, making healthcare more efficient, personalized, and sustainable.
As the demand for advanced therapeutics, regenerative medicine, and biotech solutions grow, chemical engineers will play greater role in transforming human health and enhancing quality of life worldwide.

REFERENCE LINKS:

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2. *Link: https://pubs.rsc.org/en/content/articlelanding/2021/cs/c9cs00886a*
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4. *Link: https://pubs.rsc.org/en/content/articlelanding/2021/cs/c9cs00886a*
5. *Link: https://allinfoche.com/future-trends-in-chemical-engineering/*

NIGERIAN SOCIETY OF CHEMICAL ENGINEERS

COMMUNIQUE OF THE 32ND FELLOWS' CONFERENCE OF THE NIGERIAN SOCIETY OF CHEMICAL ENGINEERS HELD IN IKEJA, LAGOS

PREAMBLE

The 32nd Fellows' Conference of the Nigerian Society of Chemical Engineers (NSChE) was held in the Radisson Blu Hotel, Ikeja, Lagos on October 10, 2024. The theme of the Conference was: POWER SECTOR DEVELOPMENT – THE NEXUS BETWEEN INDUSTRIALIZATION AND ECONOMIC DEVELOPMENT. The one-day event comprised several activities including the following:

Welcome Address by Engr. Anthony Ogbuigwe, FAEng, FNSE, FNSChE, National President of NSChE

- Chairman's Opening Remarks by Mr. Aigbe Olotu, Board Member of Ikeja Electric Plc who represented Mr. Kola Adesina, MFR, Chairman, Sahara Power Group
- Keynote Presentation by the Guest Speaker, Mrs. Folake Soetan, Chief Executive Officer, Ikeja Electric Plc
- Questions & Answers Session
- NSChE Appreciation Awards by Prof. Ayo Ogunye, FAEnG, on behalf of NSChE, to the Chairman of the event and the Guest Speaker

The number of Fellows who participated in the Conference was fifty-two (52) consisting of forty-four in the venue and eight (8) online.

INTRODUCTION

The conference's overall objective was to highlight the nexus between power sector development, industrialization, and economic development and drive home the point that power sufficiency for industries and the Nigerian populace, in general, will translate into significant wealth and job creation and engender accelerated inclusive economic growth. The conference also explored solutions to the perennial challenges of Nigeria's electricity industry.

OBSERVATIONS

1. The Conference noted that the Power Sector is the backbone of any economy because it is the key driver of industries, businesses and homes. It noted further that Nigeria's unreliable power supply with its outdated infrastructure and regulatory bottlenecks have constrained industries, businesses and homes into struggling with high costs of operations leading to some businesses closing shops outrightly.
2. The Conference noted that without adequate and reliable power, industrialization is impossible, and without industrialization, economic development is unattainable. It noted further that Nigeria's manufacturing sector, agro-processing industries, technology hubs and small & medium enterprises (SMEs) all require a stable power supply to thrive.
3. The Conference observed that in Nigeria, SMEs face a huge burden of providing their own power and other utilities to operate their businesses with cost going as high as 30 to 40% of the initial capital investment. This poses a great burden to industrialization and economic development.
4. The Conference noted that the Transmission Company of Nigeria (TCN) manages a huge infrastructure of about 20,000km of the conglomerate of the 330kV and 132kV transmission lines and several substations. Nigeria's grid is interconnected with 27 generation companies (GenCos) in different locations interspersed with 11 distribution companies (DisCos). Transmission is the only one in the value chain in which the government is directly involved in its operational activities and the grid has been failing incessantly in the last few years. The installed capacity of the GenCos is estimated at an average of 12,000MW. This is far higher than the total national transmission grid of about 4,000MW. The remainder generated by the GenCos is 'stranded' or technically rejected resulting in a huge power deficit not available to the DisCos and ultimately to the consumers.

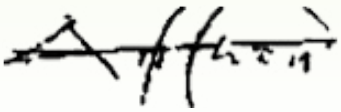
5. Following the enactment of the Electricity Act 2023, the Nigerian Electricity Regulatory Commission (NERC) is actively implementing policies that allow the States and other entities to generate and distribute electric power. NERC is also addressing various challenges bordering on gas supply to GenCos, grid transmission infrastructure, dilapidated DisCos infrastructure, metering gaps in consumer base and estimated billing concerns, albeit with little success at the moment.
6. The Conference noted that Chemical Engineers, by training and practice, are experts in industrial processing across several segments such as petroleum refining, gas processing, fertilizer, detergents, sugar, agro-processing, cement, energy production, pharmaceuticals, among others. This expertise positions them as top-tier professional assets in proffering solutions to efficient utilization of energy in Nigeria to fast-track industrialization and economic growth.

RECOMMENDATIONS

1. The Nigerian Government should address power issues holistically as a national emergency to curb industrial and business stagnation including encouraging businesses particularly big conglomerates to remain in Nigeria rather than relocate to other countries.
2. Though the implementation of the Band 'A' customer policy by DisCos whereby such class of customers receive power up to 20 hours daily, as directed by NERC, has improved power availability to some industries, businesses and homes, NERC should not rest on its oars but work towards getting all and sundry to be supplied with stable electric power 24 hours every day. This initiative should include the use of mini-grids and renewable energy.
3. Government needs to devise policies that provide incentives to SMEs to reduce the heavy burden they are facing in providing their own power and other utilities for business operations. This will improve their capacities to contribute significantly to economic development.
4. The Government should fast-track the current efforts of upgrading the grid transmission system by constructing additional lines to relieve the existing overloaded 330kV and 132kV lines. This should be treated as a national emergency to quickly close the power transmission gap existing in the electricity value chain.
5. NERC should put together a timetable agreeable to key stakeholders and engage them periodically in constructive patriotic dialogue aimed at proffering implementable solutions to the enormous challenges confronting Nigeria's electricity industry. Among the key stakeholders to be invited by NERC are: GenCos, Gas Suppliers, DisCos, Electricity Consumer Association, Manufacturers Association of Nigeria (MAN), Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA), Nigerian Association of Small-Scale Industrialists (NASSI), Nigerian Society of Chemical Engineers, Electricity Boards in States, among others. Among the key actions that require immediate attention by NERC and DisCos is equitable metering of all consumers of DisCo-supplied electricity to enable consumers to get value for their money and estimated billing abolished.
6. Chemical Engineers under the umbrella body of the Nigerian Society of Chemical Engineers, who by training and practice are professional experts in industrial processing, should be engaged by the government at all levels, industries, and businesses to work across sectors such as energy production, chemical process industries, agro-processing companies, pharmaceutical firms to proffer solutions on how to achieve efficient energy manufacturing and cost savings in the use of energy.

Signed for and on behalf of the **Nigerian Society of Chemical Engineers,** Conference Organizers and Participants,

Engr. Anthony Ogbuigwe, *FNSChE, FNSE*
President, Nigerian Society of Chemical Engineers



Engr. Anthony Ogheneovo, *FNSChE*
Executive Secretary, Nigerian Society of Chemical Engineers

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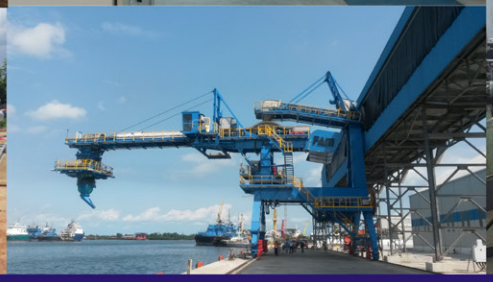


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NSChE STAFF COURTESY VISIT TO PAST PRESIDENTS

NSChE Secretariat Staff delegation led by Executive Secretary, Engr. Anthony Ogheneovo (2nd from L) paid a courtesy visit to Engr. Anthony Shobo, FAEng (Past President of NSChE) seated at front.

NSChE Secretariat Staff delegation led by Executive Secretary, Engr. Anthony Ogheneovo (3rd from R) paid a courtesy visit to Engr. Ayo B. Solanke, FNSChE (Past President of NSChE), 4th from right.

PROF. ELETTA'S APPOINTMENT

Professor Omodele Abosode-Eletta is the 1st Female Director at National Center for Hydropower Research and Development, Ilorin.

The Director General of the Energy Commission of Nigeria (ECN), Dr. Mustapha Abdullahi, FNSE, here receiving Professor Omodele Abiodun Abosode-Eletta, the newly appointed Director of the commission, at the headquarters.

NSChE'S 54TH INTERNATIONAL CONFERENCE/AGM IN PICTURES

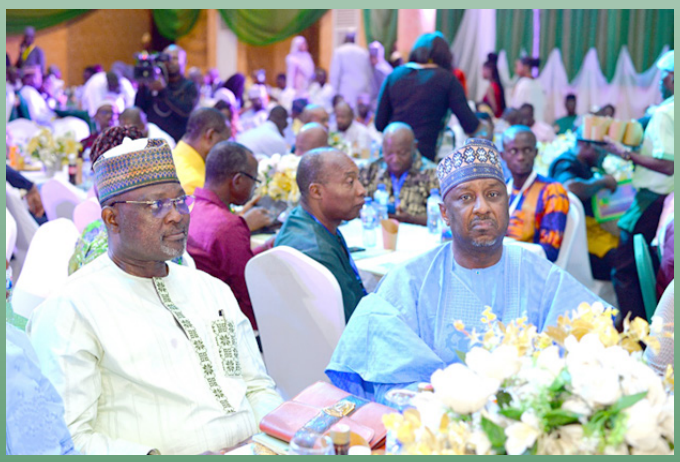
THEME: VALUE ENHANCEMENT IN SOLID MINERALS AND AGRO-ALLIED SECTORS FOR INDUSTRIAL DEVELOPMENT

VENUE: SHEHU MUSA YAR'ADUA CENTER, ABUJA | DATE: 13TH–16TH NOV. 2024

NSE President, Engr. Margaret Oguntala with some members of the Lagos/Ogun Chapter of NSChE at the opening ceremony of the Conference.

NSE President, Engr, Margaret Oguntala, FNSE, Chairman of the opening ceremony of the Conference presented an appreciation Plaq to the MD of BUA Cement, Dr, Salihu Jamari who was a lead speaker. Past President, Engr. Onochie Anyaoku moderated the session.

Some NSChE Students present at the Conference



A cross-section of NSChE members at the dinner and Fellows' investiture program of the Conference.

Change of Baton: *Engr. Anthony Ogbuigwe, FAEng, hands over the Baton of NSChE leadership to Engr. Bayo Olarewaju-Alo, FAEng, as the 24th National President of the Nigerian Society of Chemical Engineers*

Some recipients of NSChE prestigious Fellowship at the Conference

Immediate past president, President and some members of NSChE Council at the handing over ceremony of the Immediate past president to current President of NSChE.

NIGERIAN SOCIETY OF CHEMICAL ENGINEERS

COMMUNIQUÉ OF THE 54TH INTERNATIONAL CONFERENCE, EXHIBITION & AGM

HELD AT THE SHEHU MUSA YAR'ADUA CENTRE, ABUJA, 13TH – 16TH NOV, 2024

1.0 INTRODUCTION

The 54th International Conference, Exhibition, and Annual General Meeting of the Nigerian Society of Chemical Engineers (NSChE) focused on the theme: "Value Enhancement in Solid Minerals and Agro-Allied Sectors for Industrial Development."

This landmark event jointly hosted in collaboration with the Nasarawa State Government convened regulators, industry practitioners, academics, and other stakeholders to identify challenges and propose actionable strategies for enhancing value in Nigeria's solid minerals and agro-allied sectors. A key outcome was the development of a strategic roadmap to unlock the sectors' potential for industrial transformation.

The conference, chaired by Engr. Margaret Oguntala, FNSE, FNSChE (President of the Nigerian Society of Engineers), featured dignitaries including:

- His Excellency, Engr. Abdullahi Sule, FNSE, FNIMechE (Executive Governor of Nasarawa State), represented by Hon. Samuel Kaku (Commissioner for Science, Technology, Industries, and Innovation).
- Engr. Abubakar Momoh, FNSE, PPA (Hon. Minister of Regional Development), represented by Engr. Aluyah Dauda Okodugha, FNSE.
- Prof. Rahmon A. Bello, FNSChE, FNSE, FAEng. (President of the Nigerian Academy of Engineering).

2.0 KEYNOTE SPEAKER

His Excellency, Engr. Abdullahi Sule, FNSE, FNIMechE (Executive Governor of Nasarawa State)

3.0 LEAD PAPERS

- Engr. Kanu Akachidike: Nigeria in the Emerging Global Economy: Recommendations for a National Policy on Hydrogen. (A paper by the Education and Research Sectoral Group of the NSChE).
- Dr. Salihu Jamari, FNSChE: Gas Utilization for Enhanced Food Security in Nigeria.
- Dr. Kabiru Hassan Yar'Adua: Prospects and Challenges of Processing Solid Minerals in Nigeria.
- Prof. Idris Mohammed Bugaje, FNSChE, FNSE, FSESN (Executive Secretary of the National Board for Technical Education), represented by Prof. Diya'uddeen Basheer Hassan, FNSChE (National Coordinator of the Technical, Vocational, Education and Training -TVET Programme): Building Capacity Across Agro-Allied and Solid Minerals Sectors to Enhance Nigerian Content.

4.0 PANEL DISCUSSIONS

Experts from academia and industry explored strategies for building capacity to enhance Nigerian content, featuring:

- Prof. Diya'uddeen Basheer Hassan (National Coordinator, TVET Programme).
- Engr. Yusuf Haliru Binji (CEO, BUA Cement PLC).
- Prof. Mohammed Gana Yisa (COREN).
- Engr. Dele Ayankele (President, Miners Association of Nigeria).
- Prof. Rahmon A. Bello (President, Nigerian Academy of Engineering).

5.0 KEY TAKEAWAYS FROM THE CONFERENCE

5.1 RESOURCE POTENTIAL:

Nigeria is blessed with;

- Over 44 potentially commercially viable solid minerals, including limestone, iron ore, tin, etc.
- Rich agricultural products like cassava, yam, groundnut, maize, sorghum, millet, Cocoa, oil palm, rubber, etc.

Despite these, the export of raw materials persists, stifling economic potential.

5.2 CHALLENGES

a) Limited access to modern technology and financial resources.

b) Inadequate manpower, infrastructure, and relevant data.
c) Bureaucratic bottlenecks in mining operations.
d) Environmental degradation from mining activities.
e) Insufficient investment and weak linkages between extraction and downstream processing.

5.3 Opportunities
- The solid minerals sector currently contributes less than 1% to Nigeria's GDP but has the potential to transform the economy through value addition, beneficiation, and refining.
- Leveraging Nigeria's abundant natural gas reserves for fertilizer production and energy can enhance food security, though infrastructure and funding remain critical barriers.
- Investing in capacity development schemes, targeting value addition can create jobs, reduce dependency on imported goods and reduce the stress on the Naira as well as accelerate economic development.

6. RECOMMENDATIONS

To unlock the full potential of Nigeria's solid minerals and agro-allied sectors, the conference proposed the following actionable steps:

6.1 Capacity Building
- Develop specialized curricula for agro-processing, mining technology, and environmental management.
- Establish partnerships between educational institutions, professional bodies, industries, and international bodies.
- Promote research and development in crop science, post-harvest technology, sustainable mining, and mineral processing.

6.2 Public-Private Partnerships (PPPs)
- Engage private companies for technology transfer and global market access.
- Collaborate with local and foreign entities to bridge technology gaps.

6.3 Policy and Regulatory Support
- Incentivize local content through tax breaks and grants.
- Enforce strict compliance with local content laws.
- Support SMEs and startups with access to grants, loans, and skills acquisition programs.

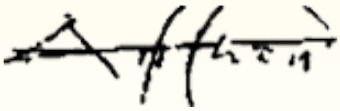
6.4 Strategic Roadmap
- Develop a comprehensive roadmap to create an investor-friendly environment in the agro-allied and solid minerals sectors.
- Promote academia-industry collaboration for practical, hands-on training.
- Encourage homegrown innovation and adopt indigenous technologies.

7. ACKNOWLEDGEMENTS

The NSChE extends its gratitude to the following organizations for their generous support for the conference: Nasarawa State Government, NNPC Limited, Aradel Holding, Nigeria LNG, BUA Cement, Dangote Petroleum Refinery, EEMS Limited, GGI International Limited, Daewoo E&C, Delta Afrik Engineering Ltd, Debyl Limited, Platform Petroleum Limited, Vitapur (A Vitafoam Company) and Oilserv.

Signed for and on behalf of the Conference Organizers and Participants

Engr. Anthony Ogbuigwe, *FNSChE, FNSE*
President, Nigerian Society of Chemical Engineers



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CURTAILING PETROLEUM PRODUCTS TRANSPORTATION & HANDLING INCIDENTS IN NIGERIA

Mr. Gogomary Oyet,
General Manager, Health, Security, Safety & Environment, NNPC Retail

1.0 PETROLEUM PRODUCTS TRANSPORTATION

Petroleum product transportation refers to the movement of petroleum products such as premium motor spirit (PMS), automotive gas oil (AGO), aviation turbine kerosene (ATK), Bitumen and Crude oil from one location to another. This can occur through various modes of transportation, including Trucks, Pipelines, Trains, Vessels, and Barges. Trucks are the major mode of transporting petroleum products in Nigeria. See Fig. 1 & Fig. 2.

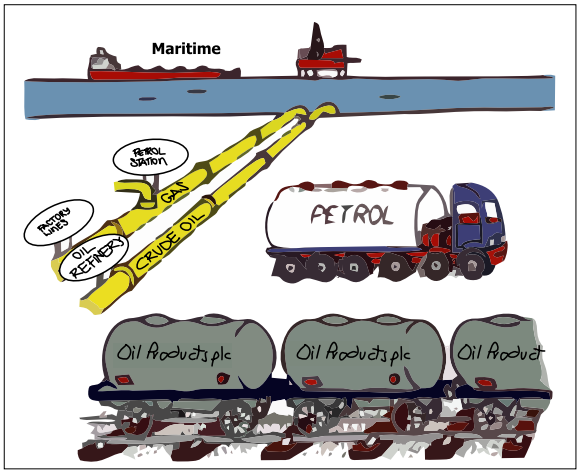

Fig. 1: Various means for petroleum products transportation such as ocean vessel, trucks, rail tanker wagons, pipelines

Fig. 2: Petroleum product transportation by Ocean vessel

2.0 ACCIDENT CAUSATION FACTORS

The factors responsible for road accidents have been identified as follows:
Driver 48%
Road 34%
Vehicle 18%
Source: Truck Transit Park Implementation Rally by FRSC South west Nigeria, 27th November 2019

The focus of Major Energies Marketers Association of Nigeria (MEMAN) members is to mitigate the risk in each of these areas.

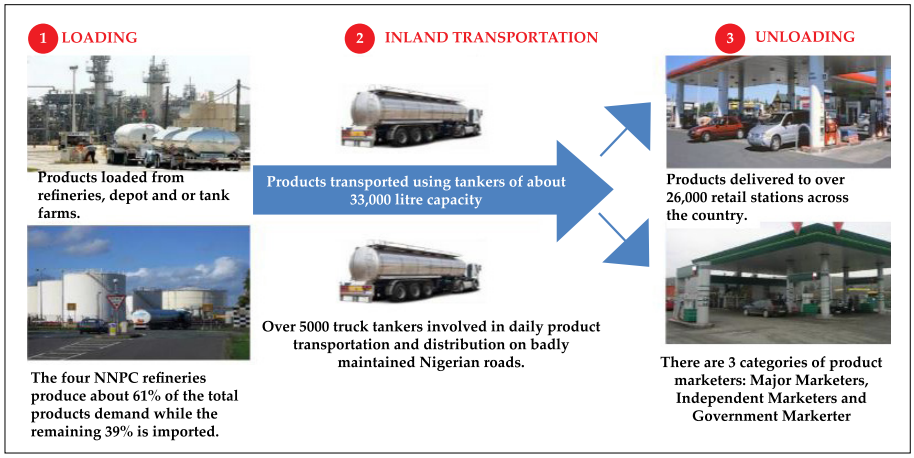

Fig. 3: Petroleum product lifting by truck tankers and destination sequence

3.0 PETROLEUM PRODUCTS TRANSPORTATION BY ROAD

According to the Federal Road Safety Corps (FRSC, 2011), it is estimated that 95% of total product volume transported by road is done using truck tankers of about 33,000 litres capacity. See Fig. 3.

Fig. 4: Management of truck movement with speed-limiting device

4.0 WAYS TO CURTAIL PETROLEUM PRODUCTS TRANSPORTATION & HANDLING INCIDENTS

i. **Journey management planning and route optimisation:** Plan routes to avoid blackspots and danger zones and minimize travel distances to improve turnaround time.

ii. **Use of technology:** Use of technology includes the following: Speed-limiting devices, leak detection sensors, onboard computers for tracking, API fittings for foot valves and top manholes, GPRS maps, and collision avoidance systems. See Fig. 4.

iii. **Training:** Provide heart and mind safety culture awareness, driver training, daily safety pep talks, monthly safety awareness meetings, scenario/ incident knowledges sharing, and quality product handling training. See Fig. 5.

iv. **Inspection and Maintenance:** Carry out Truck and Equipment audits, comprehensive truck safety and quality inspections, and proper maintenance to ensure trucks are safe to load.

v. **Use of Rail, Barge, Vessel and Pipelines:** Use rail, barge, ocean vessel, pipelines to transport petroleum products to longer distances to reduce the possibility of truck road accidents.

vi. **Adherence to transport and company laws/ regulations:** Adher to road signs, road marks, traffic lights, and the company driving time policy.

vii. **Pipelines and Rail Options:** It is more profitable to invest in incident prevention than incident management, and this explains why the safest

Fig. 5: Training on safety

"Provide heart and mind safety culture awareness, driver training, daily safety pep talks..."

"There is still a lot of work to be done to stem road transport accident trend in the downstream petroleum industry."

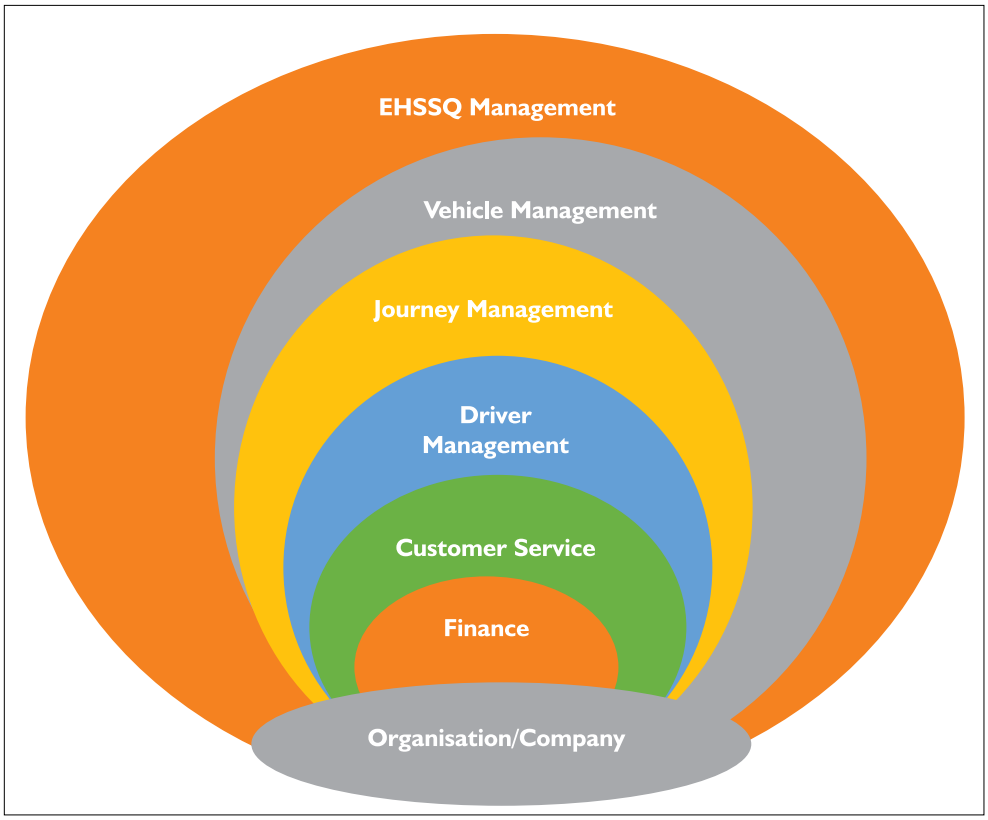

Fig. 6: The seven pillars of Global Hauler Assessment (GHA) for fleet management

means of transporting petroleum products over a distance greater than150km remains via pipelines and not trucking.

The government should welcome the advocacy for pipeline rehabilitation, reconstruction, and extension for efficient and safe transportation of bulk petroleum products across the country.

Transportation of petroleum products via rail is another close alternative to the pipelines. The use of tanker wagons on rail will also ensure that bulk volumes of different petroleum products are efficiently and safely moved from production sites and tank farms.

5.0 FLEET MANAGEMENT SYSTEM & SEVEN PILLARS OF GLOBAL HAULER ASSESSMENT (GHA)

The seven pillars for fleet management include Environment, Health, Security, Safety & Quality (EHSSQ) Management, Vehicle Management, Journey Management, Driver Management, Customer service, Finance and Organisation & Company. See Fig. 6. These pillars need to receive more diligent attention in the petroleum industry in Nigeria so as to achieve the desired results.

6.0 CONCLUSION

There is still a lot of work to be done to stem road transport accident trend in the downstream petroleum industry.

a. MEMAN has taken up the initiative towards self-regulation and this is a step in the right direction.
b. There is a need for marketers to comply with the Road Transport Safety Standard Scheme (RTSSS). The RTSS contains the FRSC regulations guiding the haulage of petroleum products in the country.
c. Government should improve road infrastructure and drive the review of the policy on capacity of haulage trucks.
d. There is an urgent need for public awareness and community engagement on safety practices around accident sites involving petroleum products.

EDITOR'S NOTE: This is an abridged version of the presentation by Mr. Gogomary Oyet, General Manager, Health, Security, Safety & Environment, NNPC Retail in a Seminar organized by Process Safety Initiative of Nigeria (PSIN) in collaboration with Nigerian Society of Chemical Engineers (NSChE) on August 15, 2024. The contents of this presentation are personal to the author and do not represent the publication of a policy framework of NNPC Retail.

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FUNDAMENTALS OF CODES & STANDARDS IN CHEMICAL ENGINEERING PRACTICE

1.0 INTRODUCTION

Generally, Engineering Codes and Standards refer to sets of guidelines and regulations that define the requirements, specifications, and practices for designing, constructing, operating, and maintaining various engineering systems and products. They are essential tools for ensuring safety, quality, reliability, and consistency in engineering projects.

Engr. Olanrewaju, Adebayo Bamidele, *MNSChE, MNSE, MIChemE, CEng (CEO, Olanab Consulting Ltd.)*

Codes and standards are integral to chemical engineering practice, ensuring safety, reliability, efficiency, and environmental protection in all aspects of chemical processes and plant operations. They provide a set of guidelines and regulations that must be followed to meet legal, safety, and performance requirements. In chemical engineering, adherence to these codes and standards is crucial, as the field often deals with hazardous materials, high-pressure systems, and complex chemical reactions.

This article explores the significance of codes and standards in chemical engineering, key organizations that develop them, and their applications in various aspects of chemical engineering practice.

2.0 DEFINITIONS AND DIFFERENCES BETWEEN CODES & STANDARDS

Specifically, engineering codes are legally enforceable rules or regulations that set the minimum requirements for design, construction, and operation in various engineering fields (e.g., civil, electrical, mechanical, structural, etc.), while engineering standards refer to technical specifications or guidelines that provide detailed instructions on the design, manufacture, testing, and maintenance of engineering products or systems to ensure quality and performance.

The terms codes and standards are often used interchangeably, but they have distinct meanings, especially in the fields of engineering, construction, manufacturing, and safety.

Table 1 gives an illustration of their differences.

S/N	Aspect	Codes	Standards
1.	Definition	Legally enforceable rules that define minimum requirements for safety, health, or environment	Detailed guidelines or specifications for technical requirements (e.g., materials, processes)
2.	Enforceability	Mandatory; compliance is required by law or regulation	Voluntary; compliance is optional unless referenced in a code or contract
3.	Purpose	Ensure public safety, welfare, and regulatory compliance	Provide technical specifications, ensure consistency, and define best practices
4.	Scope	Covers broad areas such as building, electrical, fire safety codes	Narrower in focus, addressing specific technical aspects like material properties, testing methods
5.	Development Process	Developed by government agencies or regulatory bodies, subject to formal legislative procedures	Developed by standards organizations (e.g., ISO, ASTM, ANSI), often with industry input
6.	Legal Status	Has legal force; failure to comply can result in penalties or legal action	
7.	Applications	Applied to specific industries or processes by authorities to ensure compliance with safety and regulatory requirements	Applied to specific products, processes, or systems to ensure quality and uniformity

Table 1: Differences Between Codes & Standards in Engineering

Fig. 1: *Popular organizations responsible for developing codes, standards in engineering.*

3.0 IMPORTANCE OF ENGINEERING CODES & STANDARDS

i. Safety Assurance: Chemical processes often involve hazardous materials and conditions. Codes and standards provide minimum safety requirements to protect personnel, the environment, and equipment. They help in mitigating risks associated with chemical reactions, high pressures, and temperatures, as well as the handling and storage of dangerous substances.

ii. Regulatory Compliance: Adherence to codes and standards is often mandated by local, national, or international regulations. Compliance ensures that chemical plants and operations meet legal requirements, avoiding fines, shutdowns, and other legal repercussions.

iii. Quality and Reliability: Standards ensure the maintenance of quality and reliability of equipment, materials, and processes. This uniformity is essential for the consistent production of chemical products and the longevity of chemical plants.

iv. Interoperability: Standards facilitate the compatibility of equipment and systems from different manufacturers. This interoperability is crucial for the integration of various components in complex chemical processes.

v. Global Trade: In an increasingly globalized industry, adherence to international standards enables chemical companies to trade across borders, ensuring that products meet the requirements of different markets.

vi. Innovation Facilitation: Standards provide a common framework that allows engineers to focus on innovation within safe and proven boundaries. They provide a solid foundation upon which new technologies and processes can be developed.

4.0 KEY CODES & STANDARDS IN CHEMICAL ENGINEERING

i. ASME Boiler and Pressure Vessel Code (BPVC)
ASME is one of the most influential organizations in setting standards for mechanical engineering applications in chemical engineering. Their Boiler and Pressure Vessel Code (BPVC) is widely recognized for establishing rules for the design, fabrication, and inspection of boilers and pressure vessels. For example,

- ASME Boiler and Pressure Vessel Code (BPVC) provides rules for the design, fabrication, and inspection of boilers and pressure vessels. It is widely used in chemical engineering, especially in designing reactors, heat exchangers, and storage tanks.
- ASME B31.3 Process Piping Code covers the design and construction of piping systems in chemical plants. It ensures the mechanical integrity of piping systems, addressing issues like material selection, stress analysis, and leak testing.

ii. American Petroleum Institute (API) Standards
API develops standards that are essential in the oil and gas industry, covering various aspects such as refinery operations, pipeline transportation, and offshore production. API standards are critical in the design and operation of equipment used in chemical processing. For example,

a. API 650 standard governs the design and construction of large, welded storage tanks used in the petroleum and chemical industries. It includes guidelines for material selection, welding, and inspection to ensure the integrity of storage tanks.

b. API 570 standard focuses on the inspection, repair, alteration, and rerating of in-service piping systems. It is crucial for maintaining the safety and reliability of piping in chemical plants.

iii. International Organization for Standardization (ISO):
ISO develops international standards across various industries, including chemical process industries. See Fig. 1. ISO 9001 (Quality Management Systems) and ISO 14001

"Chemical engineers rely on codes and standards during the design phase of processes to ensure that all components and systems meet the required safety..."

(Environmental Management Systems) are particularly relevant to chemical engineers. For example,

a. ISO 9001 (quality management standard), although not specific to chemical engineering, ensures that processes are consistent and meet customer requirements. It is widely adopted in chemical engineering to maintain high-quality production standards.
b. ISO 14001 (environmental management standard) helps chemical companies minimize their environmental impact, comply with regulations, and continually improve their environmental performance.

iv. National Fire Protection Association (NFPA) Codes

NFPA provides codes and standards related to fire safety. In chemical engineering, NFPA standards help in ensuring safe storage, handling, and processing of flammable and combustible materials. For instance,

- NFPA 30 standard provides guidelines for the safe storage and handling of flammable and combustible liquids. It is particularly relevant in chemical engineering for designing storage facilities and ensuring safe handling practices.
- NFPA 497 standard outlines recommended practices for classifying hazardous areas for electrical installations in chemical plants, preventing fire and explosion hazards.

v. American National Standards Institute (ANSI) Standards

ANSI oversees the creation and dissemination of standards across various industries, including chemical process industries. They coordinate U.S. standards with international standards to ensure global compatibility.

vi. IEC Standards

International Electrotechnical Commission (IEC) standards are essential in the design and operation of electrical systems in chemical plants, ensuring safety and reliability in electrically powered equipment.

vii. Center for Chemical Process Safety (CCPS) Guidelines

CCPS of the American Institute of Chemical Engineers (AIChE) provides a series of guidelines and standards focused on process safety management, helping chemical engineers design safer processes and manage risks associated with chemical production.

viii. Occupational Safety and Health Administration (OSHA) Regulations

OSHA regulations are vital for ensuring safe working conditions in chemical plants. OSHA standards address issues such as hazardous material handling, process safety management, and protective equipment. For instance, OSHA's Process Safety Management (PSM) Standard (29 CFR 1910.119) is crucial for preventing the release of hazardous chemicals in chemical plants. It outlines requirements for process hazard analysis, mechanical integrity, and emergency planning. Fig. 1 illustrates popular organizations responsible for developing some codes & standards in engineering.

5.0 APPLICATION OF CODES & STANDARDS IN CHEMICAL ENGINEERING

i. Process Design & Construction: Chemical engineers rely on codes and standards during the design phase of processes to ensure that all components and systems meet the required safety and performance criteria. For example, Codes like ASME BPVC and API 650 guide engineers in designing and constructing pressure vessels and storage tanks, ensuring they can withstand operational pressures and environmental conditions without failure.

ii. Materials Selection: Standards guide the selection of materials for construction in chemical plants. For instance, corrosion resistance, mechanical strength, and thermal stability are crucial factors that must be considered according to standards like API 571, which deals with corrosion and materials issues in the petroleum industry. ASME B31.3 provides guidelines for selecting materials that can withstand the corrosive and high-temperature environments typical in chemical processes.

Fig. 2: Process inspection walk-through and maintenance.

"...OSHA's...essential for managing highly hazardous chemicals and preventing accidental releases..."

iii. Piping Systems: The design and installation of piping systems in chemical plants must comply with standards such as ASME B31.3 (Process Piping). This standard outlines the requirements for materials, design, fabrication, assembly, erection, examination, inspection, and testing of piping systems.

iv. Safety Systems: The implementation of safety systems, such as pressure relief devices, must adhere to relevant standards like API 520/521, which provides guidelines for sizing, selection, and installation of pressure-relieving systems. OSHA's PSM standard and AIChE's CCPS guidelines help engineers identify and mitigate risks in chemical processes, preventing accidents and ensuring safe operation.

v. Process Safety Management & Environmental Compliance: Standards are also critical in the day-to-day operations of chemical plants. For instance, OSHA's Process Safety Management (PSM) standard (29 CFR 1910.119) is essential for managing highly hazardous chemicals and preventing accidental releases that could cause catastrophic injuries or fatalities Standards like ISO 14001 help chemical engineers design processes that minimize environmental impact, ensuring that emissions, effluents, and waste management practices comply with environmental regulations.

vi. Quality Assurance: ISO 9001 sets the criteria for quality management systems, ensuring that chemical engineering processes produce consistent, high-quality outputs. This standard is crucial in industries where precision and consistency are paramount, such as pharmaceutical manufacturing.

vii. Equipment Fabrication: Fabrication of chemical plant equipment, such as reactors, heat exchangers, and storage tanks, must follow industry standards to ensure they meet performance and safety requirements. For example, ASME BPVC provides guidelines for the construction of pressure vessels, ensuring they are safe for operation under high pressure and temperature conditions.

viii. Inspection & Maintenance: API 570 and other inspection standards ensure that in-service equipment remains safe and operational, extending the life of chemical plants and reducing downtime. Fig. 2 illustrates some engineering walk-through for preventive maintenance activities.

Fig. 3: The process of developing engineering codes and standards

6.0 DEVELOPMENT OF CODES & STANDARDS

i. Consensus-Based Process: Most codes and standards are developed through a consensus-based process involving various stakeholders, including industry experts, government agencies, academia, and professional organizations. This collaborative approach ensures that the standards are comprehensive, practical, and up-to-date.

ii. Regular Updates: As technology and industry practices evolve, codes and standards are regularly updated to reflect new knowledge, materials, and techniques. This is crucial for maintaining the relevance and effectiveness of the standards in a rapidly changing industry.

iii. International Collaboration: Many standards are developed through international collaboration, ensuring that they are applicable across different regions and industries. Organizations such as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) play a significant role in developing global standards. Fig. 3 illustrates the development of engineering codes and standards.

7.0 CHALLENGES IN IMPLEMENTATION

i. Global Variations & Harmonization: Different countries may have varying codes and standards, creating challenges for multinational companies. Harmonizing these differences requires careful planning and sometimes additional testing or redesign to meet multiple standards. When harmonized, this would simplify compliance and reduce the complexity of international operations.

ii. Rapid Technological Advancements: The fast pace of technological advancements can sometimes outstrip the development of relevant standards, leaving engineers to navigate areas where codes may be outdated or non-existent. This requires

"The fast pace of technological advancements can sometimes outstrip the development of relevant standards, leaving engineers to navigate areas where codes may be outdated or non-existent."

Fig 4: Rapid pace of technological change

continuous research and collaboration among stakeholders to ensure that standards remain relevant.

iii. Complexity and Volume: The sheer number and complexity of codes and standards can be overwhelming. Chemical engineers must stay updated with the latest revisions and interpretations, which requires ongoing education and resources.

iv. Cost of Compliance: Adhering to codes and standards can add significant costs to projects, particularly when they require specialized materials or additional testing. However, these costs are often justified by the enhanced safety and reliability they provide.

v. Customization: Some standards and codes may not cover all specific situations in a chemical plant, requiring engineers to interpret and adapt them to meet unique process needs. Future standards will need to address issues such as carbon footprint reduction, resource efficiency, and the circular economy.

8.0 CONCLUSION

Codes and standards are fundamental to chemical engineering practice, guiding engineers in designing, constructing, operating, and maintaining safe and efficient chemical processes. While adhering to these codes and standards can be challenging due to their complexity and the rapid pace of technological change (fig. 4), their benefits in ensuring safety, quality, and regulatory compliance are indispensable. Chemical engineers must be well-versed in the relevant codes and standards, keeping abreast of updates and new developments to ensure their work meets the highest standards of safety and performance. By adhering to these guidelines, chemical engineers can design and operate plants that meet the highest standards of safety and quality, contributing to the overall success and sustainability of chemical process industry.

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ENVIRONMENTAL SUSTAINABILITY AND SAFETY IN ENGINEERING

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ABSTRACT

In the world of engineering, environmental sustainability and safety have increasingly become important considerations. As professionals, it is our responsibility to ensure that our work prioritizes the safety of individuals and does not harm the environment. This article discusses the various ways in which engineers can incorporate sustainable practices into their designs, construction, and operational phases of projects as well as the importance of adhering to safety regulations and standards. It also examines emerging trends, such as circular economy principles, renewable energy adoption, and advanced safety management systems, which contribute to more resilient and sustainable engineering solutions. By implementing sustainable and safe practices, we can not only protect the environment but also create a better and safer world for future generations. As professionals, it is crucial that we are mindful of these factors in all our engineering endeavors, and continuously strive towards a more sustainable and safer future.

Keywords: *sustainable, development, resilient, emerging, standard*

1.0 INTRODUCTION

Environmental sustainability and safety have become crucial aspects in the field of engineering. As we continue to advance and develop as a society, it is important to consider the impact of our actions on the planet and its inhabitants. The role of engineers in achieving a sustainable and safe environment cannot be over-emphasized.

With their expertise and technical skills, engineers are well endowed to design and implement solutions that can improve the quality of life for current and future generations.

In this article, we will delve into the importance of environmental sustainability and safety in engineering, and how engineers play a vital role in creating a better and safer world for all.

2.0 THE SIGNIFICANCE OF ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability refers to the responsible use of resources that ensures the preservation and protection of the environment for future generations. Fig. 1 shows Environment in Perspective. In today's world, where rapid industrialization and urbanization

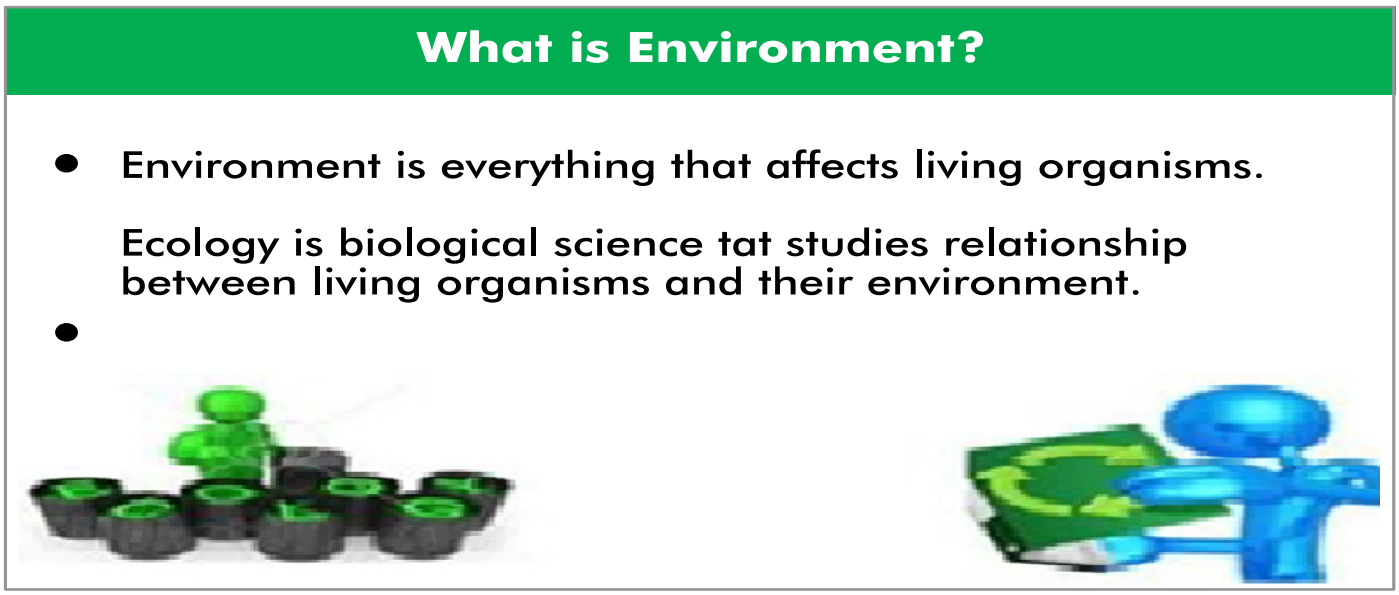


Fig. 1: Environment in perspective

are taking place, the need for sustainable practices has become more crucial than ever before. The negative consequences of reckless resource consumption and pollution can be felt in every aspect of our lives, from the air we breathe to the water we drink.

Engineers play a pivotal role in promoting environmental sustainability through their work. From designing eco-friendly buildings to developing sustainable energy solutions, engineers are known in showing the expertise in implementing practices that reduce the negative impact on the environment. With the use of advanced technologies and innovative designs, engineers can develop solutions that are both efficient and environmentally responsible *(Onyenechere et al, 2023; Movelli, 2011).*

Fig. 2: Sustainability concept in perspective

2.0 SUSTAINABLE DEVELOPMENT

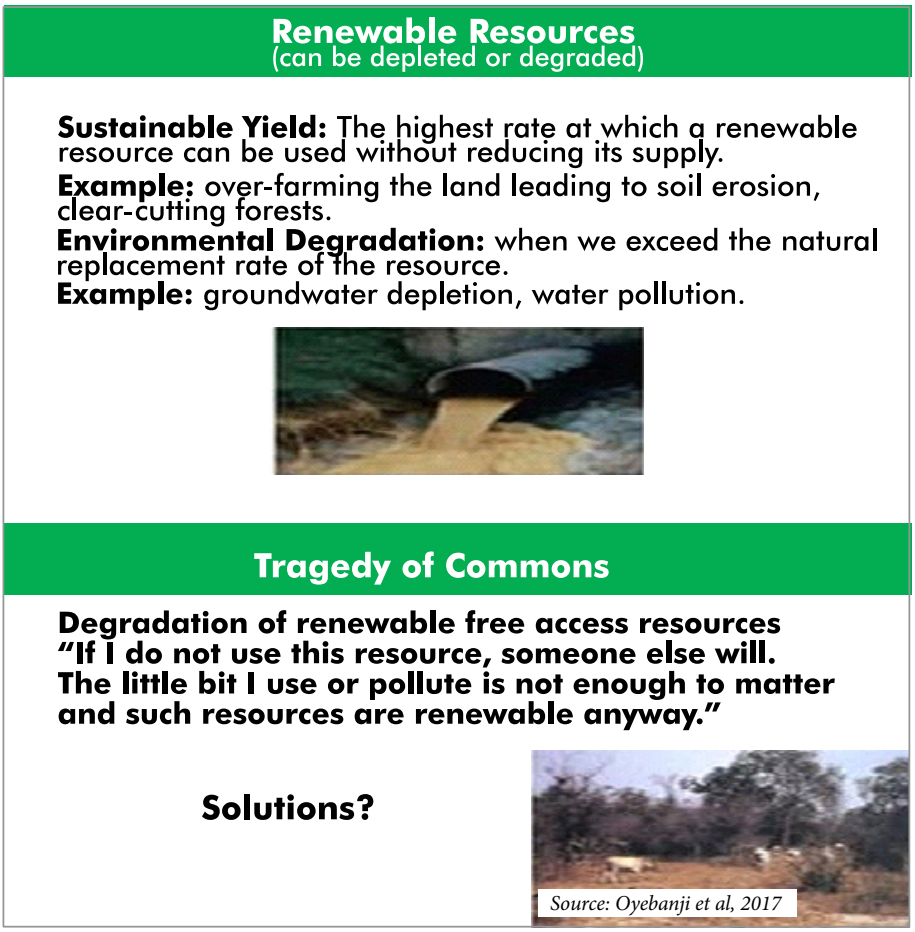
Sustainable development refers to the process of meeting the needs of the present without compromising the ability of future generations to meet their own needs. Fig. 2 shows Sustainability Concept in Perspective. Sustainable development involves balancing economic growth, environmental protection, and social well-being. Sustainable development aims at ensuring that resources are used efficiently and responsibly, supporting long-term prosperity while minimizing harm to the environment and society. Key principles of sustainable development include reducing poverty, promoting equality, conserving ecosystems, and transitioning to renewable energy sources *(Adejumo and Adejumo, 2014).*

There is the need to preserve both human and material resources in the pursuit of development. Therefore, the onus rests on individuals and corporate organizations to engage in socio-economic activities which are compatible with the needs of man and the environment. The main thrust of sustainable development (SD) is the long-term sustainability of the economy and environment. This is only achievable via the integration and recognition of safety, economic, environment, and social concerns throughout the decision making process *(Imusien et al, 2013).*

3.0 ENSURING SAFETY IN ENGINEERING PRACTICES

Apart from environmental sustainability, safety is another essential aspect that engineers must consider in their work. In the engineering field, safety refers to the protection of human life and property from potential hazards. Engineers have a responsibility to ensure that their designs and projects meet safety standards to prevent accidents and minimize risks *(Oyebanji et al (2017); Khudkovskaya et al, 2021).*

"...need to preserve both human and material..."



Figs 3 & 4: Environmental degradation as consequence of unsafe human activity

With advancements in technology, engineers are now able to predict and mitigate potential safety risks more accurately. They can use simulations and testing methods to identify potential hazards and make necessary changes to their designs before they are implemented. See Figs. 3, 4 & 5. This proactive approach not only ensures the safety of the public but also saves time and resources for the project.

4.0 THE ROLE OF REGULATIONS IN PROMOTING ENVIRONMENTAL SUSTAINABILITY AND SAFETY

To ensure that environmental sustainability and safety are upheld in engineering practices, there are various regulations and standards in place. These regulations are set by governing bodies and organizations to govern the design, construction, and operation of engineering projects. They aim to minimize the negative impact on the environment and ensure the safety of the public.

Furthermore, these regulations also serve as guidelines for engineers to follow, ensuring that their designs and projects are compliant with industry standards.

"This proactive approach not only ensures the safety of the public but also saves time and resources for the project."

Fig. 5: Climate change as consequence of unsafe human activity

Fig. 6: United Nations SDGs in perspective (World Bank, 2021)

By adhering to these regulations, engineers not only protect the environment and promote safety but also maintain their credibility and professionalism.

i. What are United Nations Sustainable Development Goals (SDGs)?
   - The United Nations SDGs are a set of 17 global goals established by the United Nations in 2015. See Fig. 6.
   - They address a wide range of social, economic, and environmental challenges, such as poverty, inequality, climate change, and environmental degradation.
   - The SDGs serve as a roadmap for a more prosperous, equitable, and sustainable world by the year 2030, with the goal of ensuring that no one is left behind in the pursuit of sustainable development.

ii. Engineering and UN SDGs: What readily capture the attention of Engineering in the United Nations SDGs are the following:
   - SDG 6 (Clean Water and Sanitation)
   - SDG 7 (Affordable and clean Energy)
   - SDG 9 (Industry, Innovation & Infrastructure)
   - SDG 11 (sustainable Cities & Communities)

"...SDGs serve as a roadmap for a more prosperous, equitable, and sustainable world by the year 2030..."

5.0 CONCLUSION

It is evident that environmental sustainability and safety are crucial aspects in the field of engineering. As professional engineers, it is our responsibility to pay attention to these aspects of comprehensive and inclusive project execution practice. By adhering to these principles, we can pave the way for a more sustainable world for all.

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