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SASKFERCO UREA PLANT REVAMPING[1]

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SUMMARY

The Saskferco urea plant has a design capacity of 2000 MTPD based on Stamicarbon-H/A process. The plant operates since 1992 at 116% design capacity. In 1996, it has been decided and agreed with Stamicarbon & H/A to redesign the urea plant for a guaranteed capacity increase to 2850 MTD.

The paper will describe the revamping work:

1. Booster of the suction of the CO_2 compressor
2. Modification of the conventional urea reactor trays
3. Parallel stripper
4. Parallel rectification column
5. Additional evaporator
6. Modification of carbamate pumps
7. Modification of granulator
8. New F.B.C.
9. New scrubber
10. Added screens

The revamping work has been completed during the September 97 turnaround of the plant. The obtained results will be also presented.

RESUME

L'unité d'urée de Saskferco a une capacité de 2000 t/j utilisant le procédé Stamicarbon H/A. L'unité fonctionne depuis 1992 à 116% de la capacité théorique. En 1996, il a été décidé et convenu avec Stamicarbon & H/A de redessiner l'unité d'urée pour augmenter la capacité garantie jusqu'à 2850 t/j.

L'exposé traite du travail de réhabilitation :

1. *Pousser l'aspiration du compresseur de CO_2*
2. *Modifier les plateaux classiques du réacteur d'urée*
3. *Epurateur parallèle*
4. *Colonne de rectification parallèle*
5. *Evaporateur supplémentaire*
6. *Modification des pompes à carbamate*
7. *Modification du granulateur*
8. *FBC nouveau*
9. *Nouveaux laveurs*
10. *Tamis supplémentaires*

Le travail de réhabilitation a été achevé pendant la révision de septembre 1997. Les résultats obtenus sont également présentés.

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[1] *Réhabilitation de l'unité d'urée de Saskferco*

I. INTRODUCTION

- Saskferco operates in Belle Plaine Saskatchewan since 1992 an ammonia / urea plant producing 1700 MTD NH_3 and 2200 MTD granular urea
- Ammonia: Krupp - Uhde process (design capacity 1500 MTD)
- Urea solution process: CO_2 stripping of Stamicarbon (design capacity 2000 MTD)
- Granulation process: Hydro - Agri Fluid Bed Granulation
  (design capacity 2000 MTD)
- In April 1996 board decision to increase capacity to 2850 MTD
- Urea solution part revamping: **Parallel Stripper**
- Granulation part revamping: **3 E** Method - **E**xtend **E**xisting **E**quipment
- In September 1997 during plant turnaround revamping has been successfully completed and plant reached new design capacity:
  - 1850 MTD ammonia
  - 2850 MTD granular urea
- Actually both plants are running above new design capacity
- Pan Orphanides has been involved as Saskferco's technology consultant in the conceptual design of the revamping, in the Basic Engineering phase and in the fabrication (expediting and inspection) of critical equipment (Parallel Stripper, CO_2 compressor booster, CO_2 compressor and turbine revamping), as well as during the Design-Construction and Commissioning of the original plant.
- **Brief Presentation of Stamicarbon Urea Melt Production Process (Figure 1):**

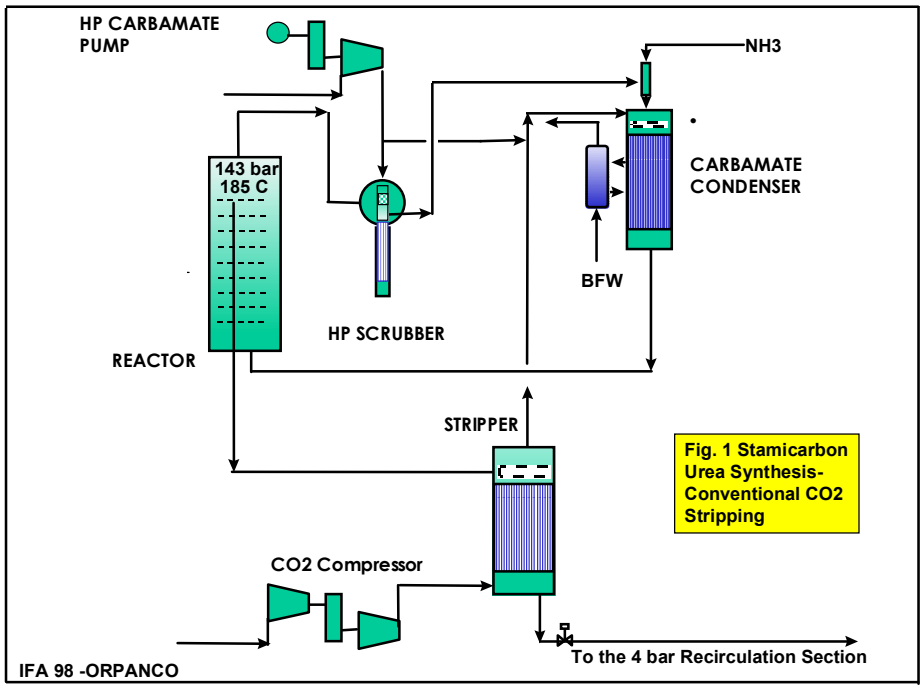


Fig. 1 Stamicarbon Urea Synthesis- Conventional CO2 Stripping

- Well proven, most often applied urea production process
- Many single line units of above 2000 MTD urea capacity in operation
- Low overall energy consumption process
- Simplest efficient urea production process
- **Brief Presentation of Hydro - Agri Urea Granulation Process (Figure 1a):**

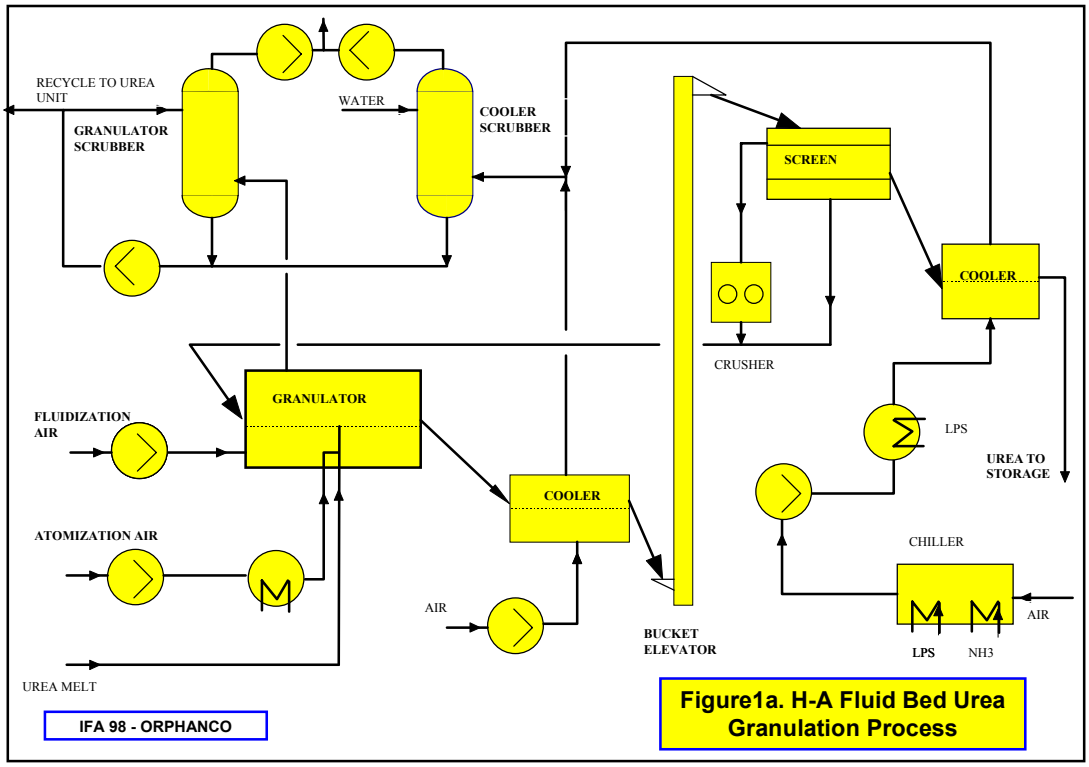


Figure1a. H-A Fluid Bed Urea Granulation Process

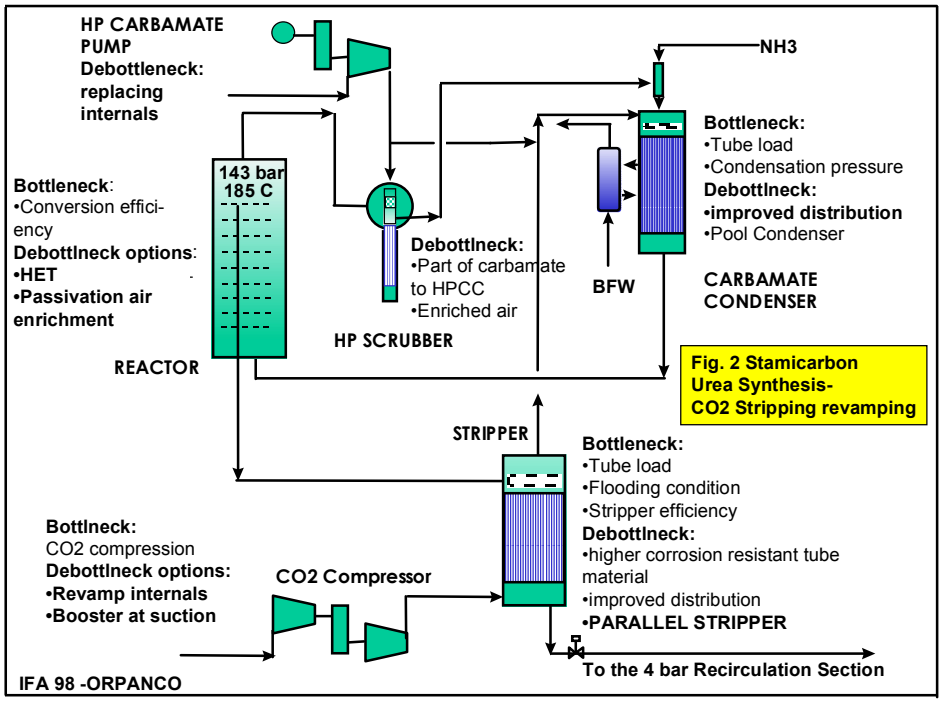
- Well proven in last 15 years most often applied urea granulation process
- Many single line units of above 2000 MTD urea capacity in operation
- Low recycle, low overall energy consumption process
- 95 to 96% urea solution required (single evaporation stage)
- Dust emissions lower than 150 g/MT of urea
- Hard - round - dust free- free flowing - with excellent storage / handling properties product
- 90 to 95% between 2 and 4 mm
- Moderate recycle temperature (65°C)
- Low final product temperature due to cooling by dehumidified air is independent from climatic conditions.

II. UREA SOLUTION PLANT REVAMPING

II.1 Urea Synthesis and Feed Stock Supply

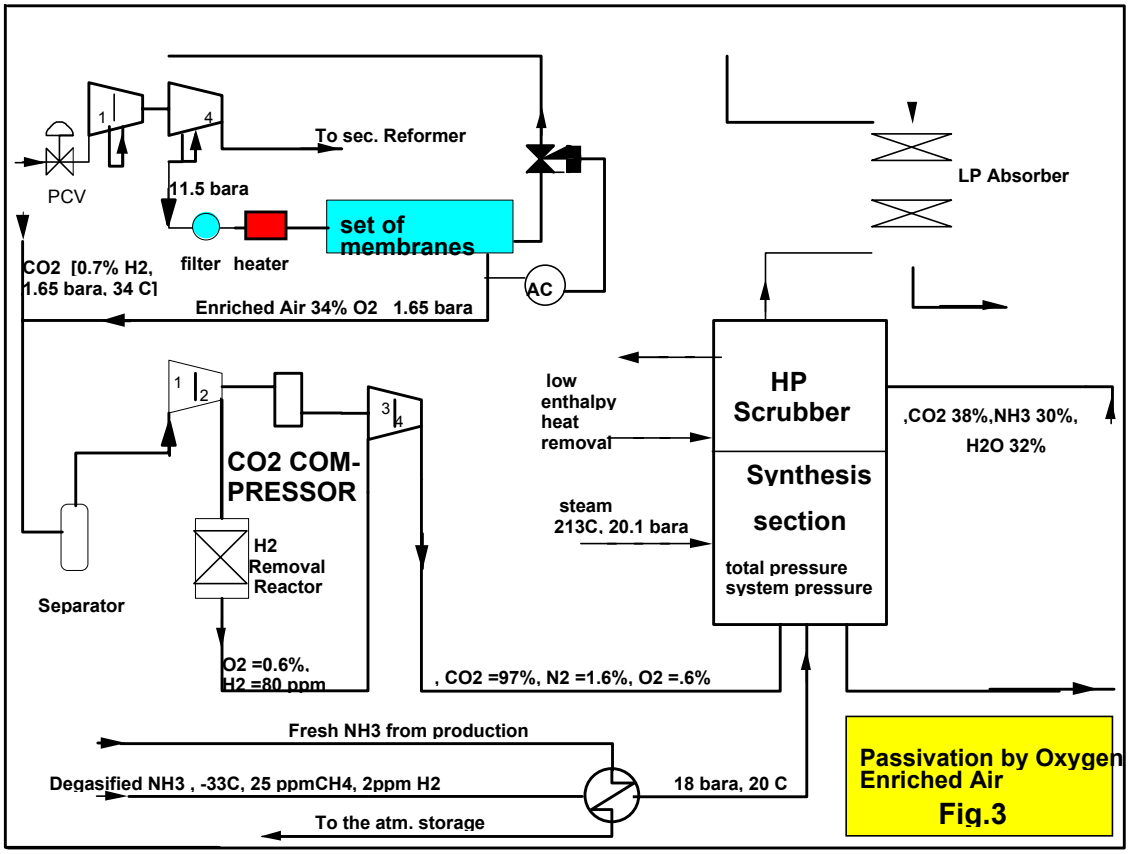
- The most cost intensive part of a urea plant revamping is the Urea Synthesis.

- In Figure 2 the typical conventional Stamicarbon CO_2 stripping urea synthesis section is shown. Next to each main equipment the bottlenecks to the targeted capacity increase and the possible ways of debottlenecking are indicated. In bold letters the specific debottlenecking method applied in this job:

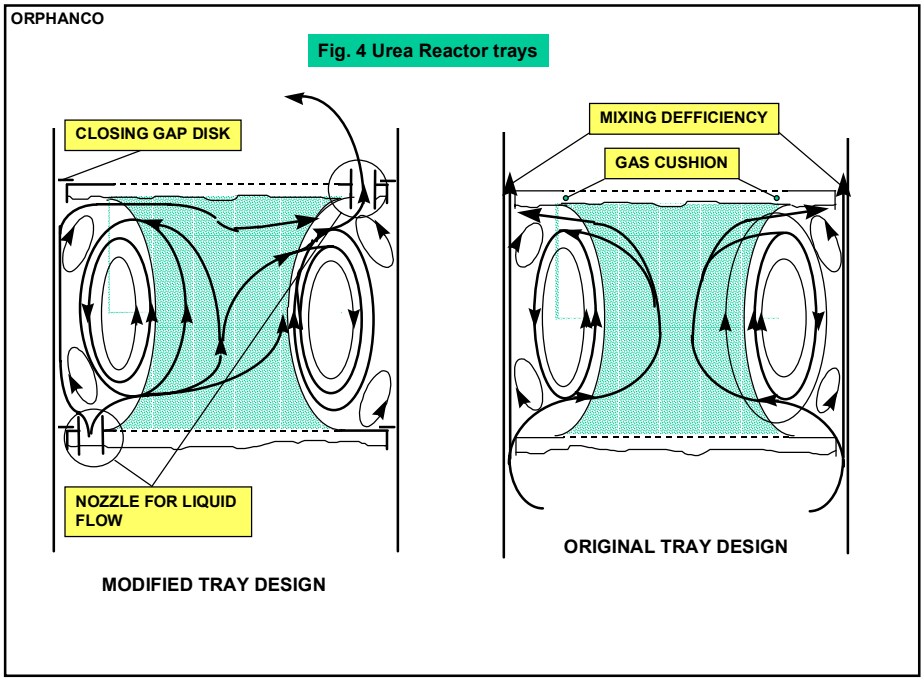


Urea Reactor

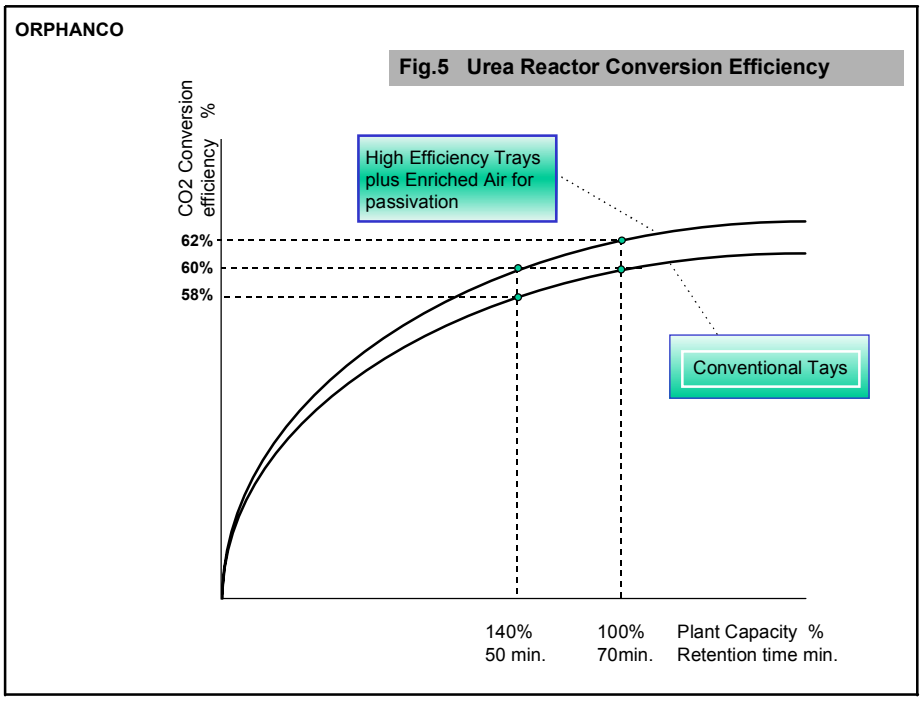
- Replacing the passivation air by enriched air (see Figure 3): i.e. reduction of inerts, which mean increase of the effective reaction pressure



- Adding one bottom tray and modifying the existing trays in order to intensify the mixing of the gaseous and liquid phase and reduce the liquid bypass to a minimum (see Figure 4). In this specific case the original trays have been modified. It seems that it is finally better to replace the existing trays with new, than to modify them.



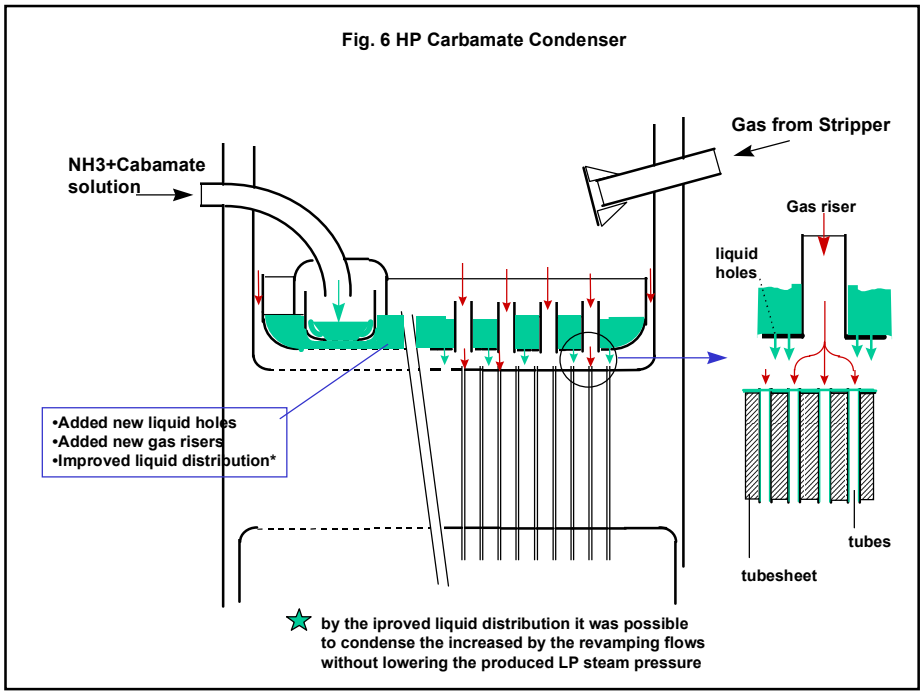
- By applying the above two main modifications the CO_2 conversion in the reactor could be maintained at 60 to 61% at the new capacity of 2850 MTD (see Figure 5)



HP Carbamate Condenser

- Modification of the gas and liquid distributor to accommodate the increased gas and liquid flow and improvement of the liquid distribution (see Figure 6).

- It is foreseen to recycle part of carbamate directly back to the HPCC in order not to overload the HP scrubber.

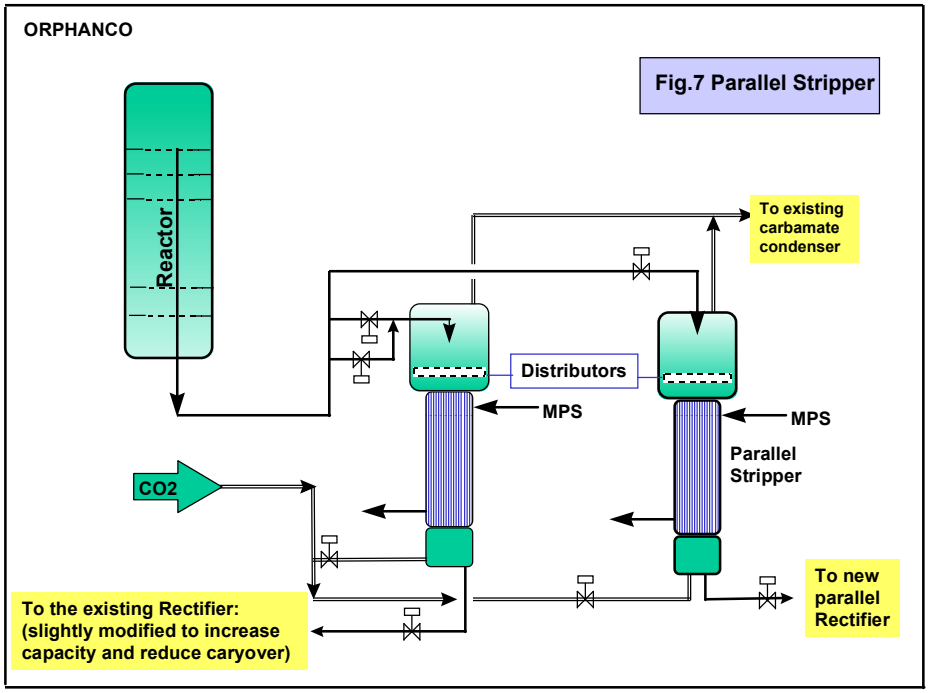


HP Scrubber

- Practically no change. Slight internal re-arrangement due to enriched air use for passivation

Stripper

- Installation of a **Parallel Stripper (see Figure 7)**: 30% increase of stripping surface

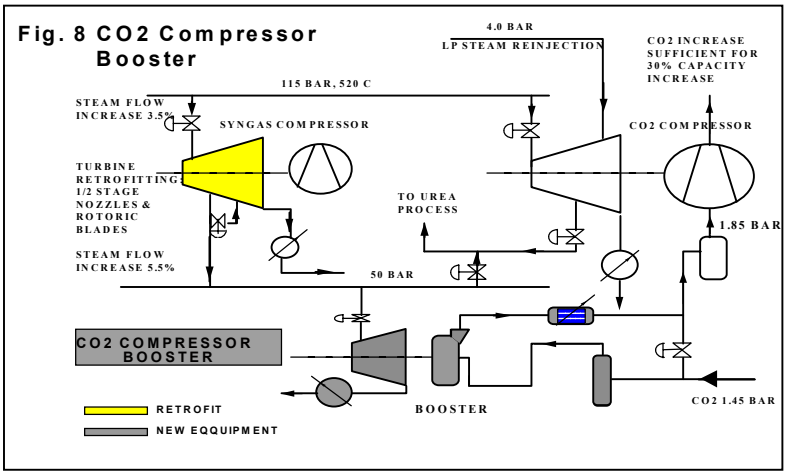


HP Carbamate Pumps

- Pump internals modification to increase pump capacity by 30%

CO_2 - Compressor / Figure 8

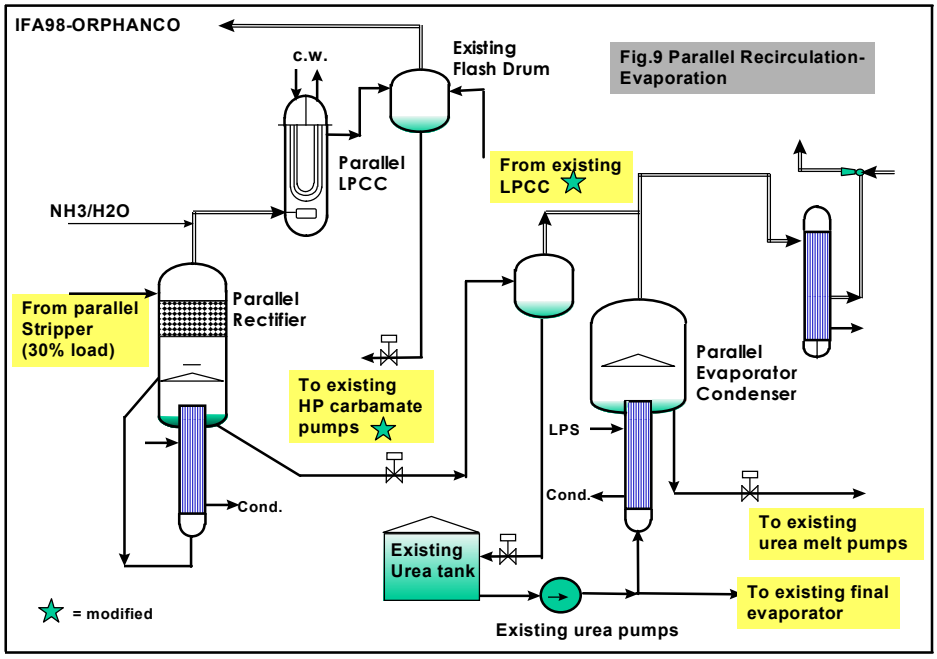
- Turbine internals for increased efficiency
- Installation of a booster



II.2 Recirculation - Evaporation Section

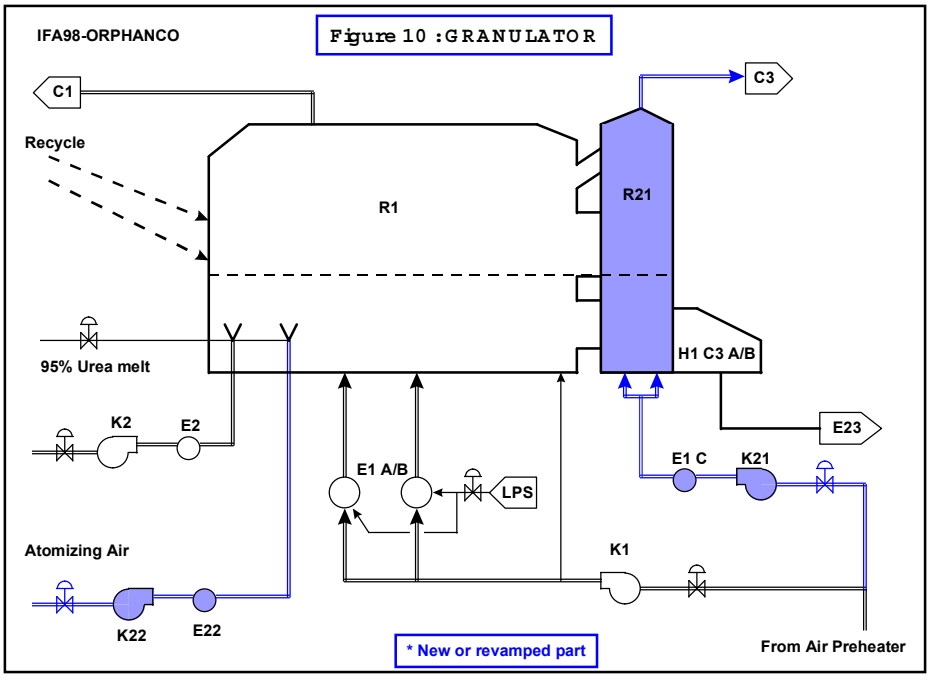
A new recirculation - evaporation unit to handle 30% of the new capacity has been installed, comprising, as it shown in Figure 9 following items:

- A new rectification column
- A new LPCC
- A new evaporator
- A new vapour condenser



III. GRANULATION UNIT REVAMPING WORKS:

III.1 Granulator R1- R21 / Figure 10



- New compartment is used for cooling only to compensate loss of cooling section due to addition of new headers
- Existing granulator with new perforated plate tailored to allow higher air flow
- Extended atomization air header provided with new atomization air unit at the same as original process design figures
- Connection between lower casings R1 and R21
- Connecting duct between upper casings R1 and R21
- Connecting duct between top of upper casings R1 and R21
- Additional air exhaust above cooling section
- Re-positioning of inlet chutes of recycle material
- Adjustment of partition walls for minimum backmixing in cooling section
- Addition of three new injection headers and their spray nozzles to match new design capacity

III.2 Vibrating Extractors HI C3 A/B - Safety Screens / Figure 10

- Existing extractors slightly modified and existing safety screens relocated to meet following conditions:

• Design flow	98 MT/h
• Operating flow	89 MT/h
• Temperature	100°C
• Bulk density	750 kg/m^3
• Amount of oversize	1% max of incoming solid
• Screen gauze size	10 mm

III.3 Added New Atomization Air Unit / Figure 10

Consisting of:

- One atomization air blower K22 to provide 30% extra flow
- Extra air heater E22 to heat up the air to the original design temperature

III.4 New Fluidization Air unit / Figure 10

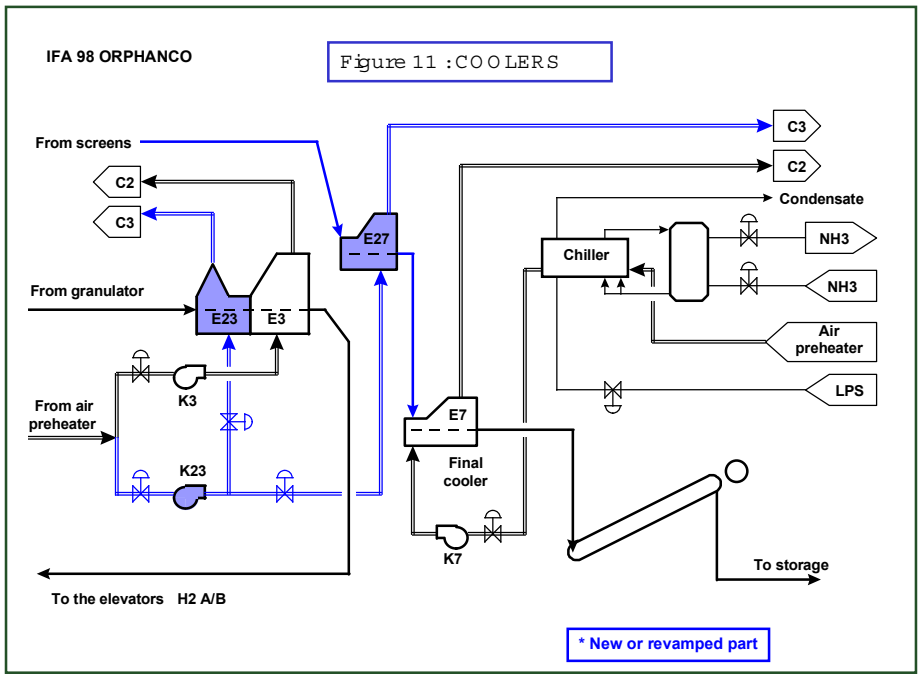
Consisting of:

- One fluidization air blower K21 to provide 40% extra flow to fluidize the new added compartment of R21
- No air heater required to heat up the granules during granulator filling up

III.5 Added Recycle Cooler E23 and New Pre - Final Cooler E27 / Figure 11

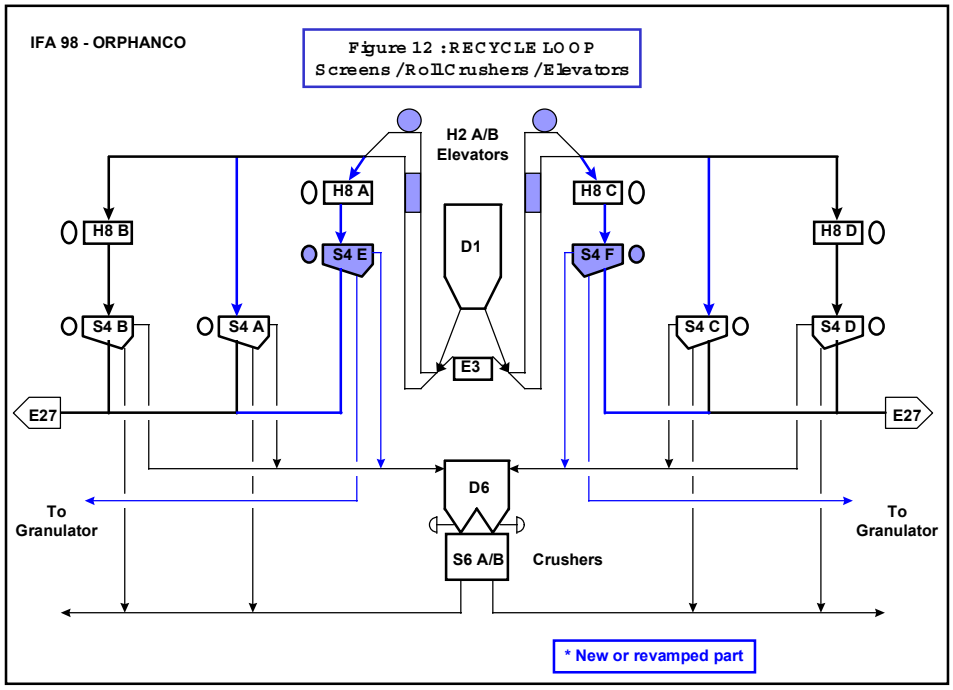
- New perforated plate with new perforation pattern in E3 and addition of 40% plate area for E 23
- Connection between lower casings E3 and E23
- Connecting duct between upper casings E3 and E23

- Connecting duct between top of upper casings of recycle coolers E3 and E23 to allow air flow between E3 and E23
- New air blower K23 to provide fluidization in both E 23 and E27, for an extra cooling air flow of 45%
- New up front end product cooler E27 to cool product from 65 to 53°C, to extend overall cooling area by 65% (installed outside granulation building)
- New gas ducts from E27 and E23 to new Scrubber S3
- No change on chiller E8 & E9, no change on fluidization blower K7 for end product cooler E 7 with lower inlet temperature



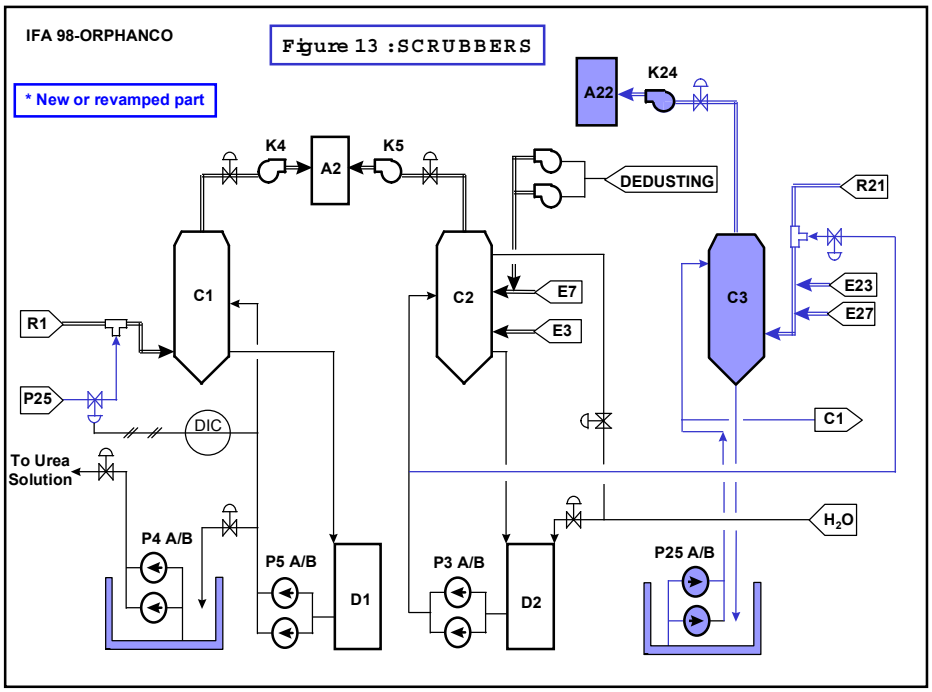
III.6 Recycle loop revamp - Elevators H2A/B, Screens S4 E/F - Figure 12

- Increase elevator H2A/B casing height & drive power. No elevation speed increase. Elevator design capacity 98 MTH, operating flow now 89 MTH
- Increased screening capacity by 50%: two new screens SF E and F added equal in size to the existing
- Rearranged chute disposition to screens. No new vibrating feeders to the screens required
- Increase of recycle bin D1 volume to the extend allowed by the free space available
- No change in existing crushers S6 A/B. Design capacity of about 2x9 MT/H sufficient to cope with oversize operating flow of about 12 MT/H
- No change to diverters
- No modification on dedusting fans



III.7 Scrubbing System - C3, P25 A/B / Figure 13

- New scrubber C3 to scrub urea dust laden air from R21, E23 and E 27. Extend of total scrubbing flow by 45%. Installed outside building.
- New scrubber exhaust blower K 24 with adjustable inlet guide vanes
- New scrubber tank
- New scrubber re-circulation pumps P25 A/B
- New scrubber stack A22
- Extended pump pit and relocation of recycle solution pumps P4 A/B, solution filter and pit fume exhaust fan.



Conclusions

- Investment cost less than 35% of a new 650 MTD capacity urea plant with new conveyor to the storage
- Plant shut down time to complete revamping and for tie-ins less than 20 days
- No operating personnel increase
- Improved product quality: due to increased fluidization air and screening surface by about 50% improved uniformity index and reduced dust in the final product
- Revamped urea plant is easy to start and operate
- Guaranteed plant capacity and efficiency obtained
- Electric power consumption, LP steam production and urea dust emissions lower than the original plant
- HPCC performance better than design.