

UNIVERSITY OF PORT HARCOURT

**NATURE ENGINEERS:
FROM IDEAS TO IMPACTS**

An Inaugural Lecture

By

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ORDER OF PROCEEDINGS

2.45 pm. Guests are seated

3.00pm. Academic Procession begins

The Procession shall enter the CBN Centre of Excellence auditorium, University Park, and the Congregation shall stand as the Procession enters the hall in the following order:

Academic Officer Professors

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Dean, School of Graduate Studies Provost, College of Health Sciences Lecturer

University Librarian Registrar

Deputy Vice Chancellor Research and Development Deputy Vice Chancellor Academic

Deputy Vice Chancellor Administration Vice Chancellor

After the Vice Chancellor has ascended the dais, the Congregation shall remain standing for the University of Port Harcourt Anthem.

The Congregation shall thereafter resume their seats. **THE VICE CHANCELLOR'S OPENING REMARKS.**

The Registrar shall rise, cap, invite the Vice Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction.

THE INAUGURAL LECTURE

The Lecturer shall step on the rostrum, cap and deliver his Inaugural Lecture. After the lecture, he shall step towards the Vice Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice Chancellor and resume his seat. The Vice Chancellor shall present the document to the Registrar.

CLOSING

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The Vice Chancellor's Closing Remarks.

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DEDICATIONS

TO MY LATE MOTHER AND FATHER

She was full of grace

He was the Teacher of Teachers

ACKNOWLEDGMENTS

As I reflect on my academic journey, I deem it worthy, first and foremost, to thank the Almighty God, who is the giver of all things, for the boundless divine enablement and infinite mercy.

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during the wee hours of the day when at home; and so on. To our children, Mrs Moradeke Olusola Oluwatosin Fadeyi, Mrs Mojisola Adesayo Abosede Oni and Mr. Adekoyejo Ayodeji Ifeoluwapo Kuye; our son-in-laws, Mr Adedamola Oni and Mr Kolawole Fadeyi; and our grandchildren, Oluwaferanmi Adesewa Oni, Oluwafikayomi Adebowale Oni and Oluwadarasimi Adedimeji Fadeyi.

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PROLOGUE

My foray into research started in 1981 with my PhD work (Kuye, 1984). The work proffers solutions to the chief difficulty in assessing the gas-phase pressure drop required to meet a designated particle emission limit for a venturi scrubber. Two different approaches for improving the accuracy of predicting venturi performance were examined. In the first approach, the performance of a number of different mini scrubbers was compared theoretically and experimentally with that of a pilot venturi scrubber (see Fig 1), one hundred times larger. The pilot venturi was found to be more efficient than any of the mini scrubbers tested. In the second approach, an attempt was made to improve the accuracy of existing mathematical models for quantitative prediction and also to improve the venturi performance. The outcome only showed a slight improvement in some cases.

We also examined the potential for using a fabricated pilot-scale gravity spray tower as a particle collector. The specifications were based on theoretical spray tower performance calculations. Preliminary experimental work, carried out on spray tower, shows that particle collection efficiencies of around 95% can be attained.

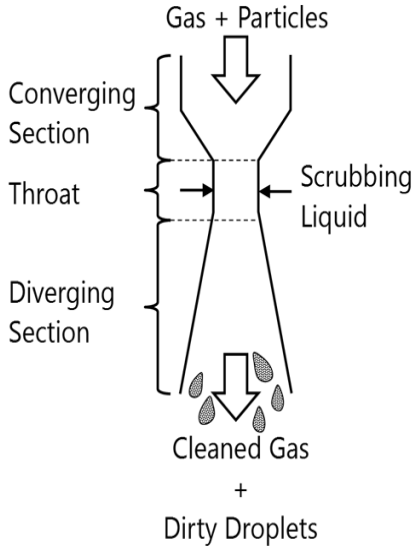


Fig 1: Schematic diagram of a pilot venturi scrubber

The work clearly showed us that a negative result is a good result from research point of view. It also demonstrated the difference between a research project and a design project – design has a pre-defined end-point while research is open ended when carried out properly. Finally, we were exposed early to the nexus between research, consultancy and industry as well as how wet scrubbers can contribute to achieving zero emissions.

This work marks the beginning of my core research area which is computer-aided mathematical modelling of process engineering systems. As a chemical engineer, this aligns perfectly with the naturalist mode in the sense that we use mathematics to mimic real life processes and equipment thereby reducing drastically the need for laboratory experimentation with some of its adverse effect on nature.

“NATURE ENGINEERS: FROM IDEAS TO IMPACTS”

1. INTRODUCTION

Chemical Engineering is a diverse, in-demand and ever-evolving discipline. It blends physics, chemistry, mathematics, biology, and design to address every day and global concerns while developing breakthrough processes and products. Its scope of practice includes the invention, design, and control of processes and products involving molecular change, both chemical and biological, as well as their operation. Chemical engineers create economic commercial processes for converting raw materials into valuable products. The raw materials are unlimited as new ones are being made available almost on a daily basis. Examples include using:

- a. sand to make glassware;
- b. crude oil to make various petroleum products including gasoline, kerosene, and diesel;
- c. vegetable oils for producing margarine;
- d. cotton fibers to make fabrics, household textiles, and apparel;
- e. agricultural commodities like yam for producing pounded yam.

Chemical engineering is a discipline that affects facets of industrial life as diverse as the production of consumer items and the generation of nuclear power. It has a rich history, evolving from batch production to industrial chemistry and eventually forming into chemical engineering. George E. Davis is considered the father of chemical engineering for his

contributions, including introducing the concept of unit operations. The profession gained recognition with the development of formal chemical engineering education and associations like the American Institute of Chemical Engineers.

Chemical engineering has been defined by many people in so many ways (Aris, 1977; Duncan & Reimer, 2019; Nnaji, 2019; Ikhu-Omoregbe et al., 2023). All engineers use mathematics, physics, and the engineering art to solve technical problems in a safe and economical manner. In addition, chemical engineer alone utilizes the knowledge of chemistry and life sciences to solve a wide range of problems. Chemical engineers therefore develop and design large-scale processes that convert chemicals, raw materials, living cells, microorganisms and energy into more useful forms and products. Majority of these sources are usually in their natural forms before being transformed. The conversion processes generate wastes which are materials that are not the prime products. The current goal of chemical engineers is designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources. The emphasis is now on resource recovery rather than waste management, which is also referred to as the Waste-to-Wealth concept. Chemical engineers use modelling and simulation techniques to design, optimize, and understand the behavior of these complex processes on an industrial scale. Thus, modelling and simulations are one of the core areas of chemical engineering. It is the bridge between abstract mathematical and scientific theory and its concrete application in industrial settings. Like nature, but under different paradigms, chemical engineers also deal with the processing of matter, energy and data. In the context of this lecture, naturalist means how chemical engineers develop

processes and products that are environmentally friendly and resource-efficient by drawing inspiration from nature.

In the subsequent sections of this lecture, we highlight some of the research works done with the aim of adding value to raw materials from nature. We start by looking at barite upgrade, waste-to-energy technologies, solar energy conversion and energy storage, food quality, and resource recovery. Before concluding, we illustrate how mathematical modelling was used to simulate the conversion of crude oil to more useful products; and the computer-aided process engineering software we developed for facilitating the design of individual process units, such as distillation columns, and heat exchangers.

2. BARITE UPGRADE

Barite is the natural form of barium sulphate (BaSO_4), which is produced primarily from barite deposits. The primary use of barite is as a weighting agent during the preparation of drilling mud in the oil and gas sector. Barite equally serves as a source of raw mineral for filler in paint and plastics; sound reduction in engine compartments; coat of automobile finishes for smoothness and corrosion resistance; friction modifier products for automobiles and trucks brake systems; radiation-shielding; cement; glass ceramics; production of barium hydroxide; and white pigment for textiles, paper, and paint. Approximately 85% of barite goes into the oil industry, about 10% into the chemical industry, 5% into the filler market (Otoijamun et al., 2021).

Nigeria has significant commercial reserves of barite, estimated to be over 22 million metric tons. As shown in Fig 2, these reserves are found across several states, including Adamawa, Benue, Cross River, Ebonyi, Gombe, Nasarawa, Plateau, Taraba,

and Zamfara (Ebunu et al. 2021; Afolayan et al., 2021; Otoijamun et al., 2021). Despite this abundance, the international oil companies (IOCs) operating in Nigeria disregard its use, claiming that the quality of Nigerian Barite is poor. Thus, increasing the IOCs operational costs and substantive loss in economic opportunities associated with local resource utilization (Afolayan et al., 2021).

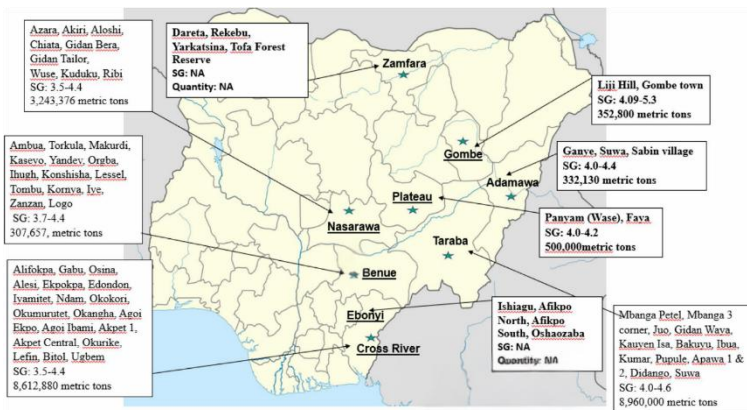


Fig 2: Barite deposit map of Nigeria showing the locations, quality, and reserve estimates (Afolayan et al., 2021)

The specific gravity (SG) of barite is a critical parameter for its application as a drilling mud component. The quality of barite from deposits in Nigeria (see Fig 2) can be broadly grouped as low quality (SG: 3.0–4.0), medium quality (SG: 4.0–4.2), and high quality (SG: Above 4.2) (Afolayan et al., 2021). For its application as a drilling mud component, SG values should range between 4.1 and 4.6 (Ebunu et al. 2021). Lower-grade barite sources that do not meet this specification requires further processing to improve their suitability.

In our works, we studied barite ores from Azara and Obubra. Azara (8.3661° N, 9.2491° E) is located in Awe local government area of Nassarawa state of Nigeria. The Azara barite deposit is a significant hydrothermal vein deposit within the Cretaceous Keana sandstone of the Middle Benue Trough. It is characterized by multiple veins (about 18) trending in three primary directions: northeast-southwest (NE-SW), northwest-southeast (NW-SE), and east-west (E-W). It has an estimated 70,000 tonnes of barite resource. Obubra, on the other hand, is a Local Government Area in Cross River State, Nigeria, known for barite mineralization and estimated to have significant barite reserves. Methods such as elutriation (desliming), froth flotation, and leaching were explored for the beneficiation of barite from Azara and Obubra with emphasis on optimizing these processes to improve their quality, which are essential for meeting American Petroleum Institute specifications (API, 2019).

The raw barite samples from Obubra and Azara have SGs of 3.99 and 3.47, respectively. The SG of the Obubra sample after desliming was 4.15, hence it was not further processed because its quality was close to the required API specification of 4.2. The low-quality Azara raw sample requires additional processing (desliming, froth flotation, and acid leaching) to achieve an SG value of 4.26. Other detailed results obtained are documented elsewhere (Utibe et al., 2022; 2023; 2024a; 2024b; 2025). We believe our results added value to the raw barite and contribute to the ongoing diversifying the Nigerian economy by developing the mining sector.

3. ENERGY

Chemical engineering contributes significantly to the energy sector by developing sustainable and efficient processes for energy generation, conversion, and storage. The key roles of chemical engineers in energy include:

- designing and optimizing processes for biofuel production, solar energy conversion, and hydrogen production.
- developing advanced energy storage solutions like batteries and fuel cells, which are essential for integrating renewable energy into the grid and for powering electric vehicles.
- optimizing processes for extracting, refining, and processing fossil fuels, as well as developing technologies for carbon capture and storage to mitigate their environmental impact.
- development of advanced reactor technologies like modular nuclear reactors, design and operation of nuclear power plants and fuel cycle management.
- improving energy efficiency across various industries by optimizing processes, developing energy-saving materials, and designing more efficient equipment.

Thus, chemical engineers bridge the gap between scientific discoveries and practical applications in the energy sector, driving innovation and developing sustainable solutions for a cleaner and more efficient energy future. Our contributions in the energy sector are in the areas of waste to energy technologies, solar energy conversion, hydrogen production, and energy storage.

3.1 Waste to Energy Technologies

In Nigeria, the cost of fossil fuel for domestic use (cooking gas and kerosene) is high and beyond the reach of an average rural dweller. Apart from this, fossil energy depletes with its usage and it is not a renewable. However, quite a number of the biomass resources (sawdust, maize stalks, rice husks, etc.) are waste products which are generated in large quantities. Direct burning of these wastes result in low thermal efficiency and wide spread pollution as well as the associated ecological problems with their disposal methods (Jekayinfa and Omisakin, 2005). One way of overcoming these issues is to convert the wastes to solid fuels through briquetting.

Simply put, briquetting is the densification process for improving solid fuel properties. A good briquette should have low moisture content, high crushing strength, high density, slow flame propagation and substantial energy content. In the briquetting process, binders are added to improve some of the properties and durability of the briquettes.

Our work (Magnus et al., 2016) investigated the production of briquettes from rice husk with cassava peels as the binder instead of the commonly used cassava starch. Rice husk is the membranous outer covering of rice and it is quantitatively the largest rice milling residue. Cassava peels, on the other hand, is completely a waste product. The combustion characteristics of rice husk briquettes made with cassava starch and cassava peels respectively as binders were also determined and compared. It was found that rice husk briquettes made with either cassava starch or cassava peels as the binder are very stable with good handling and storage characteristics. Generally, both the physical and combustion characteristics of rice husk briquettes made with cassava peels as the binder were better than the briquettes with

cassava starch binder. The relax density and combustion rate were higher for briquettes made from cassava peels when compared with that from cassava starch.

In another work (Ini & Kuye, 2017), we produced briquettes using a fabricated hydraulic piston press. The press (see Fig 3) consists of three basic components: the main frame, the mold and a hydraulic jack fitted with pressure gauge. The parts are readily available in Nigeria and relatively cheap. The piston press was used to produce briquettes at 120 bar compaction pressure using composite sawdust and different cassava based binders (see Fig 3). The sawdust particle sizes were also varied. Both, the density and the ash content of the briquettes produced were found be dependent on the sawdust particle size. The flue gas emission from the combustion of sawdust briquettes was found to contain 18.6–56.5 ppm of carbon monoxide (CO), 0.19–0.8 ppm of sulphur dioxide (SO₂) and 0.01–0.54 ppm of hydrogen sulphide (H₂S). These properties make the briquettes suitable for domestic cooking and possibly for industrial heating.

Samples of rice husk briquettes produced are shown in Fig 4a. The properties of the various briquettes produced are presented elsewhere (Magnus et al., 2016). The briquettes produced from sawdust when cassava peels starch/powder was used as a binder is shown in Fig 4b. The quality of briquettes assessed on the basis of external features was very good. Their external surface was smooth and the structure of their cross-section was compact and homogenous. All the briquettes produced were of cylindrical shapes with different height but same diameter as shown in Fig 4b. The colour was dependent on its moisture content; fresh briquettes from the mould were darker than the sun dried ones

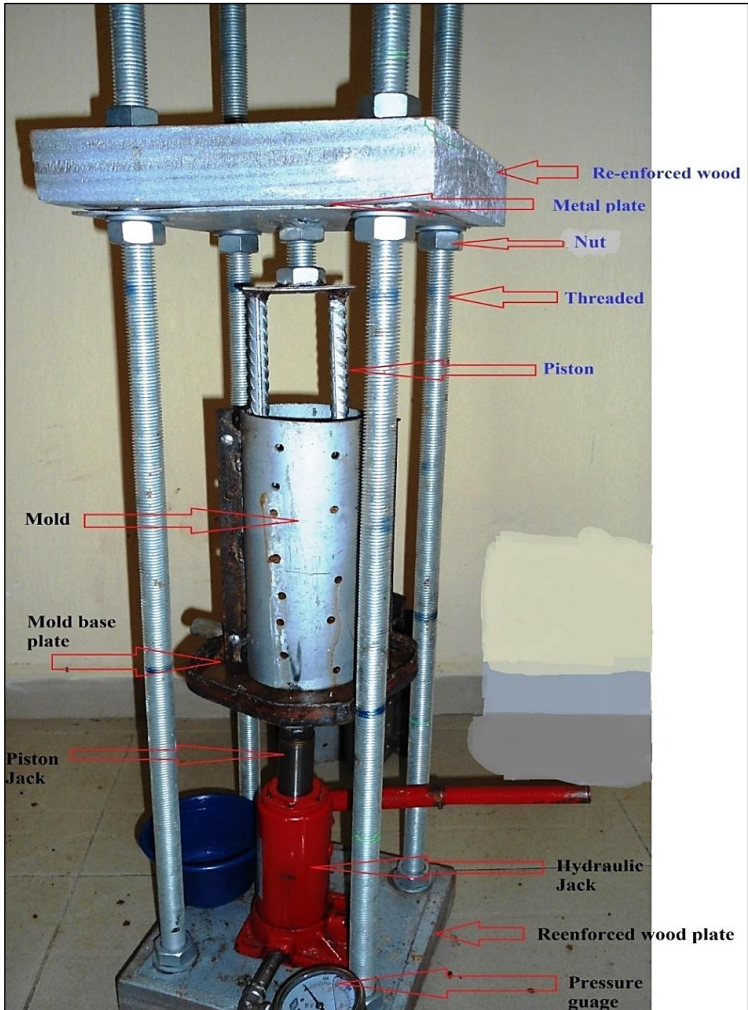


Fig 3: Fabricated hydraulic piston press for briquette production



Fig 4a: Samples of rice husk briquettes produced.



Fig 4b: Samples of sawdust briquettes.

3.2 *Solar Energy Conversion*

The sun is a natural energy source for mankind; it is clean and possesses a tremendous amount of thermal energy carried by electromagnetic radiation. The sun has a diameter of 1.39×10^6 km while the diameter of earth is 1.27×10^4 km. Sun subtends an angle of only 32° at earth's surface because of large distance between them. Sun emits electromagnetic radiations (also known as Solar Radiation) as a black body having a surface temperature of about 6000 K. The average solar radiation outside the earth atmosphere is known as solar constant and has a value of 1367 W/m^2 (recommended by World Radiometric Center).

The total radiation, also called global radiation, reaching the earth surface comprises diffuse, direct and albedo components. The direct solar radiation arrives directly from the sun and is measured by a pyrheliometer mounted on a solar tracker. Diffuse radiation is the scattered and reflected radiation that is sent to the earth surface from all directions (reflected from other bodies, molecules, cloud, particles, droplets, etc.). Solar radiation for a given location is given in terms of hourly, daily, monthly and yearly basis.

As the solar radiation passes through the atmosphere and depending on the state of the atmosphere at a specific locality, about:

- a. 10-30% gets absorbed by particles and molecules in the atmosphere;
- b. 2-11% gets reflected and scattered back to space;
- c. 5-26% gets scattered to earth (direct radiation becomes diffuse); and
- d. 33-83% reaches the earth surface (or the device installed on the earth surface).

The direct solar radiation map for Nigeria is shown in Fig 5. The figure shows higher potential in the northern regions compared to the south. The north receives more solar radiation while the south, especially in the coastal areas, receives less.

Direct solar radiation can be utilized in two ways:

- a. Solar thermal systems which convert sunlight through parabolic collectors into heat that is then used for various applications such as heating water or producing electricity via steam turbines.
- b. Solar photovoltaic (PV) systems which directly convert sunlight into electricity using solar cells.

Solar radiation is a key factor in the design and evaluation of solar systems. Naturally, the best radiation data are those observed experimentally at the study site. However, actual measurements of solar radiation are generally made only at a few places because of the cost of the equipment required and the care needed for maintaining it. Empirical models often provide a computational means of representing observed insolation.

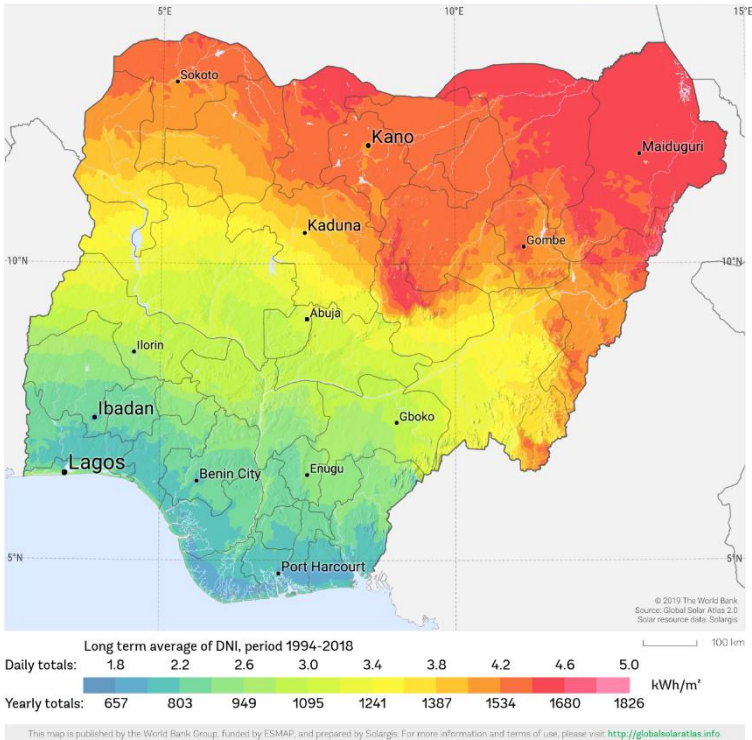


Fig 5: Solar radiation map of Nigeria

In our work (Kuye A. & Jagtap, 1994), we presented 11 different empirical models for the estimation of solar radiation from climatological data for Port Harcourt. The results obtained showed a good agreement between the actual data and those calculated using various climatological data. It was found to vary with the climatic changes of the year; the variation being greatest in August. Based on the calculated average monthly clearness index values only five seasonal patterns are identified for Port Harcourt. The percentage of days with duration of sunshine less

than 1.5 h is 28.3% while that greater than 9 h is 4.3%. The Angstrom type of regression model relating total global irradiation to sunshine duration has been found to be reasonably adequate only if long-term average monthly values are used. The clearness index is the fraction of the solar radiation that strikes the surface of the Earth. It is a dimensionless number between 0 and 1 and is defined as the surface radiation divided by the extraterrestrial radiation (radiation at the top of the atmosphere).

The quest for food security is important for human happiness, as noted in Nigeria's agricultural history. One of the staple foods in Nigeria is gari, which is derived from cassava (*Manihot esculenta*). The cassava-to-gari production line requires significant energy inputs, which have consequences for the environment through greenhouse gas emissions and deforestation. The most energy-intensive process in the cassava-to-gari production line is frying/roasting. The traditional frying process, mainly supported by burning solid fuel (firewood) in Nigeria, contributes immensely to environmental degradation and climatic change due to the felling of trees, which are natural carbon sinks, habitats and erosion control agents. The women and the girl child are the primary victims of the health hazards of the frying process because they are mainly responsible for the frying process.

As stated earlier, solar energy could be converted to thermal energy and electricity depending on the conversion technology; photovoltaic panels to electricity and parabolic collectors to heat. In our work (Sobarasua et al., 2024), we conceptualized a novel healthy and environmentally friendly solar-powered fermented cassava frying process using available local resources and it was demonstrated experimentally to support the Federal Government

of Nigeria’s policy targeting sustainable and improved cassava production value chains (Ikuemonisan et al., 2020) . In addition, the project was also conceived to alleviate the suffering of women and girls involved in the cassava value chains, usually in rural communities, to meet SDGs 1 (no poverty), 2 (zero hunger), 5 (gender equality) and 13 (climate action) specifically.

The system comprises a parabolic dish solar collector, energy storage, and frying pan, designed and fabricated using local materials (see Figs 6 and 7). The energy storage (thermal) material (gravel) enclosed in a casing was placed at the focal point of the collector to absorb the energy and deliver steady heat to fry/roast the fermented cassava in the pan.

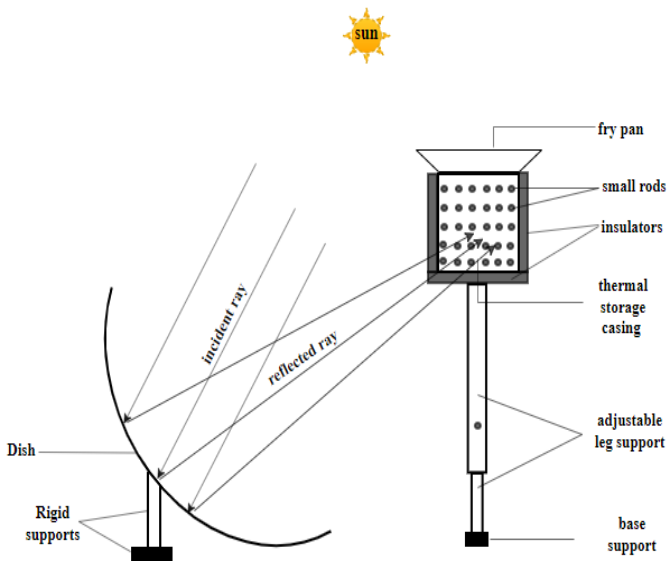


Fig 6: Schematic of fermented cassava roasting system

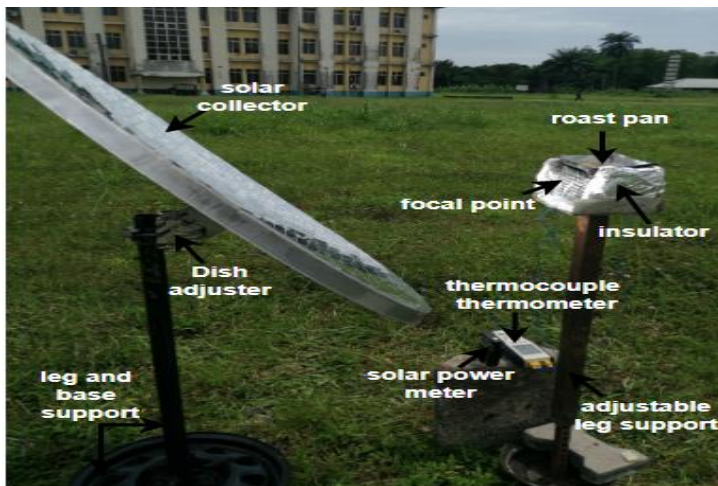


Fig 7: Photograph of solar gari roasting system

Important data (temperature, moisture content and fry/roast time) on the gari production food chain was obtained from a work study in a rural community. The roasting temperatures range between 85°C - 100°C . The designed and fabricated parabolic dish solar collector achieved temperatures between 118°C - 154°C at optimum tilt angles (see Fig 8) at Port Harcourt ($4^{\circ}54' 22.86''\text{N}$, $6^{\circ}55' 27.52''\text{E}$) climatic conditions. The focal length ranges between 50 mm and 80 mm, and the fluctuation of the focal point position was considered for the thermal storage system design. Gravel was used as thermal storage, and heat transfer was enhanced through small internally placed mild steel rods. The experimentally obtained average total fry time per batch (40g) was 24 minutes, which is more than the theoretical value of 8.5 minutes. The fermented cassava roasting experiment was conducted for three days under favourable weather conditions in the rainy season and the temperature of the storage material during roasting was within the range of 100°C to 120°C .

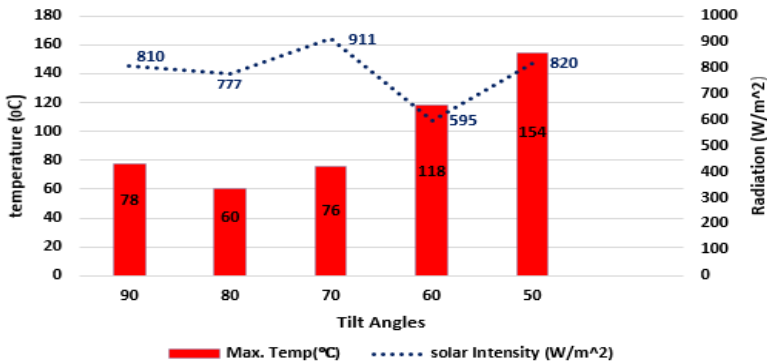


Fig 8: Maximum temperatures at different tilt angles

3.3 Energy Storage

The global energy related challenges seek a robust, reliable and sustainable energy mix solution. Most of the renewable energy sources are seasonal and require energy storage systems that would level up demands at all seasons. Thermal Energy Storage (TES) are systems that accumulates thermal energy in a medium to be used in a later time. TES has attracted growing interest for thermal applications such as hot water, space heating, cooling, and air-conditioning. Our study (Onuche et al., 2023) introduced a new criterion, called fractional area (FA), for quantitatively comparing the heat retention capacities of different materials using the area under the curve of temperature-time plot produced by the materials. FA represents the material’s relative thermal retention capacity.

Fractional area (FA) concept was tested with experimental temperature variation with time data for the six storage materials (sand, gravel, clay, salt, and kaolin). It was shown that there is a linear relationship between FA and specific heat capacity for the 5 materials as can be seen in Fig 9.

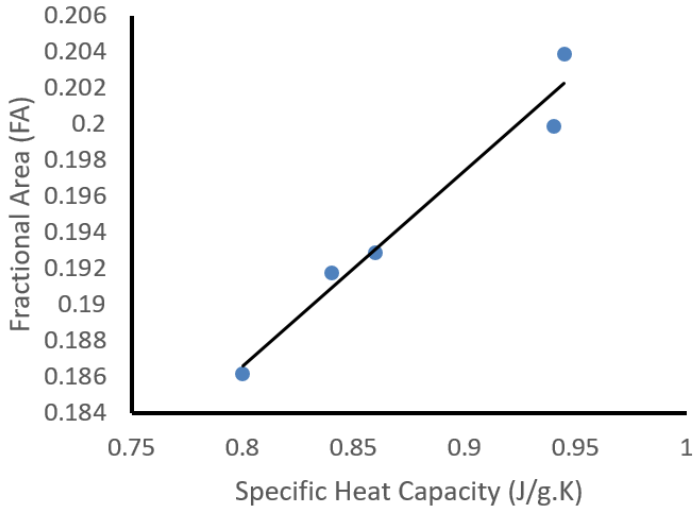


Fig 9: Linear relationship between FA and specific heat capacity

4. FOOD QUALITY

Chemical engineering plays a key role in ensuring consistent food quality. The principles of process engineering are used to design food production systems that enhance efficiency and reliability as well as ensure compliance with defined quality standards. Chemical engineers also focus on optimizing processes to limit variability. Techniques such as statistical process control (SPC) allow for real-time monitoring of production, helping to swiftly identify deviations from quality benchmarks. In our works, we have collaborated with food scientists to study the sorption isotherms of some Nigerian foods (Sanni et al., 1997; Sanni et al., 1999; Kuye & Sanni, 2002; Kuye & Ariri, 2005; Adebowale, et al., 2007). Sorption isotherms describe the relationship between a food's moisture content and its water activity at a constant temperature. They are crucial for understanding how water interacts with food, influencing product stability, shelf life, and processing techniques.

We have also carried out a techno-quality analysis of locally produced gari through experimental studies (Onuche et al., 2024). Available data indicate that there were wide variation in cassava production potential in Nigeria between 1961 to 2020 with appreciable increase of cassava production occurring within the period 1981 to 2000. Identified factors such as government policies and interventions; cassava virus and bacteria are responsible for this variation. Gari has several value chains with roasting playing a dominant role in the energy consumption and quality. Gari was produced using three fermentation pathways with each product stored in three different types of storage containers (plastic container with cover, airtight polythene bag and ordinary polythene bag) for 15 weeks and monitored regularly for quality purposes. Results obtained indicated that fermentation duration, with the exception of acid content, does not significantly affect the moisture content, swelling index and bulk density of gari within the period under investigation. These results will be useful for designing an improved environmental friendlier and climate responsive gari roasting process unit powered by solar energy in the context of energy efficiency and quality control.

5. RESOURCE RECOVERY

5.1 Sawdust to Bio Oil

Sawdust can be converted into bio-oil through fast pyrolysis, which involves heating the sawdust at high temperatures (typically between 400-600°C) in a reactor without oxygen. In the process, the sawdust is thermally decomposed to biochar, bio-oil and non-condensable pyrolysis gas. The bio-oil quality and yield are significantly influenced by various operational parameters. Bio-oil generated from sawdust can be used as a sustainable feedstock for producing renewable fuels and chemicals.

In our work, we have produced bio-oil from sawdust (Kuye et al., 2016; Ahiekpor et al., 2017). Ahiekpor et al., (2017) investigated the interactive effects of fast pyrolysis reaction variables on bio-oil yield from indigenous African hardwood sawdust and to optimize the reaction conditions in a truly inert environment using a novel fixed bed reactor fabricated in-house (see Fig 10). The effects of temperature, particle size, and sweep gas flow rate on the amount of bio-crude produced were experimentally studied and subsequently evaluated using a central composite circumscribed surface response methodology, the outcomes of which were analyzed using regression analysis with the aid of Design Expert Statistical Package. The results suggested that temperature was the most important factor, which influenced the amount of bio-oil produced. A further result was that the interactive effect of the parameters investigated was not significant. The calculated optimum conditions for maximising bio-oil yield were a reaction temperature of 530 °C, sweep gas flow rate of 3 L/min and particle size of between 0.71 mm to 1 mm. At this conditions, the calculated optimum bio-oil yield was 46.9 wt%.

This is an interesting example of life cycle economy where a waste product (sawdust in this case) is converted into a valuable resource (bio-oil), potentially reducing waste and creating a renewable energy source (Lu & El Hanandeh, 2019).

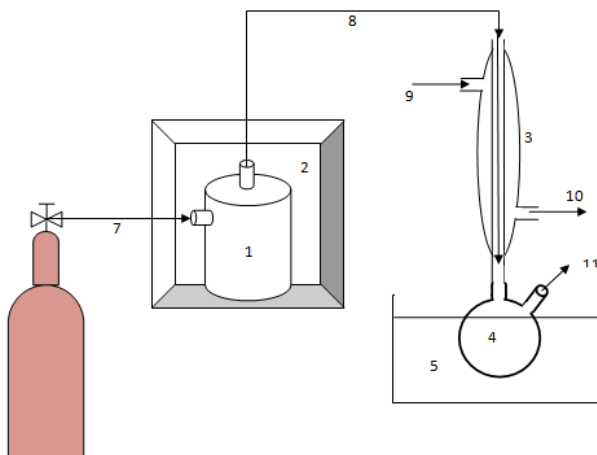


Fig 10: Schematic diagram of pyrolysis experimental set-up: 1. Reactor, 2. Furnace, 3. Reflux condenser, 4. Bio-oil collector 5. Ice trap, 6. Nitrogen bottle, 7. Inert/sweep gas inlet, 8. Vapor outlet 9. Cooling water inlet, 10. Hot water outlet, 11. Non-condensable gas outlet.

5.2 *Plastic Waste to Kerosene Grade Fuel*

We have also used locally made catalyst from coconut shells and corn cob in the pyrolysis of waste sac bags into kerosene-grade fuel (Iheonye et al., 2021; 2023). The experimental setup is similar to that shown in Fig 10. Thermal and chemical activation methods were used to prepare the local catalyst from corn cob and coconut shells. Scanning electron microscopy method was used to investigate the morphology and texture of the coconut shell activated carbon catalyst. Response Surface Method was used to design the experiment, and investigate the effect of operating parameters on fuel oil yield. The results showed that corn cob and coconut shells, which are waste materials, can be used as an alternative to synthetic catalysts. They are effective in the conversion of waste sac bags to aviation kerosene fuel grade. Yield of up to 64.54 % were obtained at 600 °C with corncobs activated carbon catalyst (see Fig 11).

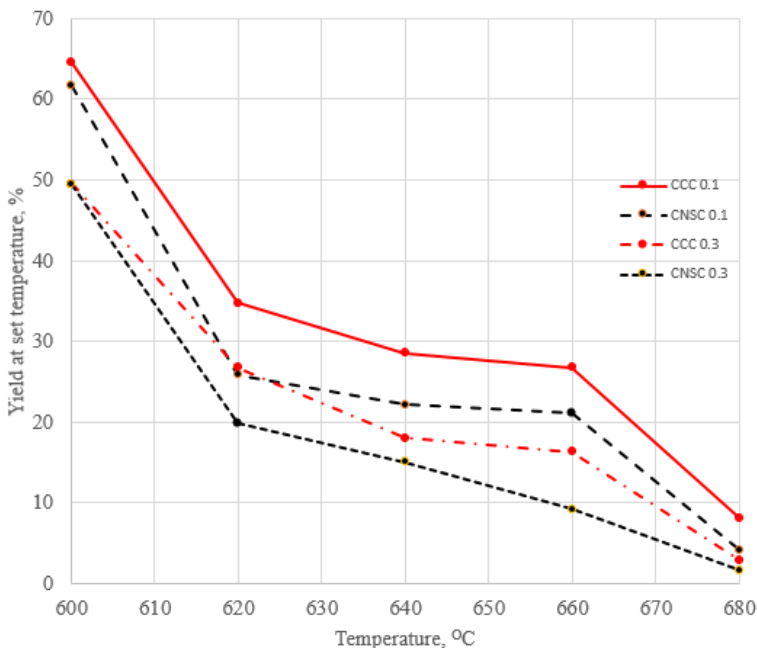


Fig 11: Effect of temperature and catalyst to feed ratio on the aviation kerosene grade yield temperature

Although our works concentrated on liquids, pyrolysis generally gives three products namely: non-condensable gases, oils and charcoal. A number of factors, such as the feedstock's composition and process parameters, affect the proportion of these products. These products can be used for different industrial applications. For instance, oils are used in the chemical industry and gas as an energy source. Bio-char, which is obtained from pyrolysis of organic waste (such as sawdust), has multiple applications in agriculture; it can be mixed with soil to enhance its quality.

6. MATHEMATICAL MODELLING

From an engineering point of view, models are of two types; a physical model and a mathematical model. The physical model describes the actual process that exists in the real world, while the mathematical model is the mathematical description of the physical model. A physical model to a chemical process is the pilot plant, but the advent of computers catalyzed development of mathematical models. Mathematical modelling or simply modelling is done in almost all phases of chemical engineering - bench scale studies, process synthesis, process design, scale up studies, etc. Process modelling is best done in stages. The first stage consists of development of unit models. The second stage includes combining these unit modules to arrive at the process model. Our works focus on the first stage and some of them are presented below.

(i). Simulation of Warri Refinery Topping Unit: Distillation is the most widely used separation process in oil refineries and chemical process industries. In this work, Ogboja & Kuye, (1985), a mathematical model was used to obtain the theoretical analogue of the atmospheric distillation column of the Warri Refinery. Desalted crude oil at the required temperature is fed into the distillation column and after processing converted to LPG, light naphtha, heavy naphtha, kerosene, light gas oil, heavy gas oil and residue. The mathematical model was solved using the crude oil and products data and physical property data as outlined by Kuye (1981). The computer program of the model was run on an IBM 370/145 machine and the total execution time was seven minutes. A comparison of actual and calculated values of temperature and draw-off points is presented in Fig 12. This result and others obtained indicated very good agreement between actual and calculated values. Hence, the program is a

good theoretical analogue of the main column of the topping unit of the Warri Refinery.

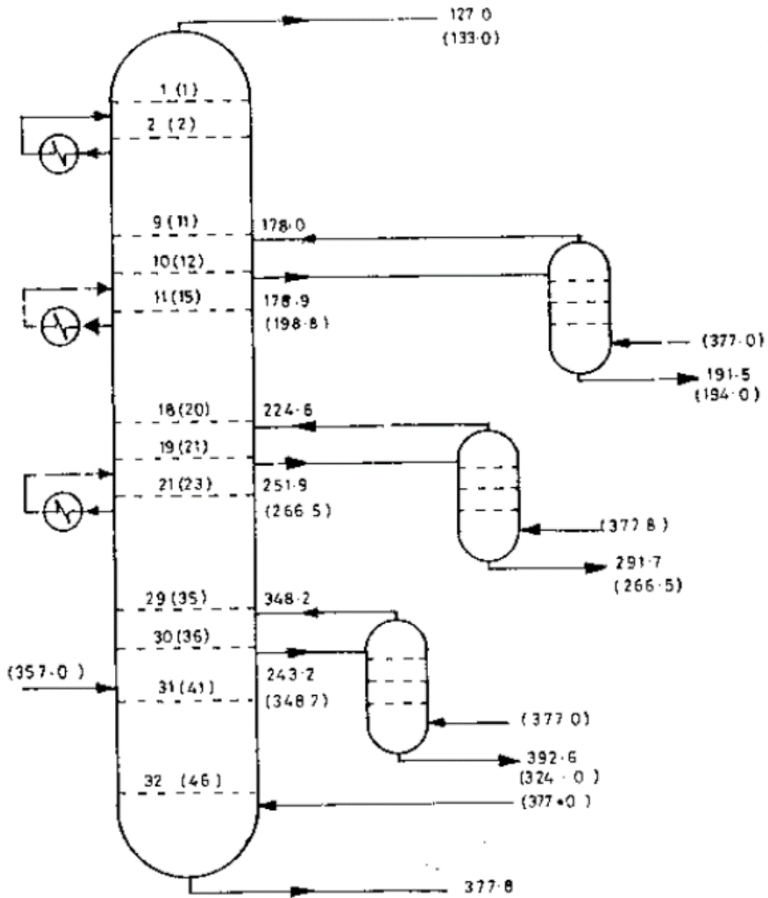


Fig 12: Temperature and draw-off points for main column and side strippers (Actual values are enclosed in brackets).

(ii). A Procedure for the Design and Optimisation of Sieve Trays: The distillation column contains internal devices such as bubble cap trays, sieve trays, and valve trays. Each type has unique benefits and drawbacks in terms of efficiency, cost, and operational flexibility. In our work, Ogboja & Kuye (1990) applied the randomized direct search technique to optimize sieve tray design. The design data was considered first before presenting the optimisation procedure. Although a lot of work had been done to provide data for the design of sieve trays, much of these data were in forms that are not very suitable for computer implementation. We, therefore had to convert the data that were available as charts or graphs in the literature to analytical forms. On average, the correlations predict the chart data to within 3% margin of error.

The optimization problem requires the computation of the optimal value of the tray efficiency from any suitable correlation subject to some specified constraints. The non-linearity of the objective function and the constraints makes the application of a search technique imperative. The procedure was tested with four different fluid systems. The results gave the global optimum value of the dependent variable. In this study, ten variables were involved and twenty points were generated for testing for optimality. The procedure was implemented with WATFOR77 on a Compaq Deskpro 286 microcomputer. The program was compiled in 7.03 seconds while the execution times for the fluid systems tested ranged from 10.03 to 12.47 seconds.

(iii). Simulation of the Drying Characteristics of Ground Neem Seeds in a Fluidised Bed (Kuye et al., 2007): Neem seeds are extracted from neem tree (*Azadirachta indica A. Juss*) and are rich in neem oil that is used as insecticides and pesticides. This study presented a mathematical model for simulating the drying characteristics and the temperature distribution of wet ground neem seeds in a fluidized bed dryer. Experimental values obtained from literature were used to validate the model prediction. Typical results are shown in Fig 13. The drying simulation results showed that there was a good agreement between the experimental values and the corresponding model predictions.

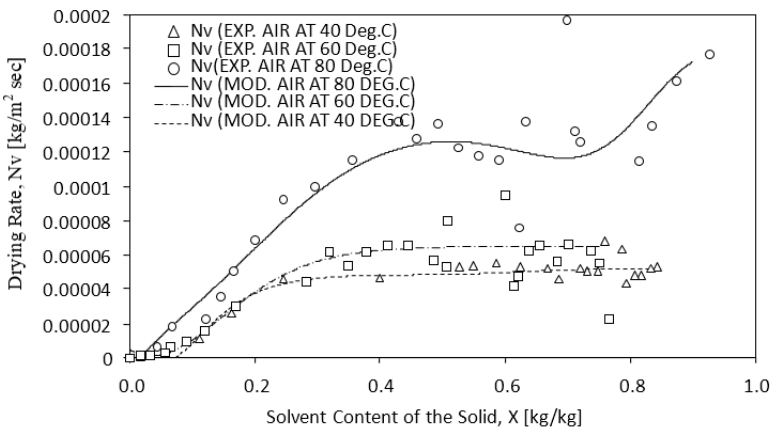


Fig 13: Drying rate curve of ethanol treated solids

7. PROCESS ENGINEERING SOFTWARE

Computer-aided process engineering software generally refer to tools that utilize computers to facilitate the design, analysis, simulation, and optimization of chemical processes. They can be used to

- a. model and simulate the behavior of chemical processes under different conditions, enabling them to predict

- performance, identify potential bottlenecks, and optimize process parameters.
- b. design individual process units.
 - c. determine the appropriate size and specifications for process equipment, ensuring efficient and safe operation
 - d. analyze process data, identify inconsistencies, and reconcile data to ensure accuracy and reliability.

We have developed and tested a number of process engineering software. Some of these are discussed below.

(a). Quality control calculations and project evaluation

Project management is part of every engineering task. Such task includes planning and scheduling, risk management, resource management, and quality control. Kuye (1993) presented a comprehensive discussion on the basic elements needed for project management as well as a detailed review of available numerical techniques. These information were then used to develop and test a spreadsheet program that can be used to calculate both ROIBT (return on investment before taxes) and DCFRR (discounted cash flow rate of return). The template can be sub-divided into six sections – the input, calculation of ROIBT, calculation of DCFRR, annual return on investment analysis, cash flow analysis and a summary of range/macro definitions. The program can be used for parametric studies such as variation of ROI as well as DCFRR with production capacity or sales price.

Also in the process industry, the most commonly used quality control tool for detecting changes in process performance is the control chart. Control charts are drawn up by taking samples of items and plotting a statistical representative of the sample such as its mean on a graph. This gives a sequential plot of

observations. If the plot crosses lines previously drawn on the graph (the confidence limits), a significant change in the process is said to have occurred and actions to correct the fault must be taken. The chart thus gives a warning of trouble and of when to take action. The developed program for performing quality control calculations (Kuye, 1992) comprises five sections namely the Input, statistical values needed for the R-chart, calculations for the mean and range charts, and a summary of range/macro definitions. The program was tested extensively using twenty-six different process data and the results confirmed the adequacy of the program.

(b). Design and Implementation of a Physical Property Databank

Physical property data is essential for process design, simulation, and optimization. This data is used to model and predict material and system behavior as well as ensuring that industrial processes run efficiently and safely. Ikiensikimama and Kuye (2005) presented a detailed specification of a physical property information system using Visual Basic 6. The physical properties used were classified into two categories; the functional properties that depends on temperature and those that can directly be used, and they contain 24 parameters for each compound. Some of these parameters can be used directly while others are for computing other properties. With the developed system, it is possible to add, delete or edit physical properties of the compounds (see Fig 14). The compounds can be sorted alphabetically using the name or formula. Range searches as well as the use of wildcard characters are supported by the system.

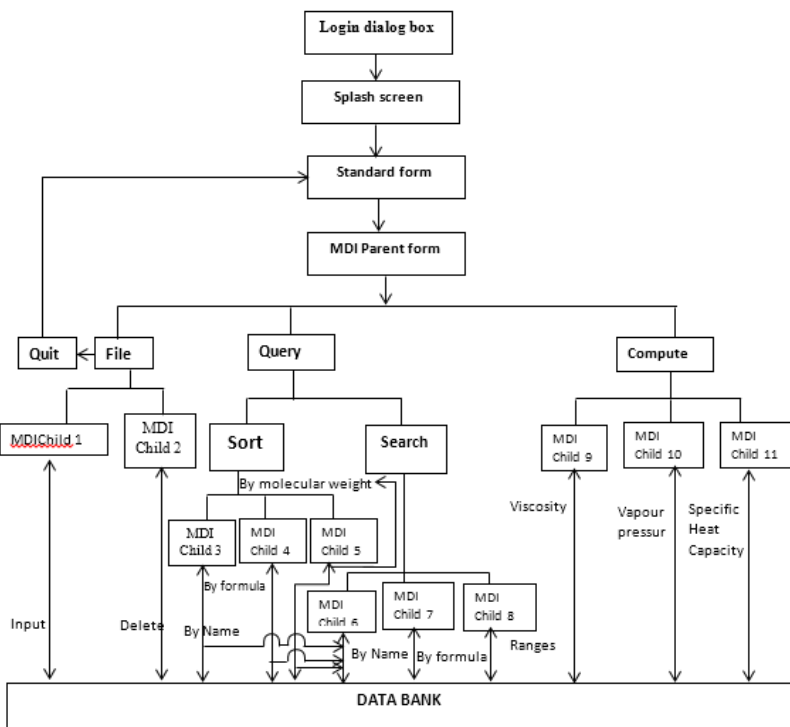


Fig 14: An overview of the system

(c). Shell and tube heat exchanger design

Shell and tube heat exchanger is process equipment for exchanging heat between hotter and cooler fluid. They are the most widely used heat exchangers in the chemical and allied industries. In our work (Kuye & Edeh, 2011), an Educational Software for Shell and Tube Heat Exchanger Design was developed. The Software can be used for teaching, learning and preliminary thermal design, as well as rating of different configurations of shell and tube heat exchangers. The program is structured to be executable on microcomputers and it is validated to guide the user on how to make standard inputs. Its interactive graphic features (see Fig 15) allow the selection of the exchanger

configuration and change of design condition to be performed with ease. The step by step approach of software development has been adopted in this work to simplify the design and teaching of shell and tube heat exchanger. With the provision of a tutorial module in the task component of the software, the user learns the basic concepts required in the design of shell and tube heat exchanger, such as preliminary information on shell and tube heat exchanger, shell and tube example, design consideration and design equations.

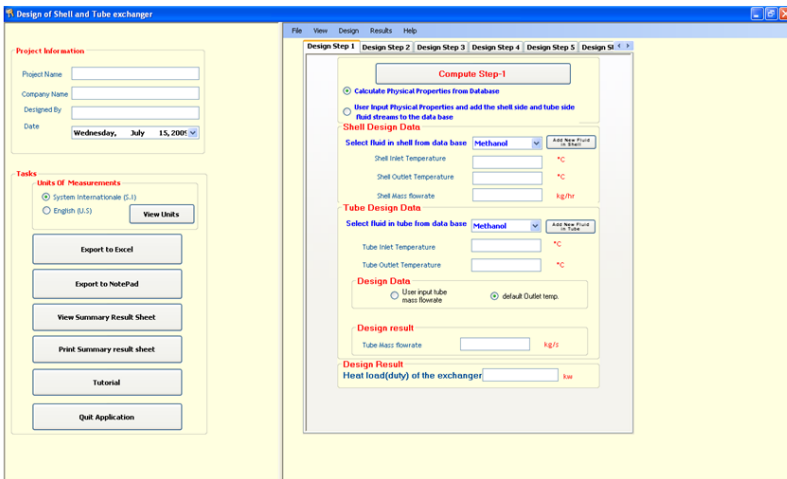


Fig 15: Shell and tube heat exchanger design software

(d). National Project on Computer Aided Process Equipment Design (CAPED)

This work was sponsored by the Raw materials Research and Development Council (RMRDC), Abuja. The other team members are: Dr. D. B. Ayo from RMRDC, Abuja, Prof. F. O. Chukwuma from University of Port Harcourt, Prof Ken Okpala from Federal University of Technology, Owerri, Prof. A. S. Ahmed from Ahmadu Bello University, Zaria, Dr. S. N. Mumah

from Kaduna Polytechnic, Kaduna and Dr. T. O. Folami from TOF Engineers and Consulting Limited, Lagos. The ultimate goal of the CAPED Team was to produce a software suite for performance evaluation and process design of commonly used equipment for raw material processing.

A significant number of process equipment used in small and medium scale industries in Nigeria are largely fabricated by road-side artisans or semi-skilled craftsmen with very little knowledge of equipment design. Such equipment when in service are either not effective or grossly inefficient. It is therefore essential that design and manufacturing of process equipment be undertaken by those with the skill and training to do so.

Computer Aided Design (CAD) has made the design of processes and equipment easier. Powerful and comprehensive process simulators are available in the industrialized world to accurately model any process from single unit to a complete process plant. In less developed countries these simulation softwares are usually unaffordable by entrepreneurs who may desire to use them. In a country like Nigeria, the situation is compounded by high inflation and unstable economy. It was in this regard that the Raw Materials Research and Development Council (RMRDC) on March 4, 2004 constituted a Computer Aided Process Equipment Design (CAPED) team to develop simulation packages based on the experience of the Council with emphasis on those equipment used in small and medium scale industries. The Team submitted its final report in December 11, 2017.

The work involved the development of a process equipment design and simulation package using visual basic. The software's main interface is shown in Fig 16.

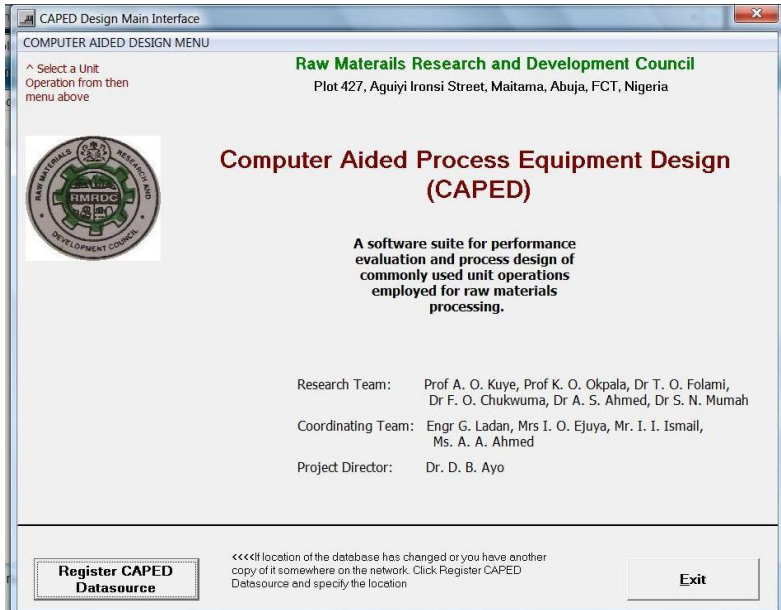


Fig 16: Main interface for CAPED software

The software developed comprises modules for three equipment, namely; gas cyclone, hydro cyclone and spray dryer.

GAS CYCLONE: Gas cyclone can be used in three principal areas, namely gas cleaning and product recovery duties in petrochemical plants/refineries, treating natural gas for power generation and cleaning exhaust gases in manufacturing plants to ensure environmental compliance. After critically reviewing available literature on the subject, the Team developed and tested a software for gas cyclones. The software produced is modular in design, interactive and user friendly and can be extended to handle dust-laden gases. Design information, cyclone

configurations and profiles are captured in the database with facility for updating as new information is gathered. Various test runs provide confidence that the outputs of the software can be used as specification data for fabrication of an intended cyclone. It is noteworthy that the software has been successfully used in the design and fabrication of a gas cyclone for the flash dryer at Godilogo Farms at Obudu, Cross River State.

HYDROCYCLONES: A hydro-cyclone is a device where solid particles or immiscible liquids are separated from water. Separation is based on density difference between the water and the matter to be separated. They are widely used in closed-circuit grinding operations, clarification of slurry, classification of solid and separation of two immiscible liquids. The software developed was tested with some examples taken from literature as well as data from Laboratory scale Hydrocyclone at National Metallurgical Development Centre, Jos. Generally, there was good agreement between the software output and the corresponding literature and experimental values.

SPRAY DRYER: The growing importance in spray drying is abundantly evident from the ever increasing number of its industrial applications. In spite of the impressive developments, the design of spray dryers has remained widely empirical. After extensive review of literature on spray dryers, the Team developed and tested a user-friendly software. The software developed was tested with some examples taken from literature. Analysis of particle size distribution of materials was carried out at the Department of Chemical Engineering, Ahmadu Bello University, Zaria. Generally there was good agreement between the software output and the corresponding literature and experimental values.

The output of the project (soft and hard copies) includes: three project reports, three monographs and five journals articles. The Team participated in RMRDC Techno Expo (2004 and 2006) National Science & Technology Exhibition (2005) Exhibitions. Three Master's Thesis were also produced from the work.

We want to thank the management of RMRDC for the opportunity to contribute to process equipment design in Nigeria thereby contributing to national development. We also want to thank the entire technical and secretarial staff of IPED at various times for the support given to the Team.

8. RESEARCH to INDUSTRY

One of cassava products with strong potentials for industrial use in Nigeria is cassava flour. It is produced by drying cassava mash. A flash dryer appears to be the most economical choice for drying mash and solids that have low moisture content and most especially heat sensitive materials. Flash dryer is a continuous drying plant used for drying variety of wet cakes. The principle is fairly simple. Wet particulate material is entrained in hot gas, usually air, flowing through an insulated duct. The powder remains suspended in air and gets conveyed while drying.

The design and fabrication of processing equipment in most developing countries are still faced with a number of problems due to lack of appropriate tools and equipment. In all the cases the resulting equipment are noisy, ineffective and with neither good finishing nor appearance. A national team was then constituted to design, fabricate, install and test an efficient and cost-effective flash dryer. The project, which lasted from 2006 to 2008, was sponsored by International Institute of Tropical Agriculture (IITA), Ibadan; Raw Materials Research and Development Council (RMRDC), Abuja; Root and Tuber

Expansion Programme (RTEP), Ijebu-Ife; and Godilogo Farms Nigeria Limited, Obudu. The IITA, RMRDC. RTEP and GODILOGO sponsored flash dryer was commissioned at Godilogo Farms Nigeria Limited, Km 42, Ranch Road, Obanliku, Obudu, Cross Rivers State on August 19, 2008.

The Team members were Prof. A. O. Kuye (Team Lead, Uniport); Dr. D. B. Ayo (RMRDC), Dr. L. O. Sanni (UNAAB, Abeokuta), Dr. A. O. Raji (UI, Ibadan); Mr. E. I. Kwaya (RMRDC), Mr. Obinna Otuu (SEDI, Enugu), Mr. W. Asiru (FIIRO, Lagos), Mr. B. Alenkhe (IITA), Mr. B. Abdulkareem (Edo A.D.P. Benin). Our efforts are well documented (Kuye et al. 2011; 2017). We also have a patent for this work (Kuye et al. 2015). The work provides fabricators with the specifications for an efficient flash dryer and helps to fulfill the aspiration of cassava processors, equipment fabricators, the Government, and people of Nigeria and of Africa in general. The Team:

- a. Reviewed available literature on the design of flash dryer system.
- b. Designed the major components of the flash dryer namely the feed mechanism, heat exchanger, drying duct and discharge mechanism.
- c. Used the RMRDC CAPED Software to design the cyclone (see Section 2.3).
- d. Rated the blower and burner.
- e. Produced the drawings.
- f. Fabricated and installed the flash dryer that can produce about 500Kg of dried cassava flour per hour.
- g. Designed and installed the Control Panel for the flash dryer.
- h. Tested the fabricated flash dryer.

Some of the pictures at different stages of the project are shown in Fig 17.



Fig 17: The flash dryer at different stages of fabrication

Samples of the products were collected during the testing stage analysed for proximate composition, particle size distribution and colour. These were compared with the results for products from other dryers and some available standards. The result is as presented in Table 1.

	%	%	%	Final	Pasting
	MC	Ash	Protein	Visc	Temp
Sampled dried in existing dryers	9.41	1.32	0.34	240.50	75.25
Sample dried in the new dryer	5.67	1.41	0.52	127.33	76.90

Table 1. Proximate analysis of the samples

The Hunter's L*a*b colour analysis showed that the flours appear brighter in colour which is an indication of good quality flour not contaminated by smoke or burning from the body of the dryer that often lead to discolouration in other types of dryers.

Also, the vibration and noise level were evaluated by comparing the operation of the new dryer against that of two existing dryers in the same factory. The vibration and the noise levels were found to be very low and within acceptable limit.

9. THE FUTURE OF CHEMICAL ENGINEERING RESEARCH

As stated earlier, chemical engineering involves solving problems that are related to transforming materials from one form to more useful products. As one problem is solved, new ones often emerge. In the future, chemical engineering is expected to tackle significant challenges, such as climate change and energy transition, reducing raw material usage and enhancing recycling for a circular economy. It will also address global food distribution while conserving resources and scaling up the production of new medicines and therapies (NASEM, 2022). Effective solutions will necessitate innovative, interdisciplinary collaborations. These partnerships, within universities and with external organizations, are crucial for tackling the complex challenges ahead. The goal is to develop effective pilot-scale or demonstration-scale processes and products. To this end, it is envisaged that future researches in chemical engineering would concentrate on the following areas:

- Advance technologies that shift the energy mix to lower-carbon-intensity sources; developing novel low- or zero-carbon energy technologies; advancing the field of photochemistry; minimizing water use associated with energy systems; and developing cost-effective and secure carbon capture, use, and storage methods.
- Techniques for minimizing land, water, and nutrient demands of agriculture and food production such as innovative metabolic engineering, bioprocess development, precision agriculture, and sustainable technologies for improved food preservation, storage, and packaging.
- Advance personalized medicine and the engineering of biological molecules (proteins, nucleic acids, etc.), use of tools to understand biological networks and the intersections with data science and computational approaches; and develop engineering approaches to reduce costs and improve equity and access to health care.
- Basic and applied research to advance distributed manufacturing and process intensification, improved product designs and recycling processes, and transition from fossil-based organic feedstocks and virgin-extracted inorganic feedstocks to new, more sustainable feedstocks for chemical and materials manufacturing.
- Developing chemical engineering tools directly or in conjunction with other fields to advancing the use of artificial intelligence, machine learning, and other data science tools; improving modelling and simulation and life-cycle assessment capabilities; and developing novel instruments and sensors.
- Using desirable traits from nature (Coppens, 2021), such as scalability, robustness, and material and energy efficiency, to design and manufacture engineered systems such as water purification membranes, fuel cells, catalysts, adaptive materials, and solutions to cancer immunotherapy.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 *Conclusions*

The future of chemical engineers is bright due to the continual technological breakthroughs and increasing demand for chemical engineering knowledge in diverse areas. In this lecture, we enumerated some of our innovative works in many chemical engineering sectors, such as petroleum refining, environmental engineering, waste-to-energy technologies, energy, agro-allied food processing equipment, and food quality. Furthermore, we developed processes for upgrading Azara and Obubra barites to meet the required API specifications for drilling fluid materials, demonstrating the practical applications of our research. Additionally, we conceptualized and experimentally demonstrated a novel, healthy, and environmentally friendly solar-powered roasting process for fermented cassava using locally available resources, highlighting our innovative approach to energy solutions.

We designed, fabricated and tested a cost-effective and energy efficient industrial-scale flash dryer now in use, and analysed the drying characteristics of ground neem seeds in a fluidised bed dryer. We also investigated the sorption isotherms of various Nigerian foods, highlighting key factors for food preservation and safety. We established a relationship between moisture content and water activity which are crucial for food quality control. Our techno-quality analysis of locally produced gari showed that fermentation duration does not significantly affect moisture content, swelling index, or bulk density.

We produced bio-oil from African hardwood sawdust and investigated the interactive effects of fast pyrolysis reaction variables on bio-oil yield using a novel fixed-bed reactor fabricated in-house. We utilized locally sourced catalysts from coconut shells and corn cobs to convert waste sac bags into kerosene-grade fuel.

We developed mathematical models to simulate the Warri Refinery Topping Unit and sieve tray design optimisation, marking a significant advancement with practical applications. Additionally, we designed, implemented, and tested software for a Physical Property Databank. We also designed shell-and-tube heat exchangers and other process equipment, all of which have real-world implications.

Finally, we have patented two of the works presented and demonstrated how chemical engineers can contribute to preserving nature by designing and managing processes for adding value to raw materials from nature; utilizing renewable energy sources; obtaining valuable resources from natural and industrial wastes, which in turn, potentially solve some of our environmental problems.

10.2 Recommendations

Department of Chemical engineering

- a. The Department has come of age; it can boast of a number of high impact research outputs with the proof of concepts demonstrated in some cases. I would recommend that the department should: (a) form research groups in line with its vision and mission statements; (b) look for collaborators/grant to construct a pilot plants for converting waste plastics to kerosene and for upgrading Azara raw barite to commercial grade required by the oil and gas industry; and (c) conduct research on Niger Delta related issues such as upgrading “artisanal refining” processing.
- b. Other research areas the department should consider include: (1) molecular simulations to gain insights into chemical processes at the atomic and molecular level and to provide a deeper understanding of material properties

and reaction mechanisms, and (2) conversion of solar energy into chemical energy through photocatalysis, which mimics photosynthesis, enabling the transformation of solar energy into molecular fuels like hydrogen or hydrocarbons.

- c. Computer programming is a critical skill for chemical engineering students, I would recommend curriculum reforms that incorporate programming alongside core chemical engineering subjects. Use of software such as EXCEL, Aspen HYSYS and MATLAB should be embedded in all years 4 and 5 courses. The Department should reactivate its Computer Laboratory.

Faculty of Engineering

- a. Agriculture will be the future of Nigeria's economy since this sector significantly offers a sustainable path for diversification away from oil dependency and promotes food security and job creation. In this regard, I would recommend that the Faculty should introduce Agricultural and Food Engineering programmes to enhance machinery for planting, harvesting, and processing crops; methods for preserving and storing agricultural products at minimal losses; techniques for transforming raw agricultural materials into consumable food products; and for designing systems for efficient water use in agriculture.
- b. The Faculty should also come up with a policy that encourages intra and inter faculty research collaboration.

The University

University of Port Harcourt should:

- a. Reactivate Senate research grant. Such grant can be used to develop software for automating staff promotion process and student academic record;
- b. Keep a register of patents by the staff; maybe the mandate for Intellectual Property and Technology Transfer Office (IPTTO) should include keeping such register and the necessary follow ups; and
- c. Come up with a policy to encourage the first step of turning patents into viable startups that would be attractive to angel investors or crowdfunders.

The Federal Government should

- a. provide robust policy reforms and public-private partnership frameworks targeted at supporting farmers and attracting investments for key agricultural infrastructure, such as irrigation systems, rural roads, and storage facilities for agriculture to contribute substantially towards GDP and employment in Nigeria.
- b. create a national database for industrial research projects, in collaboration with Manufacturers Association of Nigeria, Academia, Research Institutions, and Nigerian Society of Chemical Engineers, that would be a centralized repository of information about research projects (new, ongoing or completed), funding opportunities and procedures for applying for such funds.

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CITATION ON



ENGR. PROFESSOR AYOADE OLUDAYO KUYE

Vice-Chancellor, Sir, I have the honour to present to you the scholar who will deliver the 204th Inaugural Lecture of this great University. He is

*Engr. Professor Ayoade Oludayo Kuye,
a Professor of Chemical Engineering,
former Dean of the Engineering and
pioneer Director, Centre for Nuclear Energy Studies.*

Professor Ayoade Oludayo Kuye was born on May 23, 1956 at Ijebu-Ode, Ogun State to the family of Late Chief Amos Badejo Kuye and Late Mrs. Sabainah Yetunde Kuye. He attended Ijebu-Ode Grammar School for his secondary education and Comprehensive High School, Aiyetoro, Egbado

for his A-level education. By October 1975, he entered University of Lagos, Akoka, Lagos and graduated with a First Class Honours degree in chemical engineering by 1978. For his post graduate training, Prof Kuye went to University of Lagos for his Masters Degree and University of Strathclyde, Glasgow, United Kingdom for his doctorate degree. He bagged MSc and PhD degrees in Chemical Engineering from these institutions in 1980 and 1985 respectively.

Professor Kuye, following the footsteps of his father, the popular "Baba Teacher (Father of Teachers)" in Ijebu Okun Owa, joined the academia at the Department of Chemical Engineering, University of Port Harcourt, Port Harcourt in 1985 and rose to the rank of Professor by 1996 in the same department. Professor Kuye is a well-known academic. He is an external examiner and external assessor to many Universities in Nigeria and Ghana. Professor Kuye has mentored many students across different fields by providing guidance, career advice and opportunities for growth that build confidence and improve academic performance.

Professor Kuye's research interest is in the area of computer-aided mathematical modeling in Chemical Engineering. He has 97 publications in learned national and international journals, 12 books and numerous technical reports/monographs. He also has three patents and one copyright to his credit. His major contributions include:

- Development and testing of a number of chemical engineering software that can be used to simulate/design multi-component distillation equipment, wet scrubbers, air cyclones, hydrocyclones, spray dryers and shell and tube heat exchangers. He has also developed a physical property database system. Some of these software are already being used locally.

- Study of the effects of factors that are likely to affect the use of palm bunch ash as a source of alkali for soap production and pioneered the detailed experimental study of the performance of spray towers when used for particle scrubbing. In addition, he has studied the moisture isotherms of some cassava products (lafun, fufu and tapioca).
- Application of optimization principles to design a sieve tray and was involved in the developing a new one-dimensional optimization technique. With other Nigerian engineers, designed, fabricated, installed and tested an efficient flash dryer for the production of high-quality cassava flour.
- Presentation of a long-term (13-year) solar radiation and other meteorological information for Port Harcourt in a concise form. This information is necessary for effective design of wind-powered solar dryer for agricultural produce.
- Conversion of sawdust to briquettes and bio-oil using locally fabricated equipment.
- Conversion of waste plastics to kerosene grade fuel.

Apart from research, Prof Kuye is well known in the process and allied industry. He is actively involved in offering short courses, technical and consultancy services to process engineering as well as to oil and gas companies. Professor Kuye has been awarded many national and international grants.

Professionally, he is a COREN Registered Engineer, a Fellow of the Nigerian Society of Chemical Engineers (NSChE) and a Member of the Institute of Nuclear Materials Management. He is a World Institute for Nuclear Security (WINS) Certified Nuclear Security Professional.

Professor Kuye has held several administrative and public service positions. Within the University of Port Harcourt, he is a former Dean of Engineering, the pioneer (and former) Director of the Centre for Nuclear Energy Studies and a Member of Senate. He has also served the University in various capacities, some of these are:

- Faculty representative, Junior Staff Committee,
- Faculty representative, Student Disciplinary Committee
- Chairman, The Willbros (Pollution) Study Group
- Chairman, Departmental Graduate Committee
- Chairman, Faculty Wide Courses Committee
- Chairman, Senate Committee on Prizes
- Chairman, Central Hostels Management Committee
- Chairman, Committee on Computerization of Students Records
- Chairman, Committee on Verification of Submissions for Elevation to Professorial Cadre

Outside the University of Port Harcourt, Prof Kuye served in various capacities including:

- Member, Interview Panel for NSE/COREN Professional Interviews
- Associate Editor, NSChE Journal
- Member, NUC and COREN Accreditation Panels
- Chairman, Committee on Strengthening Research and Development Infrastructure In The Nuclear Research Centres in Nigeria.
- Chairman, Organizing Committee, National Workshop on Nuclear Security for Engineers, Scientists and Technicians, Port Harcourt.
- Foy, H. and A. Kuye (Organizers), Professional Development Course On Introduction To Nuclear Security and Safeguards for Sub-Sahara Africa.

- Chairman, Organizing Committee, Workshop on Nuclear Security for Media Practitioner in Africa, Kumasi, Ghana.
- Chair, The International Nuclear Security Education Network (INSEN), Vienna, Austria.
- Team Leader for two different national projects namely Computer Aided Process Equipment Design and Design, Fabrication, Installation and Testing of an improved flash dryer.
- Former Coordinator, NSChE Education and Research Sectorial Group.

Professor Kuye is married to Mrs. Kofoworola Adenike Kuye and they are blessed with children and grandchildren.

Prof Kuye is a worthy colleague, an honest Lecturer, a born leader and a thorough-going workman. He is a living example of the rare admixture of transparency, affability and generosity. All who meet him are struck by the confidence he exudes, the humility of his assertions and the patience to listen to others. He is a team-player and an outstanding academic.

Vice-Chancellor, Sir, it is a great honour to present to you a rare gem, a fine gentleman, the speaker at the 204th Inaugural Lecture: Professor Ayoade Oludayo Kuye, a Professor of Chemical Engineering and a Registered Engineer.

Professor Tobinson Alasin Briggs
Dean, Faculty of Engineering