

CHAPTER THREE

PROJECT DESCRIPTION

3.1 INTRODUCTION

IEFCL intends to build Train-2 Fertilizer Plant for Ammonia and Urea production. This chapter describes the location of proposed project, production process, plant's product and information on various discharges, waste and emissions. The proposed project is located geographically Latitude 4⁰49'N and Longitude 7⁰6'E within the Indorama complex on a piece of land of 26 hectares.

For identifying the location of the initiative, please refer chapter -1 Plate 1.1(Rivers State) and Plate 1.2. (Eleme Local Government)

- Due to its location and expected effects (see Chapter 5 for details), the environment of other State, Local Government Area or areas outside Nigeria is not likely to be affected by the Train2 Fertilizer project.

3.2 PROPOSED LOCATION OF AMMONIA, UREA PLANTS

In the following Table 3.1, permanent and temporary Fertilizer project components within the area of Indorama Complex are listed.

The attached Plot plan (Appendix 1.1) gives a graphic representation of the areas covered by the IEFCL-Train2 and associated auxiliary facilities identified in legends. The total land area covered by proposed IEFCL-Train2 project and associated auxiliary facilities will be approximately 26 hectars. A trial¹ of photographic rendering provided in Appendix 3.1 shows the likely landscape appearance of site, which is expected after the realization of IEFCL-Train2 Fertilizer Plant. Site layout plan of IEFCL-Train2 fertilizer plant is attached in Appendix 1.2

¹ According to the available details of engineering design a trial of photographic rendering has been provided assuming reference of a similar plant for the production of Ammonia and Urea. These plants have been inserted in the IEPL/IEFCL site area foreseen by the Project. For more details see Appendix 3.1.

Table 3.1: New permanent and temporary Project components

ID²	Particulars
A	New Permanent Project components
20	Polisher, Waste water treatment and Air Dryer Units
29	Ammonia Plant
30	Urea Plant
31	Cooling Towers
32	Urea Warehouse for Bulk Storage
33	Urea Truck Loading facilities
34	Ammonia Storage facilities
35	Natural Gas (NG) Receipt Facilities
36	Raw Water and DM Water
37	Argon Recovery / Purge Gas Recovery Plant
38	Nitrogen plant
B	New Temporary Project components (only for construction phase)
39	Temporary Office facilities; Laydown, Pre-fabrication, Construction warehouse area

² ID refers to the Legend Code in Appendix 1.1

3.3 PROJECT DESCRIPTION

The project as mentioned above entails the building of the following two Process plants to manufacture Ammonia & Urea:

- Ammonia Plant : 2300 MTPD of Ammonia
- Urea Plant : 4000 MTPD of Urea

The following paragraphs briefly describe processes involved in such plants, in addition to identification of ancillary facilities necessary for their functioning.

IEFCL has engaged Technology licensors / EPC Contractors for undertaking front end engineering design (FEED) & getting firm bids employing state of the art technology, optimum energy consumption & most environment friendly process.

Both Technology licensors are renowned in the industry and follow the latest process of operation and recovery philosophies.

For the purpose of Environmental Impact Assessment, highest levels of emission and discharge have been taken into account.

About the lifespan of the Project, it is remarkable that:

- The Project design shall be suitable for 30 years of operation with planned turn around for maintenance every 2 years or longer.
- Design capacity is considered for on stream days of 330 days/ year.
- Design and selection of equipment will be to enable operation of the entire complex on a sustained basis for first 24 months, without requiring any turnaround maintenance.

The general process of the two process plants, along with typical material flow diagram of the process are described below.

3.3.1 Ammonia Plant:

The plant is designed to produce 2300 metric tons per day of Ammonia. The Product Ammonia is delivered to Urea Plant. The plant can also deliver the liquid Ammonia to atmospheric storage tank when the Urea Plant is under shutdown.

Methane and heavier hydrocarbons in the feedstock Natural gas & atmospheric air is first reformed using a catalytic process to Hydrogen, Carbon Monoxide, Carbon Dioxide and Nitrogen. The carbon monoxide is further catalytically shifted to carbon dioxide and hydrogen. The carbon dioxide is selectively adsorbed and sent to Urea plant. The balance gas consisting of Hydrogen and Nitrogen (called syn gas) is catalytically synthesized to Ammonia.

Ammonia Plant is designed as per state of art Purifier technology developed by KBR (Kellogg Brown & Roots) with minimum emissions and discharges, having well-defined F&G (Fire and gas) detection system.

All relief valves and pressure control devices are designed for worst cases and connected to dedicated flare. Plant is designed with minimum fugitive emissions having seamless piping and special material selection wherever required. Details of fugitive emissions is mentioned in clause 3.3.5.4

Air emissions detail is mentioned in clause 3.3.5.1

The main input and products of the plant are shown in Figure 3.1.

Hereinafter is reported the description of the process shown also in Figure 3.2.

Process flow

The Ammonia Plant is a single train plant consisting of:

- A. Feed and fuel gas supply
- B. Feed gas desulfurization
- C. Primary reforming
- D. Process Air compression
- E. Secondary reforming
- F. CO shift conversion, HTS and LTS (High and Low Temperature Shift conversion)

- G. CO₂ removal
- H. Methanation
- I. Syngas drying
- J. Cryogenic Purification
- K. Synthesis gas compression
- L. Ammonia synthesis
- M. Ammonia refrigeration system
- N. Loop Purge Ammonia Recovery
- O. Hydrogen and Argon recovery
- P. Process condensate stripping

All process operation activities will be run in continuous, exception made for maintenance period of the plant.

Overall block flow diagram of the Ammonia plant and process flow scheme are illustrated below:

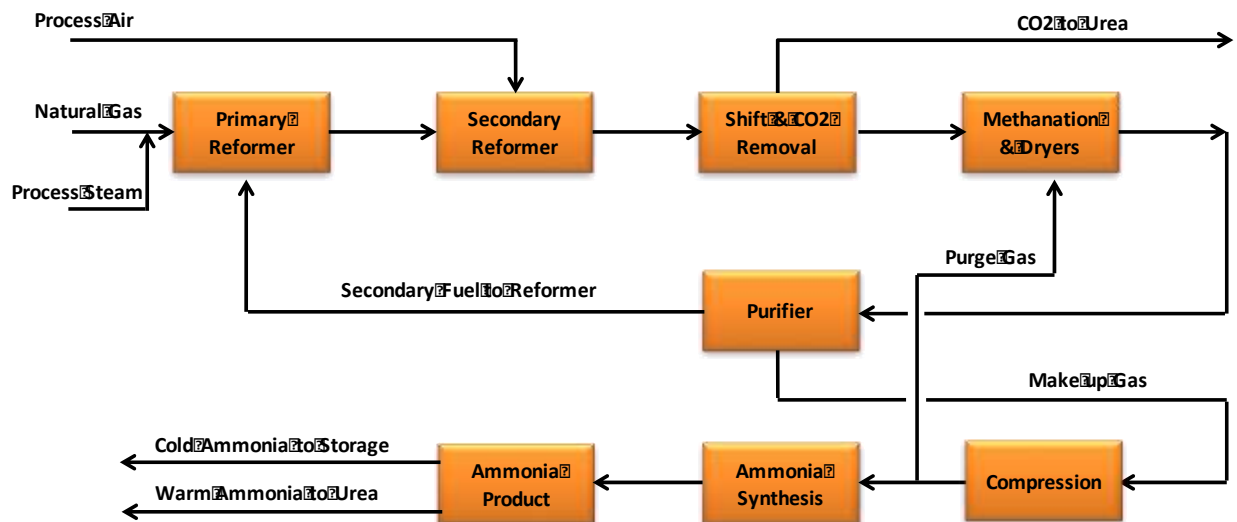


Figure 3.1: Block diagram of Ammonia Plant

The material flow block diagram of Ammonia Plant presented above shows main inputs and products only. Pl. refer section 3.3.4 and 3.3.5 for further details on material inputs/outputs expected during the operation phase.

Steam generated in Ammonia Plant is consumed internally in process as well as to drive steam turbines as a prime mover for compressors used in the plant.

Process Description

A. Feed and Fuel

The plant feed is natural gas (NG) which will be available at plant battery limit at around 48 kg/cm²g & temperature ~15 deg C. The fuel gas for the reforming & steam boiler is part of the total natural gas delivered at the battery limit. The natural gas fuel for reforming is supplemented by waste gas from Ammonia Plant.

B. Feed gas desulfurization

Feed gas supplied at the battery limit passes through slug catcher to separate liquids entrained in the natural gas. The feed gas is then added with a small amount of hydrogen (syn-gas) and heated in the convection area of reforming section. The gas then passes through a bed of cobalt-molybdenum catalyst, which converts organic sulfur into Hydrogen Sulfide (H₂S).

In the second step, the H₂S is removed in a zinc oxide bed operating in series with lead-lag combination. The desulfurized gas leaving the zinc-oxide bed contains less than 0.1 ppm of sulfur.

C. Primary Reforming

The gas leaving the zinc oxide bed is mixed with medium pressure steam to maintain specific steam-to-carbon molar ratio. It is then heated in the convection zone of primary reformer before entering to the reformer catalyst tubes where the gas and steam react in the presence of nickel base catalyst to form hydrogen and carbon oxides.

D. Process Air compression

The process air compressor provides air for the secondary reformer. The process air from the final stage of compressor is heated in the convection zone of the primary reformer and then added to the process gas into the secondary reformer.

E. Secondary reforming

The gas mixture passes through a nickel based catalyst where the residual methane is reformed to Hydrogen and carbon oxides using the heat generated by the combustion. The process gas leaving the reforming section at about 890 to 900°C is cooled to about

360°C in the Waste heat boiler, where saturated steam is produced. After cooling, the gas flows to the High Temperature CO-converter (HT CO converter).

Saturated steam at 126 kg/cm² (g) is superheated to 510°C in the super heater coils of the waste heat section of the primary reformer. After superheating, the steam is used in the high pressure steam turbine that drives the air and other compressors.

F. CO shift conversion (HTS and LTS)

The carbon monoxide leaving the secondary effluent is further oxidized with water to produce carbon dioxide and hydrogen. This conversion is accomplished in two steps conversion - The High Temperature Shift conversion (HTS) followed by Low Temperature Shift (LTS) converter. Here the CO content is further reduced down to less than 0.30 % vol. (dry).

G. Carbon dioxide removal

The CO₂ removal is performed through two-stage with aMDEA removal system licensed by BASF. The regenerated CO₂ is sent to the Urea Plant.

H. Methanation

The gas leaving the CO₂ removal section is heated & fed through Methanator catalyst beds where the remaining carbon oxides are transformed into methane and water. Practically the opposite reaction of reforming is used for eliminating carbon oxides from the gas stream going to the synthesis loop as carbon oxides that are harmful to synthesis catalyst.

The syngas leaving the Methanator contains less than 5 ppmv of carbon oxides (as CO + CO₂).

I. Syngas drying:

The Methanator effluent gas is cooled & the chilled gas flows to the Molecular Sieve Driers. The driers contain solid desiccant. Each drier is sized to remove water, Ammonia, and carbon dioxide to less than 1ppmv.

J. Cryogenic purification:

Dried synthesis gas from the Molecular Sieve Drier flows to the Purifier Expander, which is a turbo expander. Here work energy is removed to develop the net refrigeration required for the Purifier. The removed energy is recovered as electricity in Purifier Expander Generator. The expander effluent is further cooled and partially condensed in Purifier Feed / Effluent Exchanger. The process stream then enters the Purifier Rectifier, which is a trayed column.

In the rectifier, the molar ratio between hydrogen-to-nitrogen as needed for Ammonia synthesis is achieved. The condensed excess nitrogen contains all of the methane and about 60% of the argon.

K. Synthesis gas compression:

The purified synthesis gas having the correct molar ratio is compressed to the synthesis loop pressure in the Synthesis gas Compressor, which is a two-casing centrifugal compressor. Compressor is driven by Steam Turbine that uses HP steam produced in the Ammonia Plant.

L. Ammonia synthesis:

The synthesis loop consists of the 4 bed Horizontal Ammonia Converter, Feed / Effluent Exchanger, Ammonia Converter Effluent/Steam Generator, Ammonia Converter Effluent Cooler, Ammonia Unitized Chiller, Ammonia Separator.

The syngas leaving the compressor is first heated up with the converter effluent and then enters to the syngas converter. Ammonia is produced in the three-bed converter, where the hydrogen and nitrogen react over an iron-based catalyst. The reaction is exothermic and heat is recovered into steam generator located in Synthesis loop to generate HP steam.

M. Ammonia gas condensation and Refrigeration:

The refrigeration system provides the following:

- Cooling of converter effluent in unitized chiller for condensation of Ammonia.
- Production of cold (-33 °C) liquid Ammonia product.
- Production of warm (38 °C) liquid Ammonia product (normal).

- Cooling of the makeup synthesis gas in Methanator Effluent Chiller.
- Condensation of recovered Ammonia vapor from Ammonia Distillation Column.
- Condensation of Ammonia vapor from Ammonia Storage.

Ammonia Refrigeration Compressor is a four casing centrifugal compressor driven by a Steam Turbine. The compressed Ammonia is condensed in Refrigerant Condenser, and flows to the Refrigerant Receiver. From here, it can be exported as warm Ammonia product by the Warm Ammonia Product Pumps. The warm Ammonia product is routed to the Urea Plant. A small slipstream is used as reflux in the Ammonia recovery system. The cold liquid Ammonia goes to Ammonia storage tank when the Urea Plant is under shutdown.

N. Loop purge Ammonia recovery:

As described above, the loop purge gas is sent to the HP Ammonia Scrubber, which has two beds of packing, the purge gases are scrubbed with water to recover Ammonia as aqua-Ammonia solution. Similarly flash and inert gases are combined and washed off Ammonia in LP scrubber, the outlet aqua-Ammonia solution is combined and flows to distillation column where NH₃ get separated & rectified and flows to Ammonia condenser. Overhead gas from HP scrubber which is almost NH₃ free is sent back to process and from LP scrubber to Primary reformer furnace.

O. Hydrogen and Argon Recovery:

Hydrogen is recovered in Purge Recovery Plant. After Hydrogen Recovery, residual gas, being tagged as Tail gas, is sent to Argon Recovery Plant where Argon is recovered. After Argon recovery, the recovered gas is recycled back.

P. Process condensate stripping:

The process condensate contains dissolved NH₃, Methanol, CO₂ which will be removed by steam in Process Condensate Stripper. The overhead steam along with NH₃, Methanol, CO₂ is sent back to primary reformer and stripped process condensate sent to Polisher for further treatment.

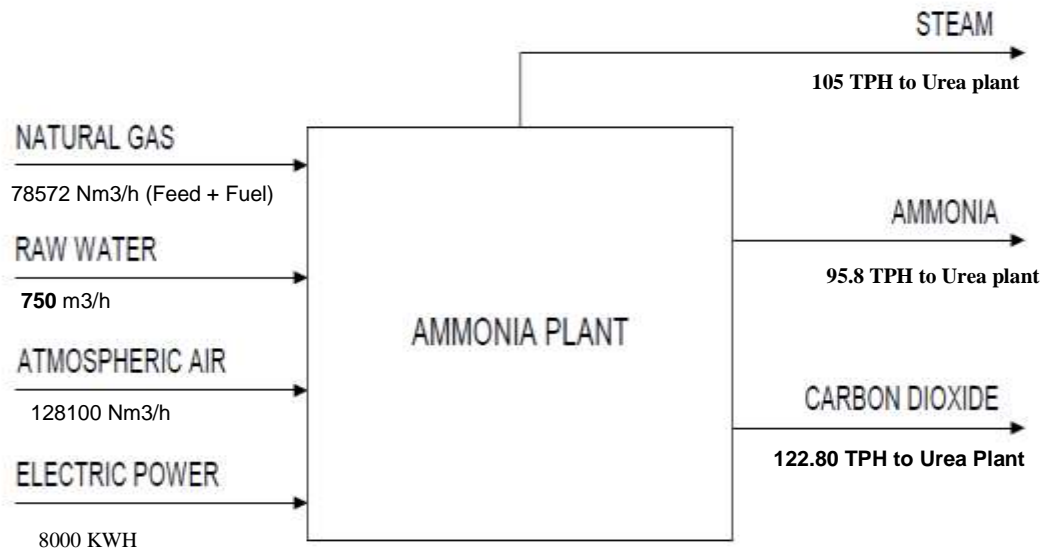


Figure 3.2: Material flow Block diagram of proposed Ammonia Plant

Product Quality:

The product Ammonia has the following characteristics at Ammonia Plant battery limit:

- Ammonia: 99.90 wt % (min)
- Water: 0.10 wt % (max)
- Oil: 5 ppm (max)

3.3.2 Urea Plant

The Urea Plant is designed to produce 4000 metric tons per day of Urea. Urea plant include two distinct sections:

1. Urea Synthesis section where Ammonia & Carbon dioxide react to produce Urea solution employing the state of the art ACES 21 technology licensed by Toyo Engineering of Japan.
2. Conversion of Urea solution to granules at the Granulator section employing spout bed fluid granulation technology employed by Toyo Engineering of Japan.

The Urea granules produced are sent to storage either for bagging or bulk shipment.

Hereinafter is reported the description of the process shown also in Figure 3.3.

The block flow diagram illustrating the material flow is illustrated below:

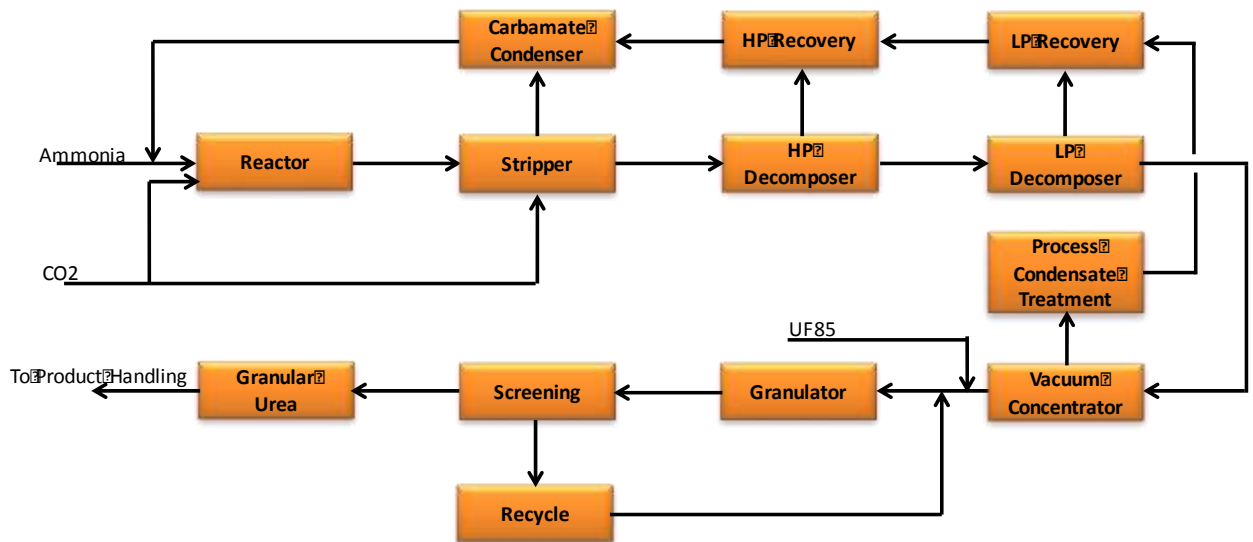


Figure 3.3: Block Diagram of Urea Plant

It may be noted that in order to have the highest levels of process safety, all relief valves and pressure control devices are designed for worst cases and connected to dedicated flare. Plant is designed with minimum fugitive emissions and special material selection have been employed wherever required. Details of fugitive emissions is mentioned in clause 3.3.5.4

Air emissions detail is mentioned in clause 3.3.5.2

Urea Process flow

Urea process is characterized by the following main process steps:

- A. Urea synthesis, NH₃ & CO₂ recovery section at higher pressure
- B. Urea purification along with NH₃, CO₂ recovery at two lower pressures
- C. Urea concentration
- D. Process Condensate treatment
- E. Granulation.

Brief description of each of each of the sections is given below.

A. Urea synthesis , NH₃, CO₂ recovery at high pressure

Urea is produced through synthesis of Ammonia and carbon dioxide. The Ammonia and carbon dioxide react to form ammonium carbamate, a portion of which dehydrates to Urea and water.

The fraction of ammonium carbamate that dehydrates is determined by the ratios of various reagents, the operating temperature, pressure and the residence time in the Reactor. The reaction products leaving the reactor flow to a stripper, a vertical in tube falling film decomposer in which the liquid, distributed on the heating surface as a film, flows by gravity to the bottom.

As the liquid film flows, it gets heated and decomposition of carbamate through surface evaporation takes place. Generated Vapours (essentially Ammonia and carbon dioxide) are removed by flowing to the top of the stripper. This gaseous stream with the recovered solution from the downstream sections is condensed and recycled to the Urea reactor by means of carbamate ejector.

B. Urea purification and NH₃, CO₂ recovery at two lower pressures

Urea purification and overhead vapors recovery take place in two stages at decreasing pressures.

The exchangers where Urea purification occurs are called decomposers. In these equipment, the residual carbamate decomposition takes place. The decomposed carbamate vapors are condensed and recycled back to the synthesis loop while the inerts are washed in the washing column before being sent to the flare stack.

The Urea solution exiting this section is purified to generate Urea solution of 69-71 wt %.

C. Urea concentration section

In order to granulate Urea, concentrated Urea solution of 97 wt% is necessary. This is achieved in vacuum concentration stage. The Urea solution leaving the purification sections having about 70% wt Urea, along with the Urea solution recycle coming from granulation unit, is sent to the Urea concentration section.

The concentration happens in vacuum conditions employing vacuum generation system. The concentrated Urea solution (~97 % by wt.), is sent to granulation unit, after mixing with UF85 additive (Urea Formaldehyde Concentrate) as anti-caking agent.

D. Process condensate treatment

The process condensates containing NH₃, CO₂ and Urea coming out from vacuum system is treated in this section to ensure that the condensate have an almost free-of-contaminants. The treated process condensate is further sent to the Polisher unit. The NH₃ & CO₂ separated from the process condensate stripper are mixed with the Low Pressure Decomposer overhead vapors, condensed and further recycled back to the synthesis loop.

E. Granulation

The Urea solution is fed on the Urea seeds in the granulator bed through the multi spray nozzles to enlarge the recycle particles (seeds) through agglomeration of the solution to seeds. The water in the feed Urea solution is evaporated in the granulator. The enlarged granules are cooled to a suitable temperature by fluidizing air on the internal fluidized beds in the granulator. Urea granules produced in the granulator are screened to separate the product size granules from over and under size granules through the double deck screen. Small sized granules are recycled back to the granulator as the seed and oversized granules are crushed through the double roller type crusher and recycled back to the granulator together with the under sized granules as the seeds. Exhaust air from the granulator and cooler is scrubbed in the wet type dust scrubber to recover the Urea dusts in the exhaust air. The water used in the dust scrubber to dissolve the urea dust is recycled back to the Urea plant to recover the Urea by evaporating the water.

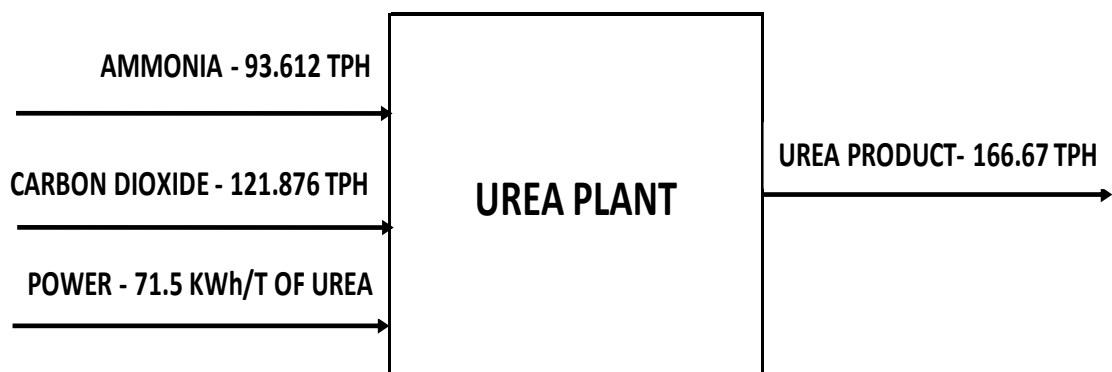


Figure 3.4: Material flow Block diagram of proposed Urea plant

3.3.3 Utilities Description

3.3.3.1 Power generation

Power will be provided by the existing captive power plant in IEPL complex. The power plant consists of four operating and one additional under construction General Electric model MS-6001 gas turbine generators which are rated at 11500 volts, 3 phase and 50 hertz. Each generator supplies power to 33 kV switch board at the main substation through the step up transformers. Power for fertilizer project is tapped off from the 33 KV bus in main substation. Each of the gas turbines can produce approximately 33 MWH of power. While the existing power consumption is about 82 MW, the new facilities are expected to consume an additional 30 MW. Thus the installed capacity is more than sufficient to meet the power demand of IEFCL-Train2 project as well.

In addition to the above, IEPL manufacturing complex is equipped with four nos. of emergency diesel generators (EDGs) manufactured by Mitsubishi heavy industries to supply emergency power in the event of outages of gas turbines. The complex has 12 MW of emergency power capacity.

3.3.3.2 Raw Water Treatment

Two new borehole pumps, filter water package & DM plant will be installed as part of the IEFCL-Train2 project. Bore holes are the only source of raw water for Train-2 fertilizer project. During normal operation, the total requirement of water will be approximately 750 m³/hr. For meeting this requirement, two (2) new boreholes will be drilled.

The raw water from the bore holes will be treated through de-carbonator. The decarbonated (to remove carbon dioxide) water will be used for firefighting. The decarbonated water is further treated through filtration devices (to remove suspended solids) and used for cooling tower make up, plant water and also as feed to DM plant.

3.3.3.3 Demineralized Water & Condensate Polishing System

A. Demineralized Water System

IEFCL-Train2 shall be equipped with a new DM plant to generate the demineralized water make-up for steam generation. DM Plant is having cation, anion & mixed bed exchanger to produce ultra-pure water. The demineralized water is further de-aerated to produce Boiler Feed Water (BFW) suitable for High pressure steam generation in the various boilers in Ammonia plant. Generated steam is used in reforming process as well as motive fluid for steam turbines to drive the various compressors in Ammonia & Urea plants.

B. Condensate Polishing System

A New Condensate Polishing System will mainly treat process condensates from Ammonia & Urea Plants & Steam Turbine condensates. Condensates are first passed through Cartridge Filters. After microfiltration, condensates are treated in the Mixed Bed Polishing System to be reused as demineralized water, after reducing salts & silica contents to desired levels to be acceptable for production of steam in boilers.

To regenerate cation & anions resins, sulphuric acid and caustic soda are used respectively.

3.3.3.4 Steam Generation and Boiler Feed Water System

Steam Generation:

IEFCL Train 2 project shall also install new steam generation and boiler feed water facilities. The steam generation systems consist of dedicated auxiliary boiler (where Natural Gas is used as fuel) as well as waste heat boilers to recover the process heat generated during the reforming as well as synthesis of ammonia. It may be noted that the net steam production in the complex is quite low at about 50 MT/Hour during normal operation through the efficient process employed to recover the heat energy.

The high pressure steam is mainly used to drive turbines driving the compressors in Ammonia & Urea units as well as in the reforming & CO shift processes.

A. Auxiliary Boiler

The Auxiliary Boiler Package is provided in order to supply steam during plant start-up as well as for steam demands of Urea process. During normal complex operation the Auxiliary Boiler run at about 40 % of load while the maximum capacity has been evaluated considering the expected steam consumption during the transient scenarios (such as Ammonia secondary reformer Start-up).

Auxiliary Boiler is designed according to the following main characteristics:

- Steam capacity (MCR) = 125 t/hr maximum
- Steam pressure at outlet = 47.4 kgf/cm²(g);
- Steam temperature at outlet = 404°C
- Fuel supply = Natural gas

B. Boiler Feed Water (BFW)

A boiler feed water de-aerator capable to serve all the BFW users of the Ammonia & Urea plants has been considered. It has been designed to provide de-aerated boiler feed water at 110°C having characteristics to produce steam with a quality in agreement with ASME guidelines. The de-aerator will have a hold-up capacity of 15 minutes (at design flow rate) before the low level switch stops BFW Pumps.

3.3.3.5 Cooling Tower

New cooling towers of sufficient capacity shall be installed to supply cooling water for Ammonia, Urea and Utilities plant users. To cover water losses due to evaporation, drifting and blow down, the cooling water basin is equipped with level measurement to control the flow rate of make-up water. Make-up cooling water shall be supplied from the water treatment plant.

Since there is provision for maximum reuse of boilers blow down as cooling water make-up, the selection of cooling water treatment will take into account adequate chemical dosing equipment to avoid any algae proliferation.

A continuous blow-down flow rate is provided in order to keep under control the dissolved solid particles within the water circulation system in both Ammonia & Urea distribution. Concentration cycles have been designed as 6.

3.3.3.6. Effluents treatment system

Liquid wastes are generated from the boiler blow downs, air compressor intercoolers, turbine condensates, steam condensates, process condensate, and oily effluent from the various processing units. Some waste streams will be individually treated in the Ammonia and Urea plant before being channeled into condensate polisher unit for reprocessing and reuse as boiler feed water. Some other streams shall be sent to the ISBL waste water treatment system. A description regarding the treatment approach of various effluent streams is given below:

A. Boiler Blow Down

Boiler blow down will be routed to the cooling tower basin as make-up.

B. Condensate from Air Compressor Intercoolers

Condensate from Air Compressor Intercoolers will be routed to the cooling tower basin as Make-up.

C. Turbine Condensate

Turbine condensate will be sent to the polishing unit and shall be reused as BFW (boiler feed water) after polishing.

In case the turbine condensate is off spec, it will be transferred to the ISBL effluent treatment section.

D. Steam Condensate

Steam condensate will be sent to the polishing unit and reused as BFW after polishing.

In case the steam condensate is off-spec, the same shall be transferred to the ISBL effluent treatment section.

E. Process Condensates

Process condensate generated in Ammonia Plant is treated in dedicated stripper and the treated condensate is sent to the polishing unit and reused as BFW after polishing. In case the process condensate is off-spec, the same shall be stored in a tank in Ammonia plant and gradually treated in the medium pressure process condensate stripper. Provision is also provided for diversion to ISBL effluent treatment section.

Process condensate generated in Urea Plant is treated in dedicated hydrolyser and stripper and the treated condensate is sent to the polishing unit and reused as BFW after polishing. In case the process condensate is off-spec, the same shall be stored in a tank in Urea plant and gradually treated in the hydrolyser and stripper. Provision is also provided for diversion to ISBL effluent treatment section.

F. Oily Water

Oil contaminated water is collected in a spill wall or into an oil trap of a pit for each potential source of oily water. Oil is skimmed manually at each pit periodically and further removed in oily water separator such as CPI separator prior to discharging to the ISBL treated effluent pit.

G. Chemical Drain

Chemical Drain around the boiler is collected and sent to the existing neutralization pit. Chemical Drain from the amine area is collected to the aMDEA solution sump and recovered in aMDEA Storage Tank.

H. Floor Washing Water in Urea Synthesis Area

In Synthesis area, the spilled process fluid on the surface of the paving or equipment is washed by steam condensate and collected in dedicated pits inside Urea plant. The collected water is treated in hydrolyser and stripper and the treated stream is sent to the ISBL treated effluent pit.

I. Floor Washing Water of Granulation Area

Granulation area is designed in such a way that wash water containing Urea is collected in Dissolving Pit and recovered to Urea Plant. The spilled process fluid on the surface of the paving or equipment is washed by steam condensate and sent to Dissolving Pit. There is no discharge to waste water system from granulation area.

3.3.3.6.1: Inside plant battery limit effluent treatment

The water consumption is optimized itself in technology and design of plants. Boiler blow down and condensate from air compressor intercooler is routed to cooling tower make-up. The granulator wash water is routed to dissolving tank for recovery. Chemical Drain from the amine area is collected to the aMDEA solution sump and recovered in aMDEA Storage Tank.

The process condensates generating in ammonia and urea plant are being treated inside plants and treated process condensates is being routed to condensate storage tank. The steam and turbine condensates also routed to this condensate storage tank. The homogenized and mixed condensate is treated in polisher unit to remove salts and silica. The purified water is used as boiler feed water.

The floor washing water from urea synthesis section is collected in dedicate pits inside urea plant and treated in hydrolyser and stripper. The treated stream is routed to treated effluent pit. The scheduled quality control on treated stream is administered to access the performance of treatment facility.

The re-generation effluent generated during regeneration of polisher resin is collected in dedicated neutralization pit having neutralization facility and after pH correction, transferred to ISBL treated effluent pit.

The treated effluent pit have neutralization facility for pH correction The air sparer are also provided to improve the water quality by increasing dissolved oxygen concentration.

The treated effluent from treated effluent pit is routed to equalization pond by means of closed pipe line. The control valve installed at up-stream of discharge pump is

controlled by DCS and operating logic is configured with pH of discharged treated effluent. If the pH of treated effluent goes beyond 8.0 or less than 6.5, then the control valve automatically closed and stop the transfer to equalization pond. In such cases the pump discharge recycled back to treated effluent pit by recycle line. The diagram showing the ISBL effluent treatment and re-use facility is illustrated below:

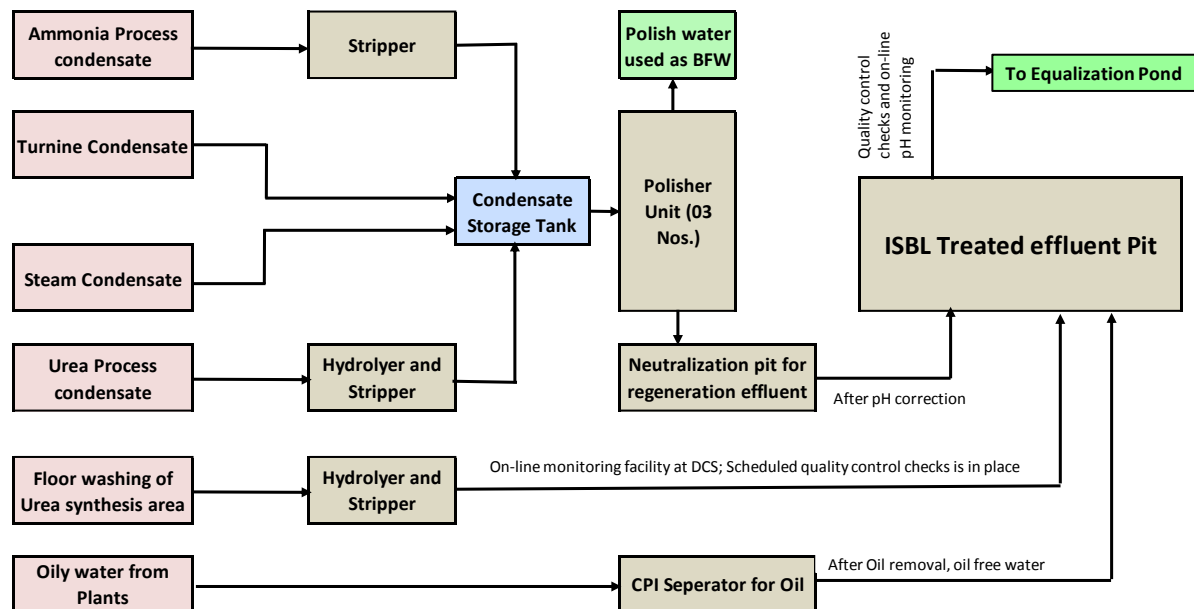


Figure 3.5: Flow diagram of ISBL Effluent Treatment Facility

3.3.3.6.2: Final treated effluent

Final treated effluent in ISBL effluent treatment facility, is directed to the equalization pond for dilution and neutralization if required before sending to holding ponds. The total holding capacity of the two holding ponds amount to 40,000M³. After checking the quality of effluent at holding pond outlet, it will be discharged to the retention pond, in controlled manner. In the retention pond, it is further mixed with storm-water runoffs from the premises and discharged to Oluka River. It may be noted that the discharges from the Retention Pond is carried out only when the pond is full & not discharged daily.

Total effluent generated by Train-2 fertilizer plant will only be 20 -25 M3/hr. however another 100 M3/hr. water from cooling tower blow down and DM plant will be sent directly to equalization pond.

The existing facilities i.e. equalization basins and holding ponds have sufficient capacity capable to manage the effluent generated by new IEFCL –Train2.

Sanitary waste from fertilizer plant which will be about 4-6 M3/hr and will be treated in existing facilities. Existing facility is having spare capacity of about 25 M3/hr.

3.3.3.7: Nitrogen System

Existing petrochemical complex is having two nos. of air separation units, generating gaseous nitrogen & liquid nitrogen. Gaseous nitrogen is directly supplied to process plants while liquid nitrogen is stored in liquid storage tanks for emergencies.

A new air separation unit is being added to augment the existing capacity and meet the requirement of IEFCL-Train2.

3.3.3.8: Natural Gas System

The system will be designed to supply continuously:

- Natural gas feedstock to Ammonia Plant
- Fuel gas to Primary Reformers (Ammonia Plant)
- Fuel gas to Auxiliary Boiler.
- Fuel gas (assist gas/purging gas) to flares

3.3.3.9: Ammonia Storage Tank

IEFCL-Train1 is equipped with one Ammonia storage tank having the following characteristics:

- Capacity: 15000 metric tons of liquid Ammonia
- Internal Diameter: 33000 mm
- Height: 27000 mm
- Operating pressure (min/max): 200/400 mm H₂O(g)
- Temperature: -33 °C
- Max. Daily Boil-off: 0.04% by wt. of full storage capacity

One new Ammonia Storage Tank of similar specification is proposed for IEFCL – Train2

The Ammonia storage tank will be double wall – double containment type, designed and constructed so that both the primary and secondary self-supporting containers shall be capable of independently containing the stored liquid.

Both inner & outer tank walls and bottoms will be made of low temperature materials and designed for product deriving loads.

The secondary containment structure will be independent from that of the primary tank. Thermal insulation of inner shell, roof and bottom will be such as the maximum allowed boil-off does not exceed 0.04% of capacity per day.

The boil-off ammonia vapour is routed to refrigeration compressor of Ammonia plant to recycle back in main ammonia stream. In shut down condition of Ammonia plant, the boil-off ammonia vapour is compressed by BOG compressor and recycle back to the storage tank. A dedicated flare stack adequate for complete burning of ammonia vapours, released during any emergency situation, is provided. The continuous pilot flame at flare tip maintained to ensure complete burning of ammonia vapours assuring that unburnt ammonia will not release in atmosphere in any case.

Ammonia storage tank will be equipped and provided with the necessary instrumentation capable of monitoring and controlling both normal operation and emergency occurrences, while assuring the highest reliability and operability.

Ammonia Storage Tank will be provided with pressure relief valves and with vacuum relief valves adequate to manage any emergency.

3.3.3.10: Urea Storage

After the Urea has been produced, it must be stored for shipment. From the granulator, the Urea will be transported by belt conveyor to the storage building. The new storage area will be capable of holding 60,000 metric tons of Urea. Storage building will be equipped with air conditioning facility to avoid lump formation of the product. Portal scraper reclaimers will be used to reclaim the product onto a belt conveyor for export to Bulk truck loading system.

3.3.3.11: Fertilizer plant system control

Distributed Control System, DCS, the most modern Control Platform is used for the Fertilizer Plant Control System. DCS centralizes plant operations to provide flexibility and simplicity by allowing central control, monitoring and reporting of individual components and processes. The redundancy within DCS facilitates high system availability and reliability. The DCS Controllers and associated inputs / outputs are connected through integrated redundant communications network to operating and engineering stations. The stations have graphical displays, easy-to-use displays for data monitoring, data logging, alarming and control. Field devices are directly connected to input / output modules that communicate with assigned controllers while reading and reporting real parameters.

DCS, ESD & FGS systems will be connected on an integrated redundant control network, Vnet/IP, that is used as real time control network connecting all active DCS, ESD & FGS components. Emergency Shut-Down System, ESD, or the safe-guarding system, shall automatically bring the relevant equipment or part of the plant to a safe condition, when a critical process variable reaches the limit of an acceptable value.

3.3.3.12: Non-Plant Facilities

All IEPL's existing Non-plant facilities such as a fire station, medical center, canteen, warehouse, garage/vehicle repair shop, etc. will be used and augmented if necessary.

3.3.4 Utilities for Construction

Raw materials (Including Utilities for construction) Input and Product/Material Output

The main materials to be used during construction phase will be:

- Construction materials (cement, bricks, steel, plastic pipe, wood),
- Electric power,
- Construction water
- Compressed air,

Total water and energy consumption, during construction amount to:

- **Water:** Total consumption will be approximately 230,000 m3.
- **Diesel consumption (only for construction equipment):** Total consumption will be approximately of 7,000 KL, average consumption around 280 KL/month from month 4, peak during the months 14-29 of 320 KL/month.

Source of water and power for construction will be from existing facilities

It is essential to give an assessment of materials input and output in terms of loads and volumes during operation. The information presented below was supplied by the technology licensors of the project:

Table 3.2: Consumption of raw materials and product output for a typical Ammonia Plant

Source	Ammonia – 2300 MTPD				<u>Destination</u>
	Input		Output		
Gas supply Co.	Natural Gas Feed	64,575 Nm ³ /h	NH ₃ CO ₂	95,833 kg/h 122,800 Kg/hr	To Urea plant/Ammonia storage
Gas supply Co.	Natural Gas Fuel	13,240 Nm ³ /h	-	-	-
Gas supply Co.	Natural Gas Fuel for Boiler	2775 Nm ³ /h	-	-	-
From existing facility	Nitrogen	220 Nm ³ /h	-	-	-
Plant air header	Compressed air	200Nm ³ /h	Compressed air from process air compressor	5,418 Nm ³ /h	For instrument & plant air header
From instrument air dryer	Instrument Air	450 Nm ³ /h	Turbine condensates	113600 kg/h	To condensate storage tank
Condensate polishing/ DM Plant	DM Water	386,500 kg/h	Low Pressure steam from boiler BD	1,653 kg/h	To SLL header
DM Plant	DM Water	30,000 kg/h	-	-	-
-	-	-	Medium pressure Steam export	104,500 kg/h	To Urea Plant

Ambient	Air to process air compressor	127,962 Nm ³ /h	Stripped process condensates	91,500 kg/h	Condensate polishing unit
Cooling tower	Circulating cooling water	209,800 m ³ /h	-	-	-
Existing Power Plant	Electric Power	10,919 kWh	-	-	-

Notes: CT – Cooling tower, BD- Blow down

Herein the pressure related to High, Medium, Low pressure indicated in Table 3.1:

- High pressure steam : 126 Kg/cm²(g)
- Medium pressure steam : 46.5 Kg/cm²(g)
- Low pressure steam : 3.5 Kg/cm²(g)

Table 3.3: Consumption of raw materials & product output for a typical Urea unit process

Source	Urea – 4000 MTPD				Destination
	Input		Output		
Ammonia Plant/ Storage tanks	NH ₃	93,745 kg/h	Urea granules	166,667 kg/h	Bagging plant/ Bulk Silo
Ammonia Plant	CO ₂	121,859 kg/h	-	-	-
-	-	-	Water Vapor to atm from Urea Cooling Tower	288 m ³ /h	-
UFC tank	UFC	1,250 kg/h	CO ₂ compressor to atm: • Inerts • CO ₂	50 Nm ³ /h 605 kg/h	Atmosphere
Cooling tower	Circulating cooling water	16,500 m ³ /h	-	-	-
Atmosphere	Atmospheric air	1,431,886 Kg/hr	Saturated air to Atm. • NH ₃ • Urea dust Dry air	34 kg/h 34 kg/h 1,431,886 kg/h	Atmosphere

Existing Power Plant	Electric Power	9,426 kWh			
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3.3.5. Types and sources of air emissions

3.3.5.1 Sources of Gaseous Emissions for the Ammonia Plant

The Plant is designed to minimize emission and effluents during normal and startup operations. Design features are described hereunder.

Process Heater (Primary Reformer)

In Primary reformer, purge gas and flash gas are burned with natural gas to supply the energy for the reforming reaction. Purge gas and flash gas contain Ammonia which is an emission source of nitrogen oxides. In order to reduce nitrogen oxides discharged from the Primary Reformer stack, the following countermeasures are taken:

1) Fuel Gas from Recovery Unit

The Ammonia in the purge gas and the flash gas is completely recovered in Ammonia Recovery Unit and the treated gas is used as fuel gas, which is sufficient to restrict nitrogen oxide emission from the Primary Reformer.

2) Besides, the gas burners selected are of Low NO_x Burners

Package Boiler

In package boiler, natural gas is used as fuel. The use of low sulphur containing clean fuel is reducing the sulphur dioxide contain in flue gas. The NO_x emissions are reduced by selecting advanced designed low NO_x Burners.

Stripped Vapor from Condensate Stripper:

Process Condensate contains some impurities such as Ammonia, carbon dioxide and methanol. These impurities are stripped with steam in the condensate stripper to reuse the condensate as boiler feed water. This application is useful for elimination of emission source. The stripped vapor containing impurities is delivered along with medium pressure steam to the Primary Reformer tubes, in which impurities are decomposed on reformer catalyst.

Therefore, there is no emission from Condensate stripper.

Stack and Venting System:

Flare stack and process vents can also be source of emission in plant during upset situation. Each flare stack is designed for complete burning of hydrocarbons even at the highest discharges in upset condition.

Stack and vent system emissions are not continuous but all the same considered under emission limits for specific pollutant from stationary sources and regulated by Guidelines and Standards for environmental pollution control in Nigeria (FMENV 1991).

3.3.5.2 Sources of Gaseous Emissions for the Urea Plant

3.3.5.2.1 Emission control in Urea Plant

Major emissions from the Urea Plant are Ammonia and Urea. These emissions are caught and recycled back to process in an efficient manner, reducing emissions of pollutants to the atmosphere and drainages. This creates additional merit of raw material consumption (Ammonia) per ton of Urea product. The Fig 3.4 below explains the inbuilt emission control system in the Urea plant to ensure 100% recycling of raw materials/products that would have ended up as emission.

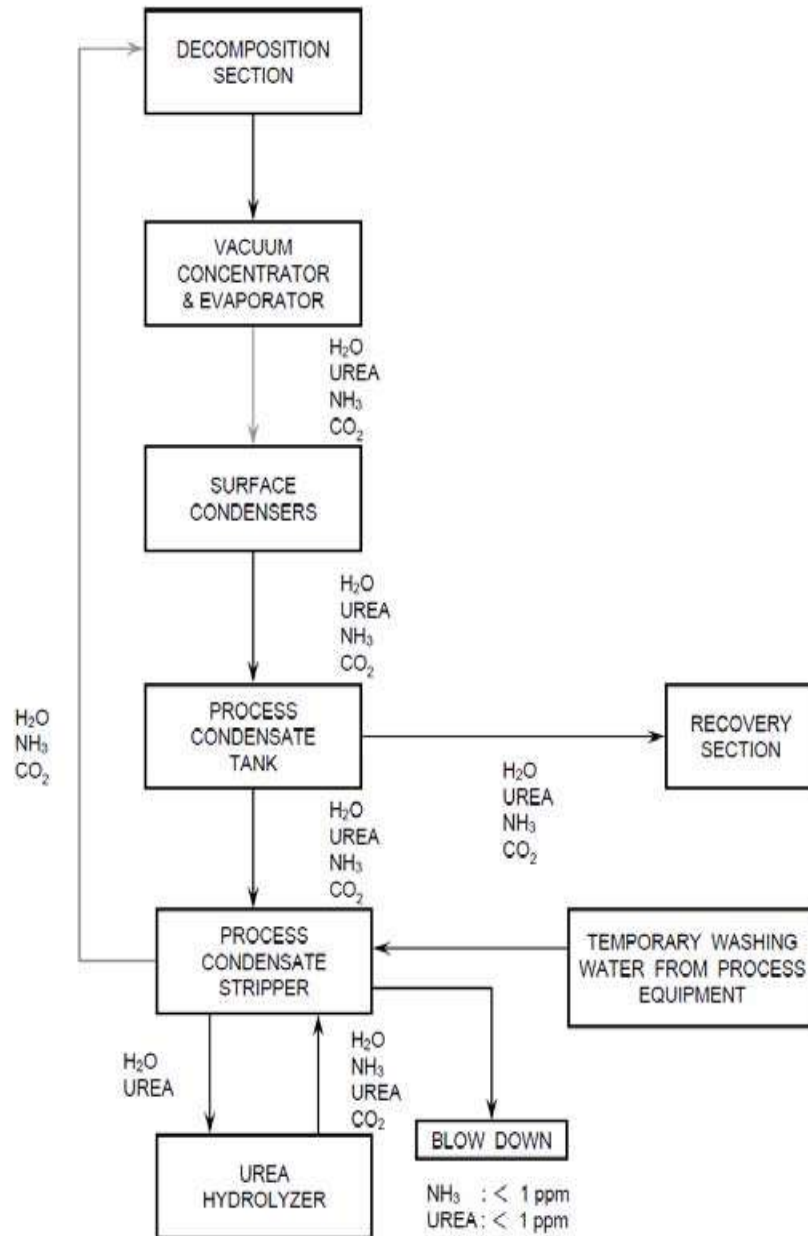


Figure 3.6: Emission control system for fertilizer plant

All drains from Urea Plant which contain Urea and Ammonia are collected into closed collection system and the solution is recycled to Urea Plant to capture even the spill on plant floor.

Stripped Vapor from Condensate Hydrolyser and Stripper:

Process Condensate contains some impurities of Urea, Ammonia and carbon dioxide. Process condensate first treated in Urea hydrolyzer, where urea is hydrolyzed in to ammonia and carbon dioxide. Thus formed, ammonia and carbon dioxide, together

with those in the process condensate, are stripped out by steam stripping. The overhead stripped gaseous mixture (Ammonia, carbon dioxide and water vapor) from process condensate stripper is recycled to LP Decomposer and recycled back to the main process stream. The treated process condensate is recycled as boiler feed water after treatment in polishing units.

Therefore, there is no emission from Condensate hydrolyzer and stripper.

Exhaust Air from Granulation

Urea dust and Ammonia contained in the exhaust air from the granulator can be a source of air pollution in Urea plant. A unique dust recovery system proven in many commercial plants has been incorporated to reduce the Urea dust and Ammonia content in the exhaust to less than 50 mg/Nm³-air.

3.3.5.3 Air emissions and applicable standards

The applicable emissions limits for the new IEFCL Train-2 Project will be in compliance with the International standards, as IFC, Ed. April 30th, 2007 Environmental, Health and Safety Guidelines-Nitrogenous Fertilizers; requirements for specific pollutants release from Nitrogenous Fertilizer Plant (Ammonia - Urea). IFC limits - Ed. December 19th, 2008, Environmental, Health and Safety Guidelines-Thermal Power Plants (> 50MWth) and Ed. April 30th, 2007, Environmental, Health and Safety Guidelines-General EHS Guidelines: Environment "Air Emissions and Ambient Air Quality" (3 MWth ÷ 50 MWth) - are applicable to the gaseous emission released from the boilers, while for other pollutants (SO_x, CO; HC, VOC), that are not normed, the Nigerian legislation (FMENV, 1991) is used. However, the more stringent limits are applicable.

In the following paragraphs, the emission source characteristics are reported in compliance with the applicable legislation and standards.

Primary Reformer

- Ref. 1 - IFC, Ed. April 30th, 2007 – Nitrogenous Fertilizers – Table 1 – Ammonia Plant;
- Ref. 2 - FMENV, 1991 - Interim Guidelines and Standards for Industrial Effluent, Gaseous Emissions and Noise Limitations, Table 3.2 - Emission Limits for Particulates from Stationary Sources (Furnaces) & Table 3.3 - Emission Limits for Specific

Pollutants from Stationary Sources.

Table 3.4: Emission characteristics of the fertilizer plant (Primary reformer)

Pollutant	Unit	Limits acc. to REF. 1	Limits acc. to REF. 2	Emissions expected
NOx	mg/Nm ³	300(*)	350-1000	<150
SO2	mg/Nm ³	NN	30-3000	<2.0
TSP/PM	mg/Nm ³	50(*)	75-600	<50
Note: (*) Assuming the following conditions, indicated in Table 1 of IFC EHS Guidelines for Nitrogenous Fertilizer production: T=273 K (0 °C), P=101.3 kPa (1 atmosphere), Oxygen content 3%, dry conditions.				

Auxiliary Boilers

- Ref. 1a - IFC, Ed. December 19th, 2008 – Thermal Power Plants, Table 6 (C);
- Ref. 1b - IFC, Ed. April 30th, 2007 – Air Emissions And Ambient Air Quality, Table 1.1-2;
- Ref. 2 - FMENV, 1991 - Interim Guidelines and Standards for Industrial Effluent, Gaseous

Emissions and Noise Limitations, Table 3.2 - Emission Limits for Particulates from Stationary Sources & Table 3.3 - Emission Limits for Specific Pollutants from Stationary Sources.

Table 3.5: Emission limits for the fertilizer plant (Auxiliary Boilers) adopted (based on IFC and FMENV Guidelines)

Pollutant	Unit	Limits acc. to REF. 1	Limits acc. to REF. 2	Emissions expected
NOx	mg/Nm ³	240	NN	<150
SO2	mg/Nm ³	NN	30-3000	<2.0

CO	mg/Nm ³	NN	NN	Not relevant
TSP/PM	mg/Nm ³	NN	75-600	Not relevant
Note: Emissions from the combustion of Natural Gas; T=273 K (0°C), P=101.3 kPa (1 atmosphere), Oxygen content 3%, dry conditions. Boiler with capacity > 50 MWth.				

NN = Not normed

Granulation Tower

- Ref. IFC, Ed. April 30th, 2007 – Nitrogenous Fertilizers – Table 1 - Urea Plant
Emission characteristics are shown in the following table:

Table 3.6: Emission characteristics (Granulation Unit) adopted from IFC Guideline

Pollutant	Unit	Limits acc. To IFC – Urea Plant	Emissions expected
TSP/PM ³	mg/Nm ³	50	<50
NH ₃	mg/Nm ³	50	<50

CO2 Emission stacks

The CO2 exhausted emissions from the process plant in the normal operation are shown in the following table 3.8:

Table 3.7 Quantity of CO2 exhausted from the process plant

Source	Quantity ton/hour	Quantity ton/year @ 330 days operation
Primary Reformer	28.31	224,215.2
GTG Power	20.57	162,914.4
Auxiliary Boiler	5.95	47,124
Flares	0.45	356,4

³ As urea dust.

3.3.5.4 Fugitive emissions

The fugitive emissions are leaks from flange, pump, sealed or tightened equipment.

A significant proportion of fugitive emissions are losses from unsealed sources, including storage tanks, open-ended (not blanketed) lines, pressure-relief valves, vents, flares, blow-down systems and spills. In other cases, these losses may be caused by leaks in the sealing elements of particular items of equipment, such as:

- Pipes / flanges;
- Valves and fitting;
- Compressors,
- Pumps;
- Sampling connection;
- Incorrect process conditions.

The **emissions from the pipes** derive essentially from flanges and connections, such as sampling points. The general approach for minimizing fugitive emissions, is thus to minimize the length of pipe runs and to minimize the number of connections.

The **valves** are generally considered the main sources of fugitive emissions in the process industries.

Fugitive emissions from the **compressors** arise generally from seal on compressed gas line and oil seal.

Fugitive emissions from a **pump** arise from seal on liquid line and oil seal.

The good approach to minimize fugitive emissions from valves, compressors and pump is the implementation of the preventive maintenance and the leak detection program.

Fugitive emissions from **sampling connections** can be controlled by returning the purged materials to the process, or by sending it to a control device.

Table 3.8: The sources and the types of fugitive emissions from the proposed plants

Source	Type of release
Ammonia Plant	
Valves, flanges, seals, sample points	NH ₃ , CO ₂ , H ₂ , Natural gas
Urea Plant	
Valves, flanges, seals, sample points	NH ₃ , CO ₂ , Formaldehyde, H ₂ , Natural gas, Dust (from loading system)

Auxiliary Boilers	
Valves, flanges, seals, sample points	CO ₂ , H ₂ , Natural gas
Utilities	
Valves, flanges, seals, sample points	CO ₂ , H ₂ , Natural gas

3.3.6 Waste Generated and Estimated Quantities

Waste type and estimated quantities during construction phase are shown in table (3.9) below. The duration of construction activities up to mechanical completion is about 32 months. During normal operation, spent catalysts will be sent back to manufacturers and other wastes are not significant and will be handled as per the existent Waste Handling System (chapter 4).

Wastes contributed by these new plants would only add to the existing stream. So the general management will involve utilizing existing plan so that the cumulative effects do not exert negative effect on the environment.

Strict adherence to standard operating procedures during production process and operation of the waste infrastructure (such as incinerators and Water Treatment Plants) will address the reduction of wastes from source.

The 4R principles of reduce, re-use, recycle and recover would help to put to useful items such as empty plastic/metal drums, pipe cutoffs, wood pallets etc.

Table 3.9: Waste types and estimated quantities during construction activity

Activity	Description	Quantity	Destination
Site preparation / ton/year Foundations	Cement / concrete - concrete debris, soil containing cement	3000-3500 ton/year	Land fill
	Scrap metal / wire - strips of metal, metal supports, pieces of wire	200-500 ton/year	Resale

Construction activities	Scrap plastic / PVC	20-30 ton/year	Recycle
Maintenance operations	Paints and solvents - traces of paint, solvents, etc.	0.3-0.5 ton/year	Approved waste management facility
	Light bulbs, fluorescent light fittings; Equipment which can contain traces of neon and tungsten	0.2 ton/year	Stored in designated place
Personal Protective Equipment (PPE) from work activities	Used PPE - goggles, gloves, etc...	5 ton/year	Incinerator
Lube oil and seal flushing of machinery skid (Pre-Commissioning phase)	Lube and seal oil - oil containing weld splatter, chips, welding flux deposits, powered metal oxides	1.3-1.8 ton/year	Resale
Camps, kitchen, offices operations	Cooking organic wastes	10-20 ton/year	Municipal/Approved dump side
	Mixed urban wastes	150-200 ton/year	Municipal/Approved dump side
	Medical wastes	0.05-0.10 ton / year	Incinerator
	Wastewaters (drinking, washing, shower, sanitary)	250 lt/day per worker	Existing ETP

The above waste type and quantities are based on Contractor's documents.

During operation, no solid hazardous waste is generated from Ammonia/ Urea plant.

3.3.6.1 Hazardous Substance

The Hazardous materials that may be used in the site include diesel fuel, gasoline (during construction) and aMDEA solution, lube oils, Diesel oil and Urea. The source of gasoline & diesel will be the existing fuel station in IEPL.

Urea Formaldehyde-85 (During operations) will be used too.

The table below specifies the hazardous nature to the environment:

Table 3.10: Hazardous materials to be used on site during construction/operations

Phase	Material	Safety properties	Impact to environment	Quantity
Construction	Diesel fuel	Hazardous/flammable	Toxic for groundwater and aquatic environment	5150 ton/month
	Gasoline	Hazardous/flammable	Toxic for groundwater and aquatic environment	120 ton/month
Operation	aMDEA	Hazardous/ flammable/slightly toxic	Toxic for groundwater and aquatic environment Any spillage from tank will be collected and reused.	3.0 Kg/hr
	UF-85	Hazardous/flammable/ toxic	Toxic for groundwater and aquatic environment	1250 kg/h
	Sulphuric acid	Hazardous/Toxic	Toxic for groundwater and aquatic environment	85 Kg/hr

These hazardous materials will be handled as per SOP (Standard operating procedures) under proper supervision and the guidance as per MSDS (Material safety data sheet). Besides that, the proper labelling of containers, display of MSDS and availability of secondary containment, spill control equipments will be ensured. The spill of sulphuric acid will be washed with plenty of water and this water will be routed to effluent treatment facility.

Any spillage of aMDEA and UF-85 is collected and reused. During construction minor spill during transfer of diesel/gasoline will be collected in secondary containment and reused.

3.3.7 Energy Conservation

The technology selected is proven with respect to energy consumption and lowest among the technologies available in the world for ammonia and urea production. The specific energy consumption for urea production will be 20.53 MMBTU/MT.

Besides that, IEFCL will adopt suggestions indicated by IFC Guidelines (Ed. April 30th, 2007 – Energy Conservation) about the Energy conservation approach for process heating, cooling and compressed air system in the project.

The majority of IFC suggestions for energy conservation has been adopted as follows (Table 3.11)

Table 3.11: Measures to provide Energy Conservation taken by IEFCL for Fertilizer plants

Sr. No.	Measures Taken
1	Adequate insulation to reduce heat losses through furnace/heaters etc. structure
2	Recover heat from hot process or exhaust streams to reduce system loads
3	Use low thermal mass insulation to reduce energy required to heat the system structure to operating temperature, in intermittently-heated systems
4	Control process temperature and other parameters accurately to avoid, overheating or over-drying
5	Review opportunities to schedule work flow to limit the need for process reheating between stages
6	Operate furnaces/heaters at slight positive pressure, and maintain air seals to reduce air in-leakage into the heated system
7	Reduce radiant heat losses by sealing structural openings
8	Where possible, use the system for long runs close to or at operating capacity
9	Near net weight and shape heat designs
10	Robust Quality assurance on input material
Heat Distribution Systems	
1	Avoid steam leaks despite a perceived need to get steam through the turbine
2	Regularly verify correct operation of steam traps in steam systems and ensure that traps are not by-passed. Provision of steam trap operational philosophy
3	Insulate distribution system vessels, such as hot wells and de-aerators, in steam systems and thermal fluid or hot water storage tanks
4	Insulate all steam, condensate, hot water and thermal fluid distribution pipework, down to and including 1" (25mm) diameter pipe, in addition to insulating all hot valves and flanges

5	In steam systems, return condensate to the boiler house for re-use, since condensate is expensive boiler-quality water and valuable beyond its heat content alone
6	Use flash steam recovery systems to reduce losses due to evaporation of high-pressure condensate
7	Consider steam expansion through a back-pressure turbine rather than reducing valve stations
8	Eliminate distribution system losses by adopting point-of-use heating systems
Energy Conversion System Efficiency Improvements	
1	Consider combustion automation using oxygen-trim controls
2	Minimize the number of boilers or heaters used to meet loads. Minimize the number of boilers kept at hot - standby
3	Use flue dampers to eliminate ventilation losses from hot boilers held at standby
4	In steam boiler systems, use economizers to recover heat from flue gases to pre-heat boiler feed water or combustion air
5	Adopt automatic (continuous) boiler blow down
6	Recover heat from blow down systems through flash steam recovery or feed-water preheat
7	Do not supply excessive quantities of steam to the deaerator
Process Heating: Measure	
1	Fuel quality control/fuel blending
Process cooling: Measures	
Heating Load Reduction	
1	Adequate insulation to reduce heat gains through cooling system structure and to below-ambient temperature refrigerant pipes and vessels
2	Control process temperature accurately to avoid overcooling
3	Operate cooling tunnels at slight positive pressure and maintain air seals to reduce air in-leakage into the cooled system, thus reducing the energy required to cool this unnecessary air to system operating temperature
4	Pre-cool using heat recovery to a process stream requiring heating or by using a higher temperature cooling utility
5	In cold and chill stores, minimize heat gains to the cooled space by use of air curtains, entrance vestibules or rapidly opening/closing doors.
6	Energy efficiency techniques, in the case of air conditioning applications:

	<ul style="list-style-type: none"> • Placing air intakes and air-conditioning units in cool, shaded locations • Improving building insulation including seals, vents, windows, and doors • Planting trees as thermal shields around buildings • Installing timers and/or thermostats and/or enthalpy-based control systems. • Installing ventilation heat recovery systems
7	Exploit high cooling temperature range: pre-cooling by ambient and/or 'high temperature' refrigeration before final cooling can reduce refrigeration capital and running costs
8	Keep 'hot' and 'cold' fluids separate; do not mix water leaving the chiller with water returning from cooling circuits
9	Consider two-stage or compound compression or economized screw compressors, rather than single stage compression, in low-temperature systems where high temperature differences are inevitable
Minimizing Temperature Differences	
1	A vapor-compression refrigeration system raises the temperature of the refrigerant from somewhat below the lowest process temperature (the evaporating temperature) to provide process cooling, to a higher temperature (the condensing temperature), somewhat above ambient, to facilitate heat rejection to the air or cooling water systems.
Elevating Evaporating Temperature	
1	Select a large evaporator to permit relatively low temperature differences between process and evaporating temperatures.
Reducing Condensing Temperature	
1	Air-cooled evaporators usually have higher condensing temperatures, hence higher compressor energy use, and auxiliary power consumption, especially in low humidity climates. If a wet system is used, ensure adequate treatment to prevent growth of legionella bacteria.
2	Select a relatively large condenser to minimize differences between condensing and the heat sink temperatures. Condensing temperatures with air cooled or evaporative condensers should not be more than 10 K above design ambient condition, and a 4 K approach in a liquid-cooled condenser is possible.
3	Refrigerant liquid lines should be connected via drop-leg traps to the main liquid refrigerant line to ensure that hot gases flow to all condensers, in multiple condenser applications.

4	Avoid head pressure control to the extent possible. Head pressure control maintains condensing temperature at, or near, design levels. Use of electronic rather than thermostatic expansion valves, and liquid refrigerant pumps can permit effective refrigerant circulation at much reduced condensing temperatures.
5	Site condensers and cooling towers with adequate spacing so as to prevent recirculation of hot air into the tower.
Refrigerant Compression Efficiency	
1	Consider turndown efficiency when specifying chillers. Variable speed control or multiple compressor chillers can be highly efficient at part loads.
Compressed Air System: Measures	
Load Reduction	
1	Examine each true user of compressed air to identify the air volume needed and the pressure at which this should be delivered
2	Do not mix high volume low pressure and low volume high pressure loads
3	Reduction opportunities: <ul style="list-style-type: none"> • Use air amplifier nozzles rather than simple open-pipe compressed air jets, • Consider whether compressed air is needed at all, • Where air jets are required intermittently, consider operating the jet via a process-related solenoid valve, which opens only when air is required, • Use manual or automatically operated valves to isolate air supply to individual machines or zones that are not in continuous use, • Implement systems for systematic identification and repair of leaks, • All condensate drain points should be trapped.
Distribution	
1	Use adequately sized distribution pipe work designed to minimize pressure losses.

3.3.8 Storm Water Management

Storm water in the existing industrial complex is totally separate from the process liquid effluents. Process effluent is treated in effluent treatment plant and there-after, it gets mixed with storm water in final retention pond. Similarly the storm water of the new plant will also be separate from the process liquid effluent. The process effluent from

IEFCL – Train2 fertilizer plant will be treated in waste water treatment facility of IEFCL – Train2 fertilizer plant and further sent to holding pond. Treated effluent water from holding pond will get mixed with storm water in final Retention Pond. Therefore the storm water from the new plant will be managed following recommendations indicated by “IFC Guidelines, Ed. April 30th, 2007 – Wastewater and Ambient Water Quality”. Applicable recommendations from the IFC Guideline shall be followed with respect to storm water management.

Storm water includes any surface runoff and flows resulting from precipitation, drainage or other sources.

Rapid runoff, even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks.

In order to reduce the need for storm water treatment, the following principles, in compliance with IFC guidelines on Wastewater and Ambient water quality, would be applied in this project (Table 3.12):

Table 3.12: Measures to reduce the need of storm water treatment

1	Storm water will be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge
2	Surface runoff from process areas or potential sources of contamination will be prevented
3	Where this approach is not practical, runoff from process and storage areas will be segregated from potentially less contaminated runoff
4	Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds)

5	Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority will be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present; Normal case will consider the disposal of neutralized waste water and of de-oiled storm water to the existing plant pond.
6	Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas. Oil Skimmer has been foreseen inside each first rain sump to remove the majority of the oil, while the remaining will be removed through a Coalescing Plate Separator
7	<p>Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.</p> <p>Organic sludge will be incinerated in existing incinerators following existing SOP and ash will be analyzed as TCLP (Toxicity characteristics leaching procedure).</p> <p>Any spent catalyst containing zinc sulphide will be handled by competent person as per the guidelines of MSDS HSE (Health safety and Environment) procedure.</p>

3.3.9 Gaseous waste

For controlling gaseous waste in the new plants, a well-designed flare systems are incorporated to flare inadvertent release of Ammonia. The flare system is provided to dispose hydrocarbons & other fluids safely during normal operation, start up, and shut down & in case of emergency in complex.

3.3.10 Transport of Men, Materials and Equipment in the New Plant

The construction activities will lead to increase traffic entering and leaving the Indorama Complex, in terms of number and type of vehicles, because of movement of employees and construction equipments/materials. Vehicular movement during this phase will include trucks, buses, minibuses and cars. Separate access and routes will be defined for movement of employees and materials. To keep controlled traffic around the Complex,

all logistics elements of IEFCL-Train2 will use the existing Logistics Park (created at a convenient distance away from the Complex along the East West expressway) before being directed to the Plant/ Project site. During construction period it's expected an additional daily traffic of about 75 trucks/containers for the transport of equipments/materials (logistics) and 50 buses (3 shift) for the movement of Staff/Contract/Visitors. During operation phase the traffic will be slightly reduced: for the movement of Staff/Contract/Visitors.

There will be a dedicated parking area of trucks in front of main gate inside complex premise without constituting any nuisance to the highway.

3.4 DECOMMISSIONING ACTIVITIES

The activities will involve demolition and site clean-up, disposal of wastes, demobilization and final site review, after a specific decommissioning plan will be reviewed and approved by FMENV, State Environmental Authorities.

3.5 PROJECT SCHEDULE

Indorama Eleme Fertilizer & Chemicals Limited plans to execute the IEFCL-Train2 in Indorama Complex using local engineers and manpower, supported by foreign experts. The project schedule will be executed as follows:

