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CAREER EPISODE 1

I. Introduction

CE1.1 My first career project was the research project on the design of mini Triazine manufacturing Plant at Thanlyin Technical University where I was attached as Intern Chemical Engineer. I was an intern in my third year of studies between December 2007 and February 2008.I was attached to the chemical engineering Department Thanlyin Technical University located at Thanlyin, Yangon Division, Myanmar. As an intern, I was supposed to develop a concept of the Triazine manufacturing and developed the report.

II. Background

CE1.2 The necessity of TRIAZINE in gas and oil industry is undeniable, especially for scavenging hydrogen sulfide (a highly toxic, flammable, foul odored and clear gas) from hydrocarbon streams during extraction and fractionalization of crude oil. Global environmental regulation agencies have diversified awareness and imposed strict rules for regulation of hydrogen sulfide emission and release into the environment, and thus restricting the mining, reservation and processing of crude oil and natural gas in which this toxic compound forms a main component. Limits for this gas in 100 standard cubic feet is 4ppm in most of the standardization agencies. The demand for TRIAZINE has been increasing with less suppliers, and thus presenting opportunities for manufacturing and processing. In this project, have designed and executed a contract manufacturing process for TRIAZINE.

CE1.3 I objectively did this project, to establish a TRIAZINE manufacturing plant on a contractual basis, with a potential chemical manufacturing company. I purposed to identify potential contract partners with the capacity to produce TRIAZINE in commercial scale, to provide a procedure for qualification testing of the identified partners, to evaluate the production economics of the TRIAZINE, to characterize TRIAZINE properties and or characteristics and determine how these features are altered by the manufacturing processes, to design the equipment, machinery and equipment for the plant, to evaluate the optimum conditions for reaction, increase the yield of TRIAZINE production from single stage reaction of Mono-Ethanol-Amine and formaldehyde in a ratio of 1:1, to balance the enthalpies and mass flux and finally find out optimization and scaling opportunities in the model plant.

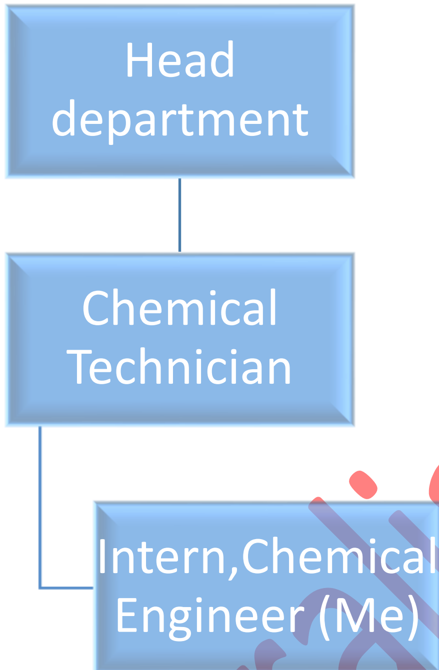

Figure 1: The organization chat.

CE1.4 For efficient project development and timely delivery of the various phases, I was tasked by the management, with various duties and roles as the sourcing specialist, as outlined below.

- listing and qualifying potential TRIAZINE manufacturers for contractual qualification and evaluation based on their current capacity, capitation and supply strengths
- Design of TRIAZINE plant major equipment, effluent treatment plant, laboratory and research apparatus facilitation.
- Simulation of the reaction processes and optimization of energy utilization in the plant
- Economic analysis of the production, techno-economic feasibility study and construction of the plant with scalable capacity
- Production process safety, risk assessment and environmental protection strategy adherence with quality procedures

- Contractual sharing negotiation, non-disclosure agreement, documentation of the works done and supervision of the plant set up.

III. Personal Engineering Activity.

CE1.5 In getting ready to begin the project, I reviewed the BIS IS 4505:1968 and IS 1278 that I compared with NAICS 211111 codes for chemical manufacturing, safety and spectrometric testing of the related product, that gave me some of the specifications for the plant. I then made arrangements and held meetings with the management, from where I was induced to the project, got guidelines and project timing, with allocations for the project budget. Afterwards, I assembled a team of professionals to constitute the specialists in various fields that I needed to play with in the project.

CE1.6 The project required a lot of data and information. I collected the data about several possible partners in chemical manufacturing industry, considering detailed analysis of their plant layouts, equipment, safety, supply of mono-ethanol-Amine and formaldehyde materials and environmental pollution mitigation strategies. I also sourced specifications for major equipment, including the reactors for capacities of at least 8000MT production line, from electronic datasheets provided by the designers and manufacturers of these components.Finally, I studied several academic research papers in this field and identified new technologies undergoing evolution.

CE1.7 With this information, I begun the design by drafting a schematic circuit diagram of a TRIAZINE manufacturing plant. I then designed the raw material storage tanks in a close proximity to the reactor, with capacities to store materials that can run the plant for 3 months. I considered selection of twin motors, each with a rating capable of running the pumps on its own, to ensure redundancy of the pumping mechanism and thus continuous processing. I made the reactor strength considering a maximum temperature of operation of 80^0C. I considered designing solenoid valves with capacities to switch on the liquid flows in the sizes of pipes as per the mass and energy balance equations.

CE1.8 In this design, I made several calculations to model the sizes, dimensions and power rating of the motors for pumping system.

$$V = \frac{D\pi}{4}$$

Where V= volume of the tank or reactor and D is their respective diameters. The temperature rise for the motor running the pumps;

$$\theta = \theta_f(1 - e^{\frac{-t}{T}})$$

T= heating time constant of the motor, θ_f=Final temperature and θ= temperature rise

CE1.9 Afterwards, I designed the reaction rate by considering speed of rotation of the reactor column and optimized the speed for uniform mixing of materials. I then designed a temperature controller using a PLC based system, where I considered making use of parallel connected thermocouples and relays connected in series for sensing and actuating the heating process respectively. I also considered using catalytic converters to neutralize the effluents from the factory.In these design process, I used the following mathematical formulation and equations to model the reactor control by PLC system

$$s = rt$$

Where S= total number of samples for storage in PLC memory, r= sampling rate and t= total sampling time.

$$mmf = NI \qquad ; \qquad H = \frac{mmf}{d}$$

Where mmf (magneto-motive force) = actuation force of a relay, H= magnetic field, N= number of turns on the coil, I= current flowing in the relay, d= length of coil path

CE1.10 After the design, of the plant, I approached the contract partner for plant setup process. First we made the laboratory scale and produced the desired TRIAZINE that upon testing in our laboratory, possessed all the chemical and physical characteristics on the test range. By scaling the process capacity, to a 2500MT and finally to the 8000MT, I managed to achieve the target production capacity that supplied the customer market share at that time.

CE1.11 Some of the challenges that abounded in the path to realizing these the objectives of these projects included adapting the production rate, to meet growing market that grew rapidly after the plant setup. Searching for catalysts to speed up the reaction bore no fruits, since there was no intermediate product formation in the reaction process. Increasing the temperature beyond the limit was also barred, since the optimum temperature was 80^0C already. I considered redesigning the feed system to allow for preheating, thorough and uniform material mixing of materials before entry into the reactor. This lowered the period of reaction and thus increased output per day to exceed the demand 10000MT

CE1.12 I used several computer tools and platforms, to realize the expectation of the project. AutoCAD was necessary in modeling the 3D structural layout of the plant, dimensioning and sizing of the plant components. I also used LABVIEW to experimentally model the plant at the laboratory scale and SPSS to derive models for the input-output relations of the plant. I made great use of ChemCAD to balance the mass flux, chemical equations and the energy flow balance equations.

CE1.13 Innovative techniques that I used to optimize this plant performance were diverse and included the use of auto-mixer to pre-heat the reactants to a temperature of 50^0C, and for uniformly mixing them to lower the reaction period time, and thus ensure high yields and throughput. I ensured reliable design by making three different models for the same circuit i.e. a computer based simulation model, a mathematical model and a laboratory physical model, which I used to ensure accuracy and precision by conforming to the performance of the three models.

CE1.14 Documentation of the project was a major part of the project. I compiled a report detailing all the stages of development, starting with the problem statement, project justification and literature review of the various components used in the plant layout design. I enumerated the step-wise design procedure for the project for each component, specifying the materials, sizes and loadings on each element. I included the code for the PLC in CX programing ladder language, and finally made 3D drawings for the assembly of the components and interconnection. I also made presentations in MS power point, which I used to demonstrate the operation of the plant to the parties of interest.

CE1.15 Team work remained a key contributor towards the success of the project, where I had to constantly update the management on the project progress, budgeting and timing. I made wide consultation with engineers in control and instrumentation, to design the waste treatment plant, with environmental control of gaseous effluents. I also made contractual negotiations and signation between the parties in the project. Maintaining a team spirit within the members that I had constituted for this project was also a breathtaking task.

CE1.16 Some of the economic decisions that I had to make were majorly based on trending between cost and reliability. E.g. I chose to optimize the production capacity of the plant by installing a mixer column in the production line, in-between the feed source and the reactor, instead of purchasing second reactor, which would have been more economical in the long-run, but wasteful in the short-run given that the demand had exceeded the production capacity by a small margin that could be met by using mixer.

CE1.17 Application of project management skills, knowledge, methods and techniques, to ensure smooth running of the project was necessary too. By drafting target based weekly reporting schedules, I held the team members responsible for their respective and specific roles and equally sharing into the success of the project, which worked well in obtaining maximum human delivery capacity. I used network planning techniques, to schedule the various activities in different phases of the project.

CE1.18 I gained a wide range of knowledge, experience and skills while executing this project. I learned how to design simple procedures for troubleshooting general industrial faults such as motor vibrations and relay trips. I also ensured constant supply of techniques for executing the project by interacting with multi-faceted personnel and professionals in the pool of stakeholders.

CE1.19 To ensure conformance to ethical code and professionalism in practice, I did my own research work and utilized my design skills, without copying any ones' work for intellectual property rights and patents. I fully obeyed the codes outlined in the engineering society by sticking to the field of my specialization and working on mutual consent. Safety-wise, I used appropriate PPE in each of the various stages and phases of the project development and installed computer anti-spyware to guard the data and information in my PC against mal-ware.

IV. Summary.

CE1.20 In short words, I carried out all the activities related to construction of a contract based manufacturing facility for TRIAZINE, including deriving the contract agreement documents with a non-disclosure clause to guard the reputation and maintain the market share, I designed the TRIAZINE manufacturing plant and studied all the techno-economic feasibility factors for contract based manufacturing agreement. I solved all the challenges that occurred during the project execution and provided troubleshooting methodologies for operators to repair the common faults that are likely to occur when running the plant. More so, I documented the project and presented to the management all the findings.

CAREER EPISODE 2

I. Introduction

CE2.1 My second project is the Membrane design process for the fruit clarification that I did in my final year of studies at Yangon Technical University, Myanmar as chemical Engineering student. I did this project between June 2008 and December 2008 at department of chemical engineering. The chemical engineering workshop where I did this project is located at Chemical Engineering Department, Yangon Technical University, Insein Rd, Yangon, Myanmar. This was my final year project thus I did the project and presented it to the faculty members.

II. Background

CE2.2 Processing of juice from fruits is a main sub-sector in food processing that has deployed conventional methods to handle different fruits, extract juice from them, recover the original aroma, clarify and concentrate the juice. Such processing, defines and determines the parameters of the juice (organoleptic content, pectin content, total phenolic compound, acidity, pH, viscosity, color, density and turbidity). Technologies are evolving rapidly to pursue the best qualities for these parameters and ensure higher nutritional values for human health while maintaining cost of product, energy consumption and waste management minimum possible. In this project I have designed, experimented and implemented an integrated membrane process for fruit juice clarification, which ensures the above qualities of juice at minimum cost per product. I have optimized the design on enzymatic membrane reactor, reverse osmosis, pervaporation and concentration units.

CE2.3 The main purpose of carrying out this project was to design a membrane process for juice clarification. I specifically aimed at minimizing the energy consumption and capital investment on the system, to obtain the minimum thermal damage, to minimize the operation time, to ensure least wastage in the plant, to incorporate pulping and clarification in process phase, to improve the throughput and yield of the plant, to evaluate possible solutions to challenges presented in the processing by fouling, to optimize the enzyme action conditions (temperature, pH, concentration and time of action), to prolong the lifespan of the complex enzyme used in the clarification process and to eliminate use of additives in the juice processing and ensure least if any aroma losses.

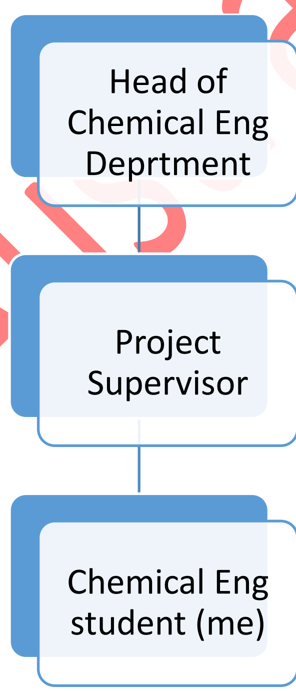

Figure 1: Department's Organization chart

CE2.4 In the process of the project development lifecycle, I was tasked with several duties and responsibilities, some of which are outlined in the following profile.

- Detailed analysis of conventional methods of juice clarification systems, apparatus, technologies and strategies with specific technical SWOT outlines for each
- Literature review of membrane technologies that are deployed or undergoing scholarly research with complete characterization of different types of membranes
- Design of an integrated membrane technology for juice clarification, specifying the structural design, mechanical models and flow rates and reactions
- Sourcing specified materials, fabrication of various components of the system, interconnection and implementation of the whole process cycle
- Experimentation and characterization of the process and detailed analysis of the products made from the system
- Carrying out economic comparison, adhering to safety rules, observing ethical code of conduct and documentation of the project.

III. Personal Engineering Activity.

CE2.5 In preparation to begin the project, I arranged and held a meeting with my project supervisor, who gave me the guidelines, opinions and clearly outlined the areas of interest in this project. I then consulted my academic advisor from where I got useful techniques and innovative procedures for executing the task. More so, I made appointment and held a discussion with the management for budget and resource allocations. I then revisited the CODEX STAN 247-2005 standard codes for beverage, nectar and juice processing, from where I noted down specifications for parts of the project. I compared these standards with the ISO 22000 codes on food processing.

CE2.6 In order to prime myself with enough data, information, skill and knowledge to the capacity required for this project, I read deep and wide on materials from a wide range of collection, including scholarly articles, research journals, published books and new technology fictions artefacts, which contained a wealth of information on fruits content, extraction methodologies and clarification techniques. I then sourced design data from user manuals and datasheets of various components for the project, from a diverse set of manufacturers across the world, from where I specified some of the components that I was designing.

CE2.7 Next, I architect a general logical flow of processes for the desired integrated membrane technology, in a schematic diagram, as shown in figure 2.

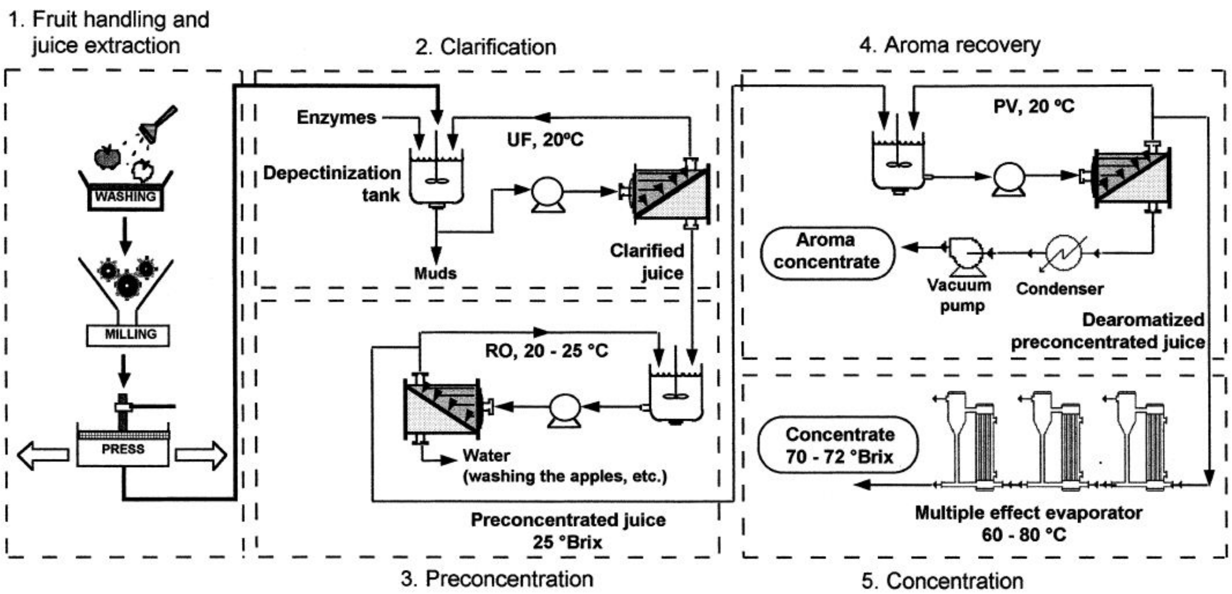

Figure 2. integrated juice clarification membrane technology circuit

From this idealization, I proceeded to design the various sub-systems in a modular design, based on reverse engineering method. I specified the de-pectinization tank dimensions, material and shape, considering the temperature and chemical contents. I them experimented with several enzymes and selected a commercial grade for the sub-process. I specified the membrane symmetry, thickness, membrane material driving force, porosity and evaluated its rejection rate, using the hydrodynamics and polarization. I then specified the reactor design parameters for the pre-concentration, with specific focus on flow rate and a reverse osmosis chamber mechanism.

CE2.8 During this first design, I made several calculations using the following mathematical models and equations formulated for the clarification system.

$$CoR = 1 - \frac{M_p}{M_c}$$

Where, Mc= concentration of the component in the retentate, C.o.R= membrane coefficient of retention and Mp= % concentration of component in the feed.

$$r = \frac{j_1 - j_2}{j_1}$$

Where r= flux decline rate, J= mass/volume flux and 1 and 2 denoted different times of observation.

CE2.9 I then designed the pervaporation apparatus constituting of feed vessel, vacuum controller, vacuum pump, condenser, pervaporation module (membrane material, pore size and shape, retention coefficient, thickness and polarization), piping and valves, considering optimum temperature, pressure and flow rates for the materials. I then specified protocols for feeding and for cleaning (mechanical, chemical and physical cleaning methodologies). Afterwards I made clear drawings for the various components, sub-systems and finally the whole system. In the subsequent design, I made calculations for the membrane mass transfer rate based on the formula given in the equation below.

$$\frac{1}{C_o} = \frac{1}{C_b} + \frac{1}{C_m}$$

Where C= mass transfer rate, o, b and m denote the overall, feed boundary layer and membrane respectively.

CE2.10 After the design, I computed a bill of quantities for a pilot plant setup, with details on equipment dimensions, materials and rating for feeding system for a capacity of 2500KGs per month. I then derived the quantities of materials, chemical and enzymes that are needed to manufacture the capacity mentioned above. From these models, I determined the energy requirements of the plant, capital investment costs, running costs and fixed cost. I also projected the profitability, payback period and revenues likely to be earned from the project. I also produced clarified several fruit juice that I used to characterize the model plant.

CE2.11 During the project lifecycle, I faced several challenges, including fouling (formation of debris on the membrane, which lowered the transfer rate and decreased the yield/throughput of the model plant). I used enzymes to break down the polysaccharide molecules (cellulose, starch and pectin), into simple soluble sugars that would undergo microfiltration, Nano filtration and hyper filtration easily. Browning was also a challenge that after investigation, I realized was resulting from both enzymatic and non-enzymatic reactions. I specified chemical treatments to this effect, using disinfectants, I technique that worked well.

CE2.12 I made use of computer aided design tools and programs, in order to achieve excellent results and meet the goals set forth for the project. I made ANSYS simulation to model the finite element analysis of the structural layout, considering the loading and stresses imposed on the structures by different forces. I used ASPEN software to derive the mass and energy balance equations that I used as simulation models to optimize the energy consumption in the plant. More so, LABVIEW was a necessary tool for investigating the product features and carrying out experimental data analysis.

CE2.13 Some of the innovative procedures that I introduced in the membrane technology solution for better performance included the hydrolysis of polysaccharides to dissolve them in order to avoid fouling. I also tabulated the experimental characterization of various types of membranes that assisted in choice of best membrane for particular application. I used hydrodynamics, to model the pore shapes of the membrane materials for maximum yields of the plant.

CE2.14 Equally important, was the documentation of the project. I made audio-visual animations to illustrate the functioning of the membranes in various components and subsystems of the clarification process that I stored in soft copy form, on a disk and in my institutional server space. I also compiled a final report that detailed the various stages of development such as literature review, system analysis, design, simulation and construction. Included in the documentation was also a picture based user manual and guide for operators, repairers and maintainers of the plant. From the analysis of the product made, I compiled report on a datasheet that can be used as reference to control different features and possibly automate the parameters of the juice.

CE2.15 In order to make excellent design and obtain the best performing system, I had to work within a team. I kept close contact with my project supervisor, constantly consulted my academic advisor and worked with diverse professionals (electrical, computer and mechatronic engineers), who gave me hands on skills and solutions for tackling the challenges specific to these fields. I also retained a professional contact with laboratory technicians, who assisted me in setting up, experimenting and collecting data for various processes of the design.

CE2.16 I made considerations for economical choices and decisions, to ensure affordability of the product. By computing the investment, fixed and running costs, I managed to derive per unit production cost. From this costing, I was able to determine suitable pricing strategy, with reasonable price and a tenable profit margin. I ensured the costs and quality trends offs balanced in order to strike a price for quality product.

CE2.17 Managing this project was highly dependent on project planning and management techniques. I used the PERT method to plan the various activities of the project in an orderly manner, evaluate the progress over different phases of the project and ensure timely delivery. I used the Gantt charts to make projections on targets met per phase of development and drew the network diagrams for processes involved in developing the project.

CE2.18 Keeping at par with skill and knowledge demand of the project, required continuous training that I gained by experience and learning. I applied the theory learned in class to make concrete and valid assumptions during the design of various parts of the project. I also studied several programming tutorials and executed examples in order to garner enough coding skills for the simulation modeling of the clarification process.

CE2.19 Safety rules and regulations were necessary. In handling the toxic chemicals, I used the necessary personal protection equipment such as gloves, lab coats, glasses and breathing masks. Keeping sharp, piercing, cutting and pointed objects in the respective holding gadgets, lowered the probabilities of accident incidences. I enumerated the precautions for handling the reactors in the user manual, in order to ensure proper operation and least damage to both equipment and the user.

IV. Summary.

CE2.20 In conclusion, I analyzed juice clarification and concentration processes, identified their weakness and strengths, characterized membrane technologies and evaluated the production economics for the fruit juice industry. I designed, modeled, simulated and implemented an integrated membrane technology for clarification of fruit juice. I carried out all the calculations necessary to parameterize and specify the equipment and production components. During the project, I used the necessary computer aided design and manufacturing tools to ease work and made precise economic decisions for the least cost and maximum benefit solution. I ensured safety rules adherence, documented and presented the project excellently.

CAREER EPISODE 3

I. Introduction

CE3.1 My third project was the Design of the Bio-Lubricant Manufacturing Plant while I was working as a Junior Chemical Engineer (Intern) at Myanmar Chemical Engineering Group (MCEG) between May 2009 and January 2010.As the company deals with design of various plants, I worked in the research and development in the company where I worked under design engineer. The location of the project was the company offices located at Hlaing Thar Yar Industrial City, Yangon, Myanmar. As an Intern I participated in this concept plant that was under development.

II. Background.

CE3.2 Myanmar Chemical Engineering Group (MCEG) deals with the design of various complete processing plants across Myanmar. Synthetic mineral oil has been a key propellant of the industrial revolution, finding wide applications in automobile engines, lubrication of moving systems, aerospace and aeronautical power, manufacturing, factories, home based uses, natural gas and cosmetics. Decades down the line, the global changes in weather, unpredictability of climate change and ozone depletion are hitting hard on biodiversity, threating extinction of some biological forms and melting polar ice that causes sea level rises. The need for a biodegradable oil therefore, becomes undebatable. It's out of this worldwide concern that I was assigned this project to analyze, develop, simulate and implement a processing plant that would manufacture biodegradable drilling lubricant, from vegetable oils such as castor and Jatropha considering use of non-edible plants for best quality of oil.

CE3.3 I purposely meant to execute the lab, pilot and commercial scale production of bio-degradable lubricant, to evaluate the process of washing the oil, to optimize and characterize the ethanol separation mechanism, to find out the best method for glycerol removal, to evaluate the effect of temperature on the esterification process, to procedurally carry out the pretreatment characterization, to optimize catalyst selection and parameterize its action, to compare cost of production for synthetic mineral oil and biodegradable lubricant, to determine the most suitable conditions for trans-esterification in the process of developing the lubricant, to design an end to end manufacturing facility with the specified capacity and derive the mechanical and electrical design of the process equipment.

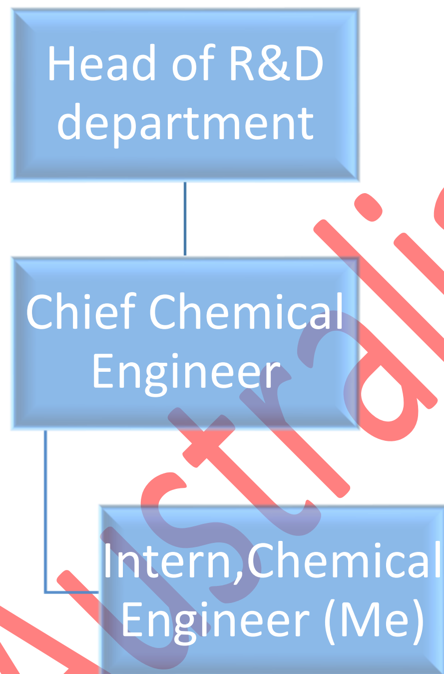

Figure 1: The company structure used on this project.

CE3.4 In the process of bio-lubricant realization, I had to perform several duties and responsibilities in ensuring that I deliver the mandate, as outlined below

- Driving Strategic sourcing and contract manufacturing projects, coordinating with Electrical, Business development, Marketing, Legal departments, R&D, Mechanical, Instrument, and the contract manufacturing company.
- Designing the manufacturing process, modeling the plant layout, simulation of the process, testing the production facilities and ensuring standardized procedures
- Leading the new manufacturing initiatives for Drilling Fluid Chemicals, Cementing Additives and Production Chemicals.

- Identifying sourcing opportunities through spend analysis and conduct market analysis to identify capable contract manufacturing partners,
- Collaboration with Category/Regional Sourcing teams to evaluate the project feasibility & engaging with Technology (R&D) teams for product qualification & development,
- Maintaining the highest standard of health and safety performance in accordance with Company's HSE policies.

III. Personal Engineering Activity.

CE3.5 In preparation to get ready for this project, I reviewed the EN14214 European Union standard codes for oil related products, analyzed the EN590:2000 codes on requirements and quality evaluation procedures for lubricants, which I contrasted with the ASTM 6751 standards for testing methods, properties and apparatus used. I then consulted several vendors who shared some basics of the technologies they use to manufacture the commodity. More so, I interviewed potential consumers of lubricants for the best properties that are customer focused and noted down some specifications for the product.

CE3.6 I then embarked on intensive data collection and information gathering, to ensure sufficient information and intelligence for the project execution. I collected several datasheets for various lubricants, analyzed them, derived specifications for moisture content, viscosity, calorific value, aniline point, acidity, carbon residue and fatty acid percentage. I then read a number of reference books and notes, biasing the literature review topics related to oil and lubricant manufacturing technologies, fluid dynamics, thermodynamics, organic and inorganic chemistry. I derived and plotted curves for the various parameters of performance of lubricating oils.

CE3.7 I then started by architecting a logical block diagram for the flow of process in the manufacturing of the biodegradable lubricating oil, as illustrated in figure 2.

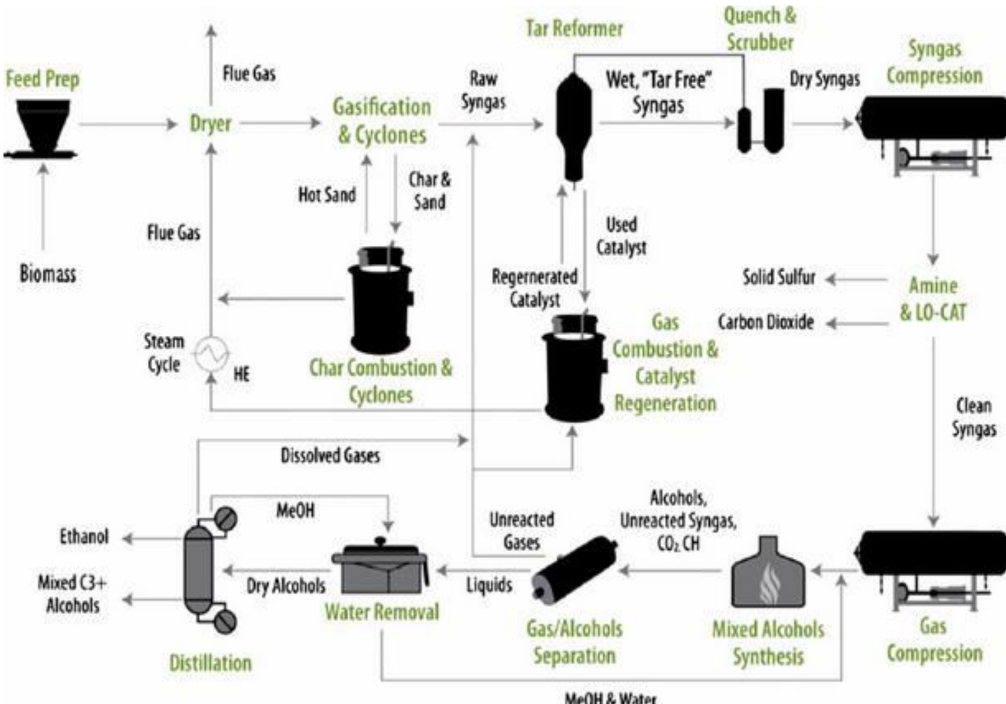

Figure 2. Plant layout and process flow for biodegradable lubricating oil

From this conceptualization, I designed the various components with specification of the reactions taking place at each point. Starting with the biomass (castor seed) feed preparation chamber sizing and dimensioning, dryer modeling and gasification and cyclones char combustion chamber and the catalyst regeneration chamber. I designed the strengths of these materials to the standards of the ASTM, and simulated them in the solid works platform. I then dimensioned and specified the mixed alcohols synthesizer and syngas compression module.

CE3.8 During this initial design, I modeled several parameters, using mathematical equations and formulation, and balanced the chemical equations for the reactions.

$$V_K = \alpha * t_F - \frac{\varepsilon}{t_F}$$

Where V = kinematic velocity, α and ε are equipment determined constants and t= time of flow.

$$MeOH + TG \xRightarrow{60^0C\ ,NaOH} Glycerol + 3FAME$$

Where FAME= Fatty Acid Methyl Ester, TG= Triglyceride, Me-OH=Methanol.

CE3.9 To specify the alcohol separator, I considered the thermal stress due to expansion and contraction. I then dimensioned this column with strength enough to withstand thermal loading and flexibility of material. I also made the separator column that would feed the lubricant compounds to the distillation chamber, from where separation would take place in a fractional distillation method to obtain the lubricating oil. To this end, I had made more calculations for the density of the lubricating oil and its content of fatty acid, using the following mathematical derivations.

$$\%FA = \frac{Titrant\ x\ Mx\ 28.2}{G}$$

Where M= normality of base, FA= free fatty acid value, G= sample mass

$$d = \frac{m}{v}$$

Where d= density, m= mass and v= volume

CE3.10 After the design work, I drafted a bill of quantities with details of all the plant equipment, size and dimension, pricing and material specification that I used to make a proposal and a technology transfer strategy for the plant setup, to the contract manufacturer. I also consulted with the legal department, who assisted in designing and drafting the contractual policies with the non-disclosure agreements, which I used alongside the business proposal, which we compared and harmonized with the drafts from the contractual firm. The firm finally agreed to take up the contract, after which I supervised the construction of the lab, pilot and commercial scale manufacturing lines in the contractors' premises.

CE3.11 In the process of project development lifecycle, I encountered several challenges, including the initial low conversion rate, which I solved by keenly studying the agitation speed, where I noted that lower speeds were leading to high diffusion resistance. I specified a speed of 1500 rpm since by increasing the pressure, the diffusion resistance tended to be lower and this solution worked well to realize a conversion rate of 92%.

Mass transfer resistance was also high due to peroxides in the castor oil. I specified the quality of the oil to 5ppm in castor oil which resulted to better performance.

CE3.12 I derived utility and project progress achievement from several computer tools and equipment. Majorly, the CHEM-Station 6890 plus platform proved best for data collection, experimentation, analysis and quantification of various parameters of the plant equipment. ASSISTAT development platform was greatly instrumental in carrying out the ANOVA analysis for the various characteristics of the processes in balancing the mass and energy equations. I also used the ANSYS to make design and 3D working drawings for the installation and fabrication of the plant.

CE3.13 Innovativeness was the key to optimum performance. I edited the normal procedure, to provide for multiple distillation columns, each with a washing unit to ensure complete separation of the lubricant of interest, from the rest of the salts and hydrocarbons. Tabulation of the catalyst behavior in terms of operating pressure, temperature and concentration on curves, was a useful methodology for optimizing the plant by variations of reaction parameters in different stages. Also, I provided future automation mechanisms for interested researchers and for consideration of increase in capacity of the plant.

CE3.14 Documentation of the project work undertaken was equally a key factor. I made the animations for the various plant equipment to illustrate the operational mechanism and reaction processes that I used to demonstrate the functioning of the model plant. From the data I collected during simulation, I tabulated the full characterization of the plant process, component mechanism and capacities. I made graphical interpretations for limits of such parameters and indicated the safety levels in the datasheets for use by maintenance and repair team. Most importantly, I made specific procedures for the machine operators and prepared a final report with all the details of design for particular capacities.

CE3.15 I had to team work with diverse professionals in order to deliver the mandate, assembling a team of mechanical, electrical, chemical and computer engineers to deliver the technical parts of the project, while having a team for business related tasks was the main idea that worked well for the group. I kept consulting with members, stakeholders and updating the management on the project progress on weekly basis for budgetary control.

CE3.16 Some of the economic decisions that I had to make included drawing the bill of quantities with a market surveyed pricing, for quality products that assisted the procurement department in acquiring the right components for the plant. I also computed the per unit cost of producing 100 gallons of lubricant, by computing the capital depreciation, fixed costs and variable costs for labor and energy. I made a business proposal to convince the contract manufacturer of the future prospects of the business. Purchasing the materials from a single vendor ensured gain in economies of large scale.

CE3.17 Planning, organizing and generally managing the project, required a wealth of decision making and policy execution skills. I used the PERT technique to plan the sequence of activities in the project and evaluate the rate of success. I used the payback period method to appraise the viability of the project and made great use of schedules to divide and specialize the labor.

CE3.18 Specifically, I trained in the institutional center for research on the most recent technologies, environmental impact and risk assessment for the project. This session added a great deal of skills and techniques that I needed to run the project smoothly. I also gained a wide range of experience, especially in converting theory into practice.

CE3.19 Adhering to laboratory safety rules and health regulations was a paramount consideration in developing the project. I took precautions for handling the highly flammable liquids and provided personal protective gear where necessary, to avoid accidents. I observed the code of conduct by doing my own work, and referencing in the documentation, any foreign material used in the project process. I also provide safety rules for plant operator and provided earthing to all metallic and electrical structures to prevent leakage current from shocking personnel.

IV. Summary.

CE3.20 In summary, I designed a biodegradable plant process for manufacturing the bio-lubricant, which is environmentally friendly, renewable and affordable. I made use of computer aided design and manufacturing to realize accurate design, and ensured safety to the equipment and peoples in the plant. I solved all the challenges during this project, based on the literature review, with optimization of the solution on basis of mass and energy balances. I documented the project and saved both soft and hard copies of the material for future use. In conclusion, the impact of environmental change and global warming, has resulted into a new rush, developing mitigating procedures and environmentally friendly fuels as outlined in this project.

SUMMARY STATEMENT FOR PROFESSIONAL ENGINEER

Competency Element	A brief summary of how you have applied the element	Paragraph in the career episode(s) where the element is addressed
PE1 KNOWLEDGE AND SKILL BASE		
PE1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	a) I used my skills in chemical engineering especially in physical science and chemistry to design, analyze, simulate and find solution to my projects. I also applied the standards and codes applicable in my field	CE1.5, CE1.7, CE1.8, CE1.9, CE1.10, CE2.5, CE2.7, CE2.8, CE2.9, CE2.10, CE3.5, CE3.7, CE3.8 CE3.9, CE3.10,
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics and computer and information sciences which underpin the engineering discipline	a) I used chemical engineering based softwares to improve my designs. b) I collected the information that I used to implement my projects in order to meet the objectives c) I performed Chemical Engineering Calculations that was critical in making my design decisions.	CE1.12, CE2.12 CE3.12 CE1.6 CE2.6 CE3.6 CE1.8, CE1.9 CE2.8, CE2.9, CE3.8, CE3.9

PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	a) I researched and consulted the supervisors and tutors when I was looking for the best solution to the challenges that I encountered. b) I acquired additional knowledge in form of trainings that I participated in while implementing my projects. c) I leverage on professionalism in Chemical engineering by following standards and codes.	CE1.11 CE2.11 CE3.11 CE1.18, CE2.18, CE3.18 CE1.5, CE2.5, CE3.5
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	a) When I encountered technical challenges, I used research and consultation methods to find the best and appropriate solution. b) I improved my Knowledge by participating in the training that enabled me to meet the objectives of my projects. c) I studied the standards, codes and the details of the project before starting and to understand it.	CE1.11 CE2.11 CE3.11 CE1.18, CE2.18, CE3.18 CE1.5, CE2.5 CE3.5,

PE1.5 Knowledge of contextual factors impacting the engineering discipline	a) Teamwork was important because of its impacts on the projects; it hand the potential of improving or slowing the rates execution through exchange of ideas. b) Project safety was another factor that affected the project because it had potential of protecting workforce from Injuries. c) I was aware of the importance of the project management that was paramount in projects competition.	CE1.15, CE2.15, CE3.15, CE1.19 CE2.19 CE3.19 CE1.17 CE2.17 CE3.17
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline	a) I appreciated the safety in my projects by ensuring I had the personal protective equipment. b) I appreciated the importance of using the standards and codes to implement my projects. c) I was aware of the project management skills that I used in my projects to ensure it was completed within the schedule and budget	CE1.19 CE2.19 CE3.19, CE1.5 CE2.5 CE3.5 CE1.17, CE2.17 CE3.17
PE2 ENGINEERING APPLICATION ABILITY		

PE2.1 Application of established engineering methods to complex engineering problem solving	a) I reviewed and applied relevant chemical engineering standards and codes to my projects. b) I used my projects investigative skills to research for the solution to the challenges that I encountered. c) I made sure I mitigated any injuries or risks by observing all the necessary safety precautions in my projects.	CE1.5, CE2.5 CE3.5 CE1.11, CE2.11, CE3.11 CE1.19, CE2.19 CE3.19,
PE2.2 Fluent application of engineering techniques, tools and resources	a) I was aware of risk management therefore I utilized my project management skills to handle my projects. b) I applied my knowledge in softwares to visualize and simulate the work that I had done and improved the results of my projects. c) I followed the safety precautions when I was handling my projects to prevent accidents.	CE1.17 CE2.17 CE3.17 CE1.12 CE2.12, CE3.12 CE1.19 CE2.19 CE3.19

PE2.3 Application of systematic engineering synthesis and design processes	a) I made consideration of the human and social factors when I was working with the team b) I respected the chemical Engineering authorities by following the relevant standard and codes applicable. c) I am proficient in technical knowledge and Problem solving skills in my projects thus I was able to solve the challenges that I encountered.	CE1.15 CE2.15 CE3.15, CE1.5 CE2.5 CE3.5 CE1.11 CE2.11 CE3.11
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	a) I utilized my knowledge in project management to ensure I implemented it as per the plans, and the designs. b) I collected accurate data that helped me in implementing my projects within the specifications. c) I managed my projects well by coming up with accurate and reliable documents in terms of reports.	CE1.17 CE2.17 CE3.17 CE1.6, CE2.6, CE3.6 CE1.14, CE2.14, CE3.14

PE3 PROFESSIONAL AND PERSONAL ATTRIBUTES

PE3.1 Ethical conduct and professional accountability	a) I used the safety tools and resources to ensure there was no injuries ,environmental degradation and tools breakage. b) I had good working relationship with my supervisor and tutor who formed part of my team in implementing the projects. c) I am a professional member of chemical engineering therefore I followed applicable international standards.	CE1.19 CE2.19 CE3.19 CE1.15, CE2.15, CE3.15, CE1.5, CE2.5, CE3.5
PE3.2 Effective oral and written communication in professional and lay domains	a) I am proficient in listening and speaking English that was used during my studies. I also used it during the meetings that I held at the beginning of m projects. b) I am good in written language as per the documentation that I prepared accurately and to the point.	CE1.5, CE2.5 CE3.5 CE1.14, CE2.14, CE3.14
PE3.3 Creative innovative and proactive demeanor	a) I used alternative approach in terms of Chemical engineering softwares to implement and solve challenges in my projects. b) I applied innovative techniques and	CE1.12, CE2.12 CE3.12

	procedures during the implementation of my projects successfully. c) I used creative approach in finding the solution to the challenges that I encountered.	CE1.13 CE2.13 CE3.13, CE1.11 CE2.11 CE3.11,
PE3.4 Professional use and management of information	a) I was proficient in gathering and utilization of the information that I collected and used it in my projects. b) I was critical in reviewing the information detail about the project that I got from the university library and from online sources. c) I was proficient with the information and accuracy that I was to document my activities as a way of tracking the project progress.	CE1.6 CE2.6 CE3.6 CE1.5 CE2.5, CE3.5 CE1.14, CE2.14, CE3.14
PE3.5 Orderly management of self, and professional conduct	a) I understood the importance of belong to the professional bodies thus I followed the standards and codes in Chemical engineering. b) I am committed for lifelong development of my chemical engineering skills because I participated in some form of trainings. c) I used my skills in project management to ensure I	CE1.5 CE2.5 CE3.5 CE1.18 CE2.18 CE3.18

	implemented the project within the budget, time and cost.	CE1.17 CE2.17 CE3.17
PE3.6 Effective team membership and team leadership	a) I valued the team work because it gave me the alternative view point by recognizing the advice from my supervisor.	CE1.15 CE2.15, CE3.15