International Fertilizer Industry Association

IFA Technical Conference

Chennai, India
24-27 September 2002

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4-BAR ABSORBER SYSTEM (a)

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1. Summary

Environment: Installation of 4-Bar Absorber System and how the release of ammonia and CO2 to atmosphere has been greatly reduced.

FERTIL Management is committed to safeguarding the environment, health and safety of the employees and the property in accordance with ADNOC HSE guidelines and regulations.

The urea plant was venting about 8 MT/day of ammonia and 18 MT/day of carbon dioxide into the atmosphere. Although, emissions were as per the technology available at the time of the plant design, it was considered to be air polluting. To control this emission, the 4-Bar absorber project was implemented in 2001.

The urea plant air emissions are now even better than the standard set by the European Fertilizer Manufacturer's Association for new urea plants.

The total cost of the project was 1.2 million US dollars. Besides improving the environment, it has also resulted in the following benefits:

☞ Recovery of more than 3,000 MT per year of ammonia, and 6,500 MT per year of carbon dioxide.

☞ Economic benefit of about 0.5 million US dollars per year, which results into a payback period of less than 3 years.

2. History

Ruwais Fertilizer Industries (FERTIL) was established as a joint venture between Abu Dhabi National Oil Company (ADNOC) holding two thirds of the equity and TOTALFINAELF of France holding one third of the equity, on 15th October 1980. The objective of the company is to produce ammonia and urea and market them internationally, using the lean associated gas supplied by ADNOC.

Located in the Ruwais Industrial City, 250 km west of Abu Dhabi on the Arabian Gulf coast, the construction of FERTIL plants began in November 1980 and were commissioned in November/December 1983.

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(a) received on 10/06/02
International Fertilizer Industry Association (IFA) Technical Conference, Chennai, India, 24-27 September 2002

The FERTIL Complex comprises of a 1,050 MTPD ammonia plant designed by Haldor Topsoe of Denmark and 1,500 MTPD urea plant based on Stamicarbon of Netherlands' CO_2 Stripping Technology. It also includes fully integrated utility plants, liquid ammonia and bulk urea storages along with bag and bulk loading and shipping facilities. Power, sea water, desalinated water and potable water are supplied by a nearby general utility plant owned by ADNOC.

The control plants of the processes were based on the Distributed Control System (DCS) TDC-2000 supplied by Yamatake-Honeywell which has been subsequently upgraded to TDC-3000 with Advanced Process Managers (APM).

Commercial production of prilled urea began in 1983 and both the ammonia and urea plants have consistently exceeded the design production capacities from 1985 till date. There has been no formal debottlenecking of the plants but with small scale in-house studies from time to time, the ammonia plant presently operates at 130% of the design and the urea plant at 120% of the design capacities consistently.

FERTIL Management is committed to safeguard the environment, health and safety of the workforce in particular and the society in general in accordance with the ADNOC HSE guidelines and regulations, which of course are in line with the international standards.

In line with our commitment as stated above, the design of the urea plant incorporated the following features, which were the best available technology at the time of the plant design.

a) Dust scrubbers designed by BECO of USA, were installed at the top of prilling tower to control the emission of urea dust, which is controlled at 30 ppm maximum. FERTIL, to date is the only plant in the GCC to have adopted this feature.

b) Desorption/hydrolyser section was incorporated in the urea plant to control the NH_3/urea contents in the waste water. It is designed for a maximum of 60 ppm NH_3 and 200 ppm urea contents in the effluent.

The performance of the plant in terms of safe operation, capacity utilisation, onstream factor and energy consumption is rated amongst the best operated plants both in the GCC and the world as indicated by various international benchmarking surveys.

Although, the urea plant has never exceeded the guaranteed consumption figures of 0.580 MT of NH_3 per MT of urea, the plant was venting about 8 MTPD of ammonia and 18 MTPD of CO_2 into the atmosphere from the vent downstream of the HP scrubber, as per the design according to the technology available at that time.

To control this emission, FERTIL decided to incorporate a 4-Bar absorber downstream the HP scrubber.

This paper briefly describes the various stages of implementation of this project.

3. Introduction

Since the urea plant consistently operated at more than 120% of the design capacity, it was decided to incorporate the effects of high load in the design of 4-Bar absorber and its effects on the existing desorption/hydrolyser section equipment and other sections of the plant including the atmospheric absorber.

Basic engineering for the project including the Design Phase Hazard Study was done along with the process licensors, Stamicarbon. Detailed engineering was later conducted by Larsen & Toubro-Chiyoda of India. This phase was completed by September 2000 and the procurement of equipment and materials was thereafter initiated. The installation of 4-Bar absorber project was carried out in the planned plant turnaround in October 2001.

4. Design Phase HAZOP

A detailed HAZOP was carried out after the basic engineering phase and the findings were duly incorporated in the detailed engineering phase. Salient features are briefed as follows:

- The off gas line of existing atmospheric absorber to the atmosphere should not have any valves, silencer, etc.

- Atmospheric absorber feed pumps were deleted as per the new requirements. New 4-Bar absorber feed pumps also supply water to users previously supplied by desorber feed pumps. Hence, the design of pipelines was checked and a new pressure control valve was provided as per the characteristics of the new pumps.

- When considering the gas outlet of the 4-Bar absorber to be blocked in, pressure will increase by the vapour from the HP scrubber. When considering that liquid outlet from the 4-Bar absorber to be blocked, the column will fill up with liquid and pressure may rise. Hence, the relief valve was accordingly designed to safely handle maximum flow through the control valve on the inlet and the maximum liquid level. It also caters to other emergency scenarios like control valve failure and instrument air failure. The location of this relief valve was, therefore, selected on the gas line between HP scrubber and 4-Bar absorber.

- Since the 4-Bar absorber project had an impact on the desorption/hydrolyser section due to incorporation of new pumps and modifications/changes to some control valves, the relief system of desorbers and the hydrolyser were checked against the worst case scenarios and that their design was verified to be adequate.

5. Project Equipment

The list of equipment for the project was:

- 4-Bar absorber (new)
- 4-Bar absorber feed cooler (new)
- 4-Bar absorber feed pump 2 Nos. (new)

Modification were carried out to the following existing equipments:

- second desorber
- atmospheric absorber
- reflux condenser
- reflux pump
- ammonia water tank
- washing water make-up pump
- desorber feed pump
- hydrolyser feed pump

6. Tie-Ins

After completion of the detailed engineering job, a detailed list of tie-ins was prepared. The purpose was to facilitate the procurement of materials, pre-fabrication and installation upto the tie-in points during the operation of the plant.

7. Installation

The 4-Bar absorber project erection involved the following:

- 4-Bar absorber column in place of inert vent silencer.
- 4 Bar absorber feed plate heat exchanger.
- 4-Bar absorber feed pumps A/B.
- New reflux pumps to replace old pumps.
- Removal of atmospheric absorber feed pumps.
- Nozzle modification of second desorber, atmospheric absorber and the reflux condenser.

The total scope of piping was also successfully erected, hydrotested and commissioned. The piping work was completed prior to the turnaround and the tie-ins during the turnaround.

The structural pre-fabrication works were completed prior to shutdown. Installation job was completed in 15 days during the turnaround.

8. Project Cost

The total cost of the project including the basic and detailed engineering, equipment, piping, electrical instrumentation and installation was US$ 1.2 million.

From the project kick-off to installation completion, it took about 18 months.

9. Process Description

The design vapour feed to the 4-Bar absorber is the outlet flow of gases from the HP scrubber which scrubs and condenses the off gases from urea reactor using the diluted carbamate solution pumped from the low pressure section of the plant.

This design vapour feed to the 4-Bar absorber is composed of the following:

NH_3	-	521	kg/h
CO_2	-	985	"
H_2O	-	30	"
N_2	-	1331	"
O_2	-	268.	"

4-Bar absorber is a packed column having two beds. Gases are firstly scrubbed in the bottom bed by ammonia water, having about 5% ammonia concentration followed by absorption in the top bed by clean water (desorber effluent) and the gases leaving the 4-Bar absorber have an ammonia content of just 0.04% by volume.

The design composition of the vent gases outlet of 4-Bar absorber is as follows:

NH_3	–	5.0	kg/h
CO_2	–	1.5	"
H_2O	–	37.2	"
N_2	–	1304.2	"
O_2	–	262.3.	"

The solution from the bottom of the 4-Bar absorber containing recovered ammonia and carbon dioxide is sent to the atmospheric absorber from where it returns to the ammonia water tank.

Implementation of the 4-Bar absorber increases the load on the hydrolyser by about 5%. To compensate for lower retention time in the hydrolyser, its temperature has been increased by 5^oC. Both the desorbers were found able to handle the new situation. The steam line and the control valve to the 1^{st} desorber was however, replaced with a bigger capacity line and valve.

Furthermore, to enhance the heat capacity of the existing reflux condenser, a sprayer has been installed above the tube sheet, which uses part of the ammonia water going to the LPCC.

After the installation of the 4-Bar absorber project in October 2001, the actual composition of the vented gas from the 4-Bar absorber at 120% load of the urea plant are as follows:

- ammonia	0.6 kg/h	0.04% by volume
- carbon dioxide	15 kg/h	0.40% by volume
- inerts (water+air)	2280 kg/h	99.56% by volume

The above analysis shows that the gas vented from the 4-absorber to atmosphere is almost clean.

10. Conclusion

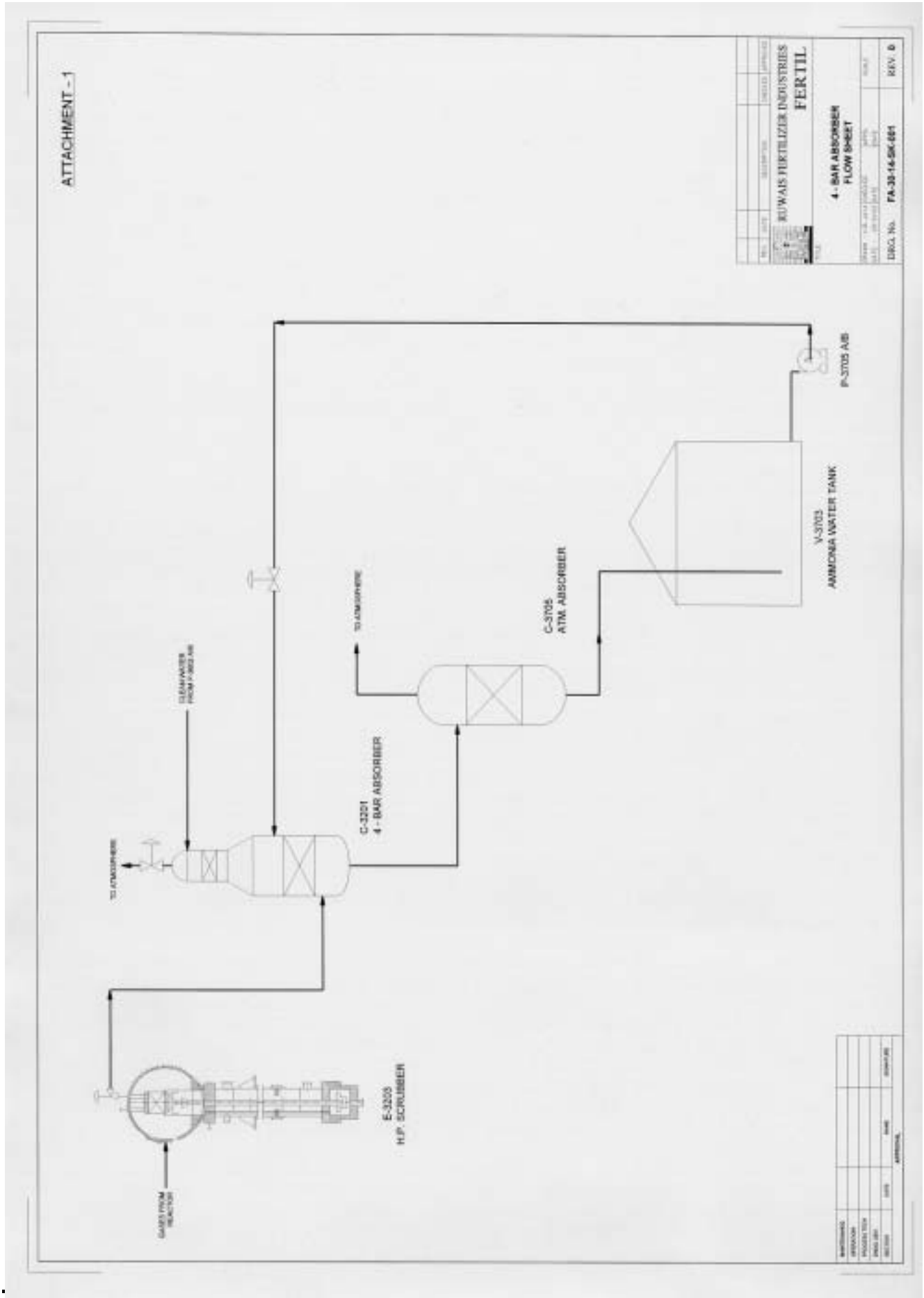
The 4-Bar absorber project has been much more successful and beneficial than originally expected. The emissions into the atmosphere have been significantly reduced and are now better than the European Fertilizer Manufacturer's Association' standard for new urea plants.

The implementation of the 4-Bar absorber system has helped:

- ☞ Reduce the emission of ammonia and carbon dioxide and SAVE THE ENVIRONMENT.
- ☞ Increase the availability of NH_3/CO_2 for enhancing urea production.

The economic benefits, based on ammonia recovery, translate into US$ 0.5 million per year and results in a payback period of less than 3 years for the project.

FERTIL Management feels proud to have contributed to the IFA theme of the year "MEETING SOCIETAL CHALLENGE TOWARDS A SAFER, CLEANER AND MORE EFFICIENT PRODUCTION".



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ATTACHMENT - 2

4 - BAR ABSORBER