

IFFCO

*Revamp of CO₂ Removal Section
In MW Kellogg Ammonia Plant to
2-stage GV Process
using existing Lo-Heat Benfield Solution*

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IFFCO

INTRODUCTION TO IFFCO

- IFFCO – Indian Farmers Fertilizer Cooperative Ltd. is a cooperative conglomeration in India producing & marketing nitrogenous and phosphatic fertilizers
- Largest Fertilizer producer in India
- Presently producing 3.7 million MT of Urea and 2.7 million MT of Phosphatic Fertilizers
- Expected to produce 4.3 million MT of Urea and 4.7 million MT of Phosphatic Fertilizers by 2008
- Distribution of 8.2 million MT fertilizer through over 37,500 Co-operative Societies

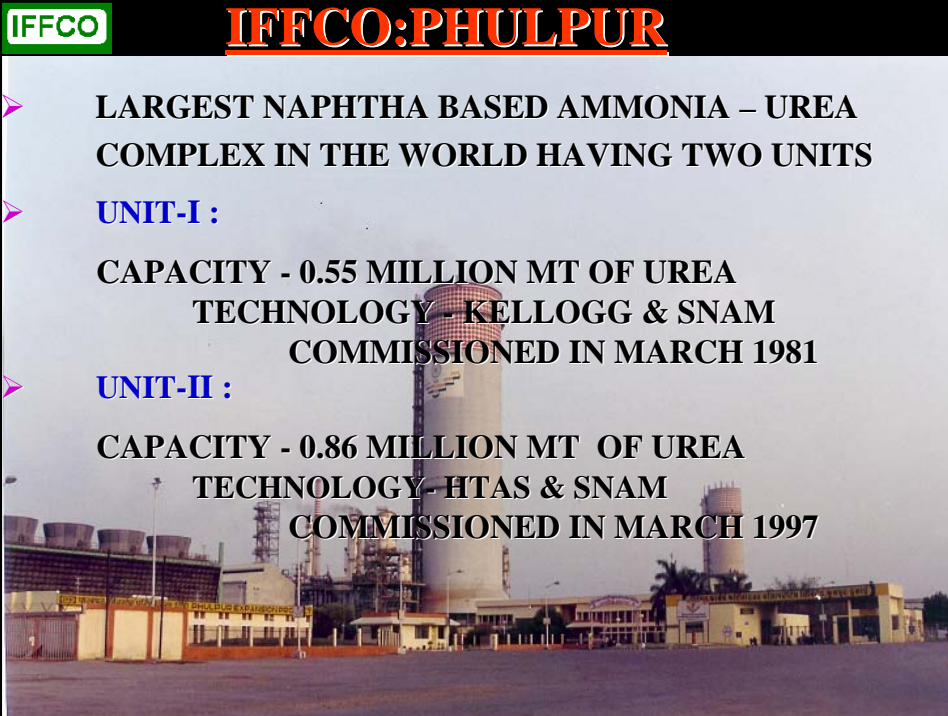
▶ **LARGEST NAPHTHA BASED AMMONIA – UREA COMPLEX IN THE WORLD HAVING TWO UNITS**

▶ **UNIT-I :**

**CAPACITY - 0.55 MILLION MT OF UREA
TECHNOLOGY - KELLOGG & SNAM
COMMISSIONED IN MARCH 1981**

▶ **UNIT-II :**

**CAPACITY - 0.86 MILLION MT OF UREA
TECHNOLOGY - HTAS & SNAM
COMMISSIONED IN MARCH 1997**



Overview of Presentation

- Ammonia Process
- Lo-Heat Benfield Process
- Process Flow Diagram
- Selection of Revamp option
- Comparison of Process : Before & After Modification
- Mechanical Modification
- New Equipments Installed
- Execution Experience
- Problem Faced during Precommissioning & Commissioning
- Future Action Plan
- Performance Evaluation
- Conclusion

Ammonia Process

- Raw Naphtha is desulphurised, mixed with steam and fed in the Reforming Section (Primary & Secondary Reformer)
- Reformed Gas is passed through two stage Shift Reactor to convert CO to CO₂
- Converted Gas is fed to CO₂ Removal Section to remove CO₂
- Recovered CO₂ is sent to Urea Plant
- After CO₂ removal, remaining gas is routed through Methanator
- Purified Synthesis Gas is sent to Ammonia Synthesis section after compression to produce ammonia
- Ammonia separated after cooling & chilling is sent to Urea Plant

Objective of CO₂ Removal Section

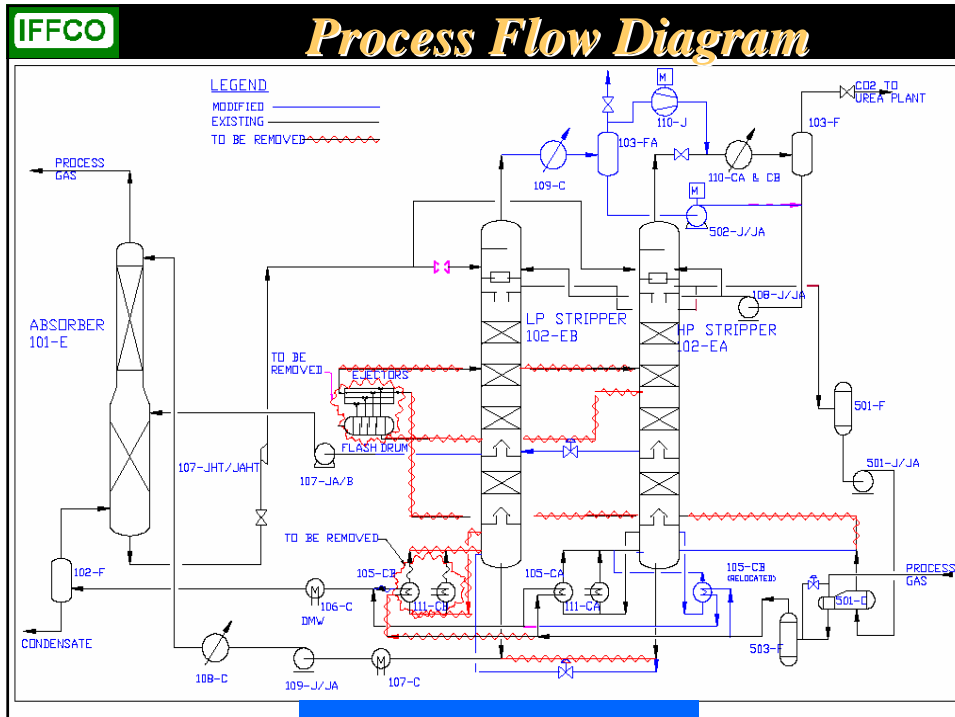
- To recover CO₂ from process gas & to make pure synthesis gas for Ammonia Production
- To supply recovered CO₂ for urea manufacture
- Specific Energy consumption of Ammonia depends on the regeneration energy of CO₂ removal section.

Lo-Heat Benfield Process

- Originally commissioned with Conventional Benfield Process
- Lo-Heat Benfield Process commissioned in 1994
- Basic Features of Lo-Heat Process
 - Usage of Aqueous Potassium Carbonate Solution activated with ACT-1 (patented chemical from UOP,USA)
 - Semi-Lean Solution from Stripper flashed in 4 stages before sending to Absorber
 - Steam Ejectors using LP Steam as motive fluid used to maintain Pressure of Flash Vessel (502-F)
 - Composition of fresh solution:

K_2CO_3	28 %
Act-1	1.0 % (Activator)
Vanadium Pentoxide(V_2O_5)	0.5 % (With 0.15 % V^{+4})

 (Corrosion inhibitor)



Selection of Revamp Option

Energy Conservation is a major objective for IFFCO. This has enabled to run the 1980 vintage Ammonia Plant with better performance. Revamp is only for reduction in regeneration energy of CO₂ Removal Process.

Preliminary Observations :

- Space limitation due to modifications over the years
- Hooking up of Scheme during Annual Turnaround

Guideline for the selection of the Process :

- Process with optimum energy savings.
- Utilization of existing solution & activator ACT-1 because it is more stable & less corrosive nature
- Utilization of existing Towers with some in-situ modification
- Installation of minimum number of new equipments

Comparison of Process

Operating Data

Before Modification:

- Fluid:
Benfield solution + CO₂ rich gas.
- Strippers
- Operating Temperature:
Top 102 °C
Bottom 125 °C
- Operating Pressure:
Top 0.68 kg/cm²
Bottom 0.90 kg/cm²

After Modification:

- Fluid:
Benfield solution + CO₂ rich gas.
- HP Stripper LP Stripper
- Operating Temperature:
Top : 104 °C 94 °C
Bottom: 128 °C 112 °C
- Operating Pressure:
Top: 1.12 kg/cm² 0.14 kg/cm²
Bottom: 1.26 kg/cm² 0.24 kg/cm²

Comparison of Process

Stripping System

Before Modification:

LoHeat Benfield Process

- Parallel stripping for regeneration at same pressure (0.7 Kg/Cm²) in two Strippers.
- Flashing of Semilean solution in the flash vessel in four stages (0.6/0.5/0.4/0.3 kg/cm²) generates steam which is compressed by motive steam in ejectors.

After Modification:

Benfield Process with GV Layout

- Two pressure level technology in series i.e., HP stripper @ 1.1 kg/cm² and LP stripper @0.14 kg/cm²
- Flashing of Semilean / Lean solution from HP strippers to LP strippers through let-down control valves.

Comparison of Process

Flow distribution of the rich solution

Rich solution from the absorber is divided in two parts and pressure is letdown via hydraulic turbines.

Before Modification:

Equal distribution of the rich solution from the bottom of the absorber to top of both the strippers.

After Modification:

60 % of the rich solution from the bottom of the absorber to top of HP stripper (102-EA) and 40 % to top of LP stripper (102-EB) .

Comparison of Process

Source of Regeneration heat

Before Modification:

- LP steam for solution reboiling in 111-CA/CB(111-CA for 102-EA stripper and 111-CB for 102-EB stripper)
- Flashing steam of flash vessel compressed by LP steam generated in 501-C. This LP steam is supplied to both the strippers.

After Modification:

- LP steam for solution reboiling in only 111-CA to HP stripper. The CO₂ stripper steam Reboiler (111-CB) along with associated piping and instrumentation are removed
- LP Steam generated in 501-C . This LP steam is supplied the regeneration heat to only HP stripper (102-EA).

Comparison of Process

Source of Regeneration heat

Before Modification:

- The Benfield solution reboiling in 105- CA/CB.
- 105- CA is used for supplying heat to 102-EA stripper and 105-CB is used for supplying heat to 102-EB stripper.

After Modification:

- The Benfield solution reboiling in 105- CA/CB.
- Both 105- CA/CB are used for supplying heat to 102-EA (HP stripper) and there is no heating source for 102-EB (LP stripper).

Comparison of Process

Pumps Suction

Before Modification:

- The semi lean pumps take suction from the partial draw-off pan (below the third bed) of both the strippers (102-EA /EB).
- The lean solution pumps take suction from the total draw-off pan (at the bottom) of both the strippers 102-EA/EB.

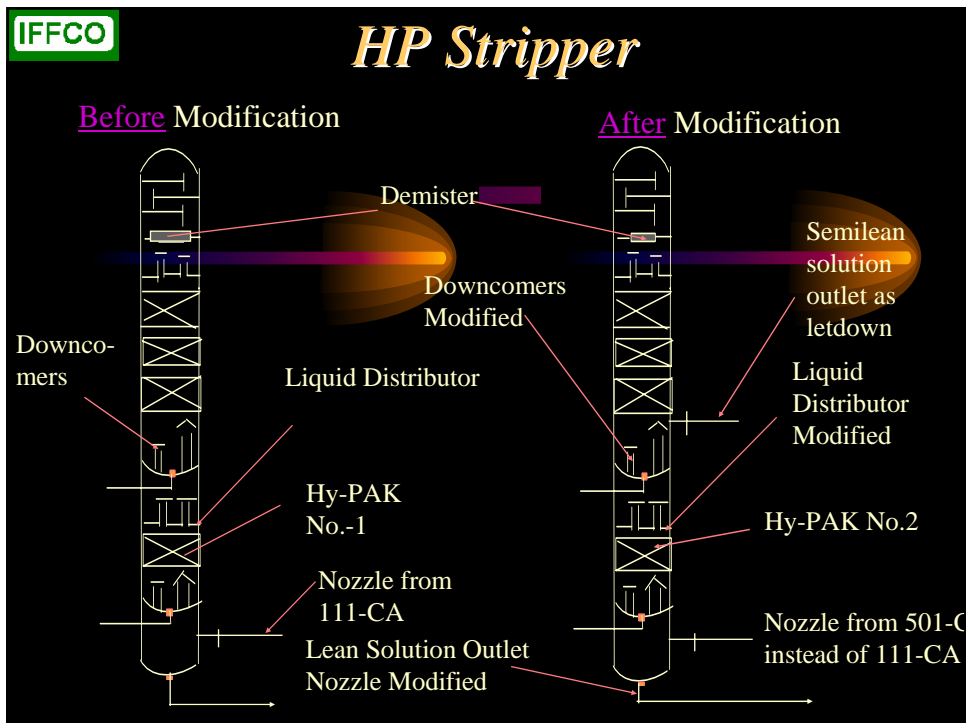
After Modification:

- The semi lean pumps take suction from the partial draw-off pan (below the third bed) of only 102-EB (LP stripper).
- The lean solution pumps take suction from the total draw-off pan (at the bottom) of only 102-EB (LP stripper). No pumps take suction from 102-EA (HP stripper).

Modifications

HP Stripper (102-EA)

- In bottom bed of 102-EA (HP stripper), existing 73 m³ of Hy-Pak No.1(1") replaced with Hy-Pak No. 2 (2") packing removed from Absorber
- Downcomers in Semi-Lean solution take-off tray modified & new downcomers added
- Flow area of Demister reduced
- Existing outlet line of lean solution outlet to 105-CA bifurcated into two branches to supply solution to both 105-CA & 105-CB.

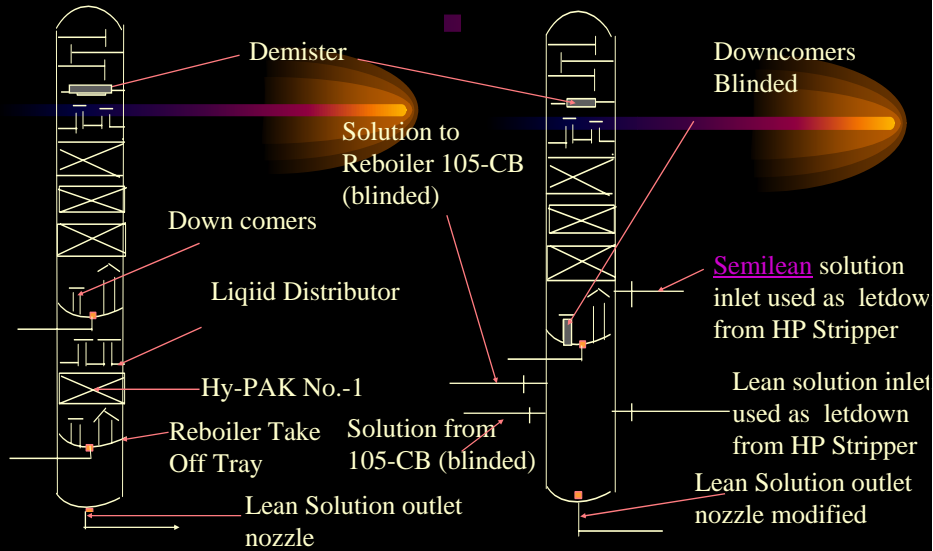


- IFFCO**
- ## *Modifications*
- ### *LP Stripper (102-EB)*
- In the fourth bed of 102-EB (LP stripper), existing 73 m³ of Hy-Pak No.1 is removed completely and discarded
 - The liquid distributor below the partial draw-off pan is removed completely.
 - Flow area of Demister reduced
 - Downcomers in Semi-Lean solution take-off tray blinded to avoid mixing of Semi-Lean & Lean solution

LP Stripper(102-EB)

Before Modification

After Modification



Nozzles Modification

HP Stripper (102-EA)

- Lean solution outlet nozzle size increased
- Nozzle for Steam inlet from 111-CA is now used for steam from 501-C
- New nozzle for solution to 105-CB is made
- Existing one nozzle of solution from reboiler was used for both reboilers 105-CA & CB
- Nozzles for water make-up, equalising line & minimum flow lines of lean & semi-lean pumps blinded.

Nozzle Modification

LP Stripper (102-EB)

- Manhole (MH5) is now used for semilean solution inlet as letdown from 102-EA.
- Nozzle for Steam inlet from 111-CB is now used for lean solution inlet as let down from 102-EA.
- The size of lean solution outlet nozzle is increased
- Some new nozzles along with existing nozzles are used for instruments tapping in LP stripper and no instrument tapping is made in HP stripper.

New Equipments Installed

- LP CO₂ Stripper condenser (109-C) by extending existing 110-CA/CB platform. (PATELS AIR TEMP)
- CO₂ Blower with Motor (110-J). (SIEMENS)
- Acid Gas Separator (103-FA). (GANSONS)
- Condensate pumps with Motors (502-J/JA) (KSB)

Experience in Execution

- Flash Tank (502-F) having diameter of 3.81 M, length of 9.91 M & weight of 51.8 MT was dismantled using two cranes.
- Internal modification & Nozzle modification of Strippers was done in house with strict monitoring for quality.
- Draw-off pan was having Stress Corrosion Cracks. Instead of repairing, SS sheet was laid over at places where cracks were visible.

Problem Faced during Pre-commissioning & Commissioning

- **Maintaining Solution Temperature during Passivation**
 - As one Steam Reboiler was removed, solution Temperature could only be maintained after Process Gas Reboilers were taken in line, which caused 24 hours delay in production.
- **Controlling Level of HP Stripper**
 - Flow of solution from HP Stripper to LP Stripper was restricted due to flashing of liquid occurring across the level control valve and the reason for the flashing was due to higher solution temperature.
- **Higher Process Gas Temperature at Process Gas Reboilers**
 - LP Steam consumption in Steam Reboilers could not be reduced below 3.5 MT/hr against guaranteed figure of 1.5 MT/hr. This was because of lesser amount of steam generated in 501-C

Future Action plan to solve commissioning problems

- Maintaining Solution Temperature during Passivation
 - Provision for MP steam connection in 105-CA/CB for heat input during passivation has been planned and will be implemented during forthcoming shutdown.
- Controlling Level of HP Stripper
 - It was concluded that during start-up HP Stripper bottom temperature should not be more than the saturation temperature of liquid
- Higher Process Gas Temperature at Process Gas Reboilers
 - Installation of bigger size by-pass control valve has been planned to maintain desired temperature at Process Gas Reboilers.

Performance Evaluations

- Regeneration Heat has been reduced from **35.2 Gcal/hr** to **27.76 Gcal/hr**
- Power Consumption in CO₂ Blower is **378 kWh**
- Net Regeneration Energy has reduced from **1049 kcal/NM³** of CO₂ to **872 kcal/NM³** of CO₂ against the guaranteed figure of **750 kcal/NM³** of CO₂
- Energy Saving : **0.108 Gcal/MT** against **0.16 Gcal/MT** of Ammonia.
- Balance energy saving is expected to achieve after change over to LNG by reducing Steam /Carbon ratio.
- Investment **Rs. 15.57 crores**
- Payback : **3.46 Years**

Conclusion

- ☑ Decision to implement 2 Stage GV Process Layout in Lo-Heat Benfield CO₂ Removal System has proved to be far sighted.