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Where the urea industry meets

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RotaScrub® Upgrade of the Medium-Pressure Inerts Washing System of a SnamprogettiTM Urea Plant

- Improve Safety Standards -

- Reduce Ammonia Emissions and Consumption Figures -

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Abstract

The SDS Separation RotaScrub® is a highly efficient solution for gas washing or scrubbing. Based on the proprietary separation technology of the RotaSep®, RotaScrub® adds a specific surface area up to 10 times higher than the next best solution and uses up to 30% less scrubbing liquid.

This results in RotaScrub® being up to 10 times smaller than the conventional packed scrubber beds, making it the most compact, robust, and efficient scrubbing solutions on the market.

The benefits of the RotaScrub® Upgrade of the Medium-Pressure Inerts Washing System of a Snamprogetti™ Urea Plant are:

- Increase safety standards (intrinsically safe design against explosions)
- Reduce ammonia emissions from 2-4 vol% to 0.2-0.4vol% (90% efficiency) based on one co-current RotaScrub® or to 0.02 to 0.04% based on two RotaScrub® unit in series.
- Reduce NOx emissions in case inerts stream is used as fuel
- Reduce ammonia consumption figures of your urea plant

Content

1. Introduction

Saipem is one of the global leader in drilling services, as well as in the engineering, procurement, construction and installation of pipelines and complex projects, onshore and offshore, in the oil & gas market. It has distinctive competencies in operations in harsh environments, remote areas and deepwater. It provides a full range of services with contracts on an "EPC" and/or "EPCI" ("turn-key") basis and it has distinctive capabilities and unique assets with the highest technological content.

Snamprogetti™ Urea Technology: The first industrial urea plant based on Saipem's NH_3 stripping technology was put into operation in 1971. Since then more than 130 urea plants based on this technology have been in operation or are under implementation with a market share of about 35% of total world capacity. Figure 1 shows the Engro Fertilizers Snamprogetti™ Urea Plant in Pakistan.

Fig. 1: Engro Fertilizer Snamprogetti™ Urea Plant

Track Records

- ✓ 941 days of uninterrupted plant operation
- ✓ More than 15 plants with capacities over 3,000 MTPD since year 2000
- ✓ First 4,000 MTPD urea plant single line
- ✓ Over 4,200 MTPD in operating plant
- ✓ 5,000+ MTPD urea plant ready
- ✓ Recent Innovations

SNAMPROGETTI™ SUPERCUPS solution enhances the yield of operation for the urea reactor. The innovative concept of SuperCups lies in the realization of a confined reaction space within the tray geometry. In this way, SuperCups perform as additional active reaction stages thus enhancing the conversion rate.

2. Existing Medium-Pressure Inerts Washing System

In a Saipem Snamprogetti™ urea plant, the Medium-Pressure Inert Washing System consists of a Medium-Pressure Inert Washing Tower (C-3), which includes three valve type washing trays installed in the top and a vertically installed cooler, also called a Medium-Pressure Ammonia Absorber (E-11).

The inerts feed of C-3 are washed with cold condensate with a temperature of some 40 °C and a flow of some 0.5-0.8 m^3/hr which is introduced at the top of C-3.

The heat resulting from the reaction of ammonia gas with condensate forming an ammoniacal solution is removed by cooling water in the vertically installed cooler E-11 by forming a falling film. The ammoniacal solution are recycled back to the upstream equipment.

A typical urea plant line with a design capacity of 1500 mtpd generates some 700-800 Nm^3/h of C-3 off-gases. The C-3 off-gas comprises hydrogen (25-30 vol%), methane (7-10 vol%), ammonia (2.5-12 vol%), nitrogen (50-55 vol%) and oxygen (6-10 vol%) [1].

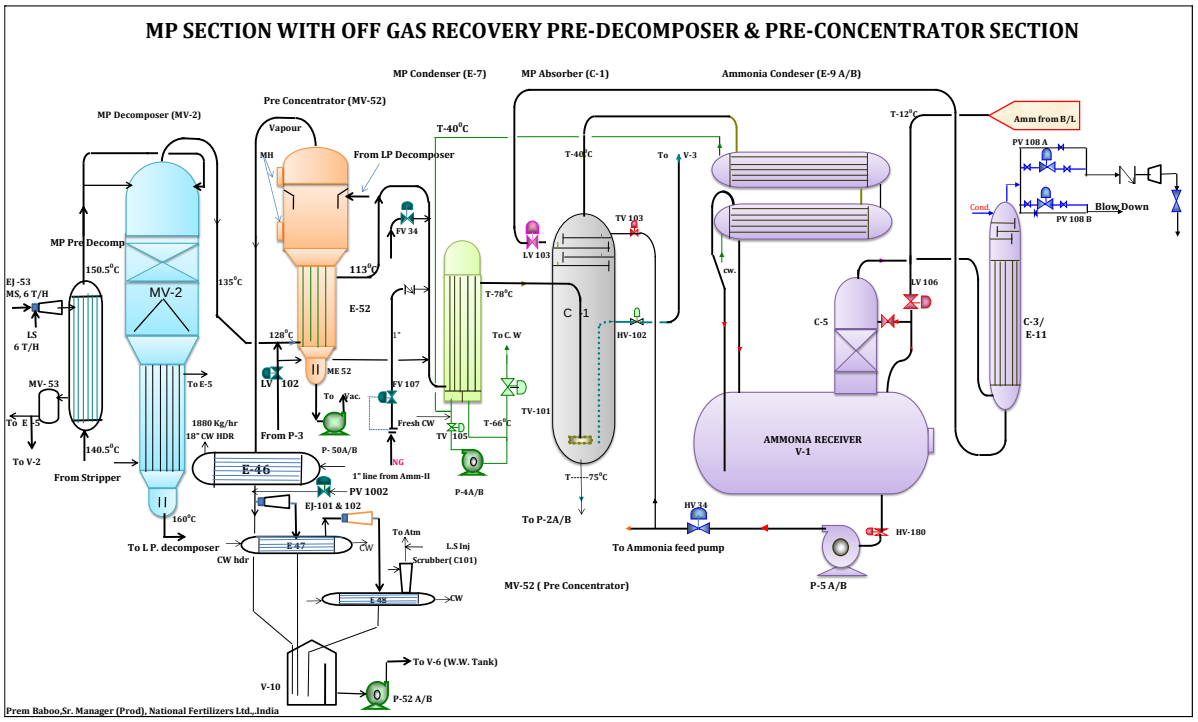

Fig. 2: The Medium Pressure Section of a Snamprogetti™ Urea Plant

The inerts along with residual ammonia are vented to atmosphere via a pressure control valve and this removal of inerts is required to maintain the Medium-Pressure loop pressure at the desired range.

Some (30-50 m^3/hr) natural gas (CH_4) is fed to the inerts feed to avoid an explosive mixture because hydrogen and oxygen are both present in inert mixture. CH4 effectively reduces the size of the explosive area in the explosion triangle as indicated in Figure 3. In green the explosive area for a mixture consisting of H_2, N_2 and air, in red the explosive area for a mixture consisting of NH_3, N_2 and air and in blue the explosive area for a mixture consisting of CH_4, N_2 and air is shown.

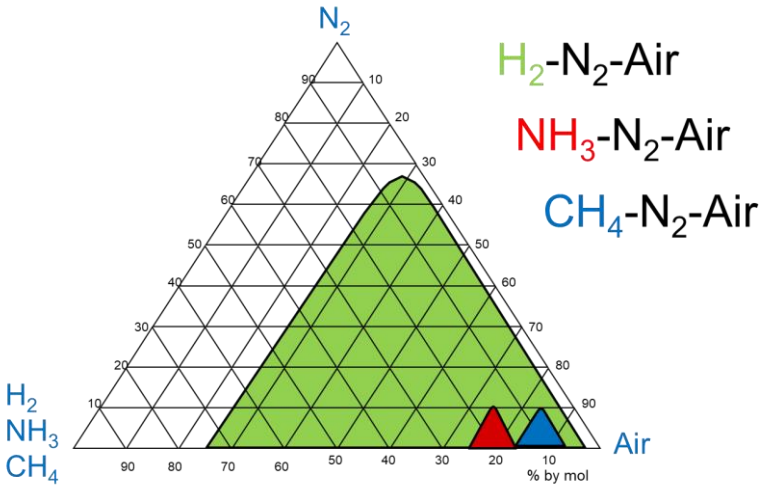

Fig. 3: Explosive area of H_2, NH_3 and CH_4

Adding ammonia (NH_3) or natural gas (CH_4) are very effective measures to reduce the explosion area of hydrogen. In order to save costly ammonia, natural gas is added to assure that one stays outside the explosive area in the Medium-Pressure Inerts Washing System.

3. The RotaScrub® Upgrade

The SDS Separation RotaScrub® is a highly efficient solution for gas washing or scrubbing. Based on the proprietary separation technology of the RotaSep®, RotaScrub® adds a specific surface area up to 10 times higher than the next best solution and uses up to 30% less scrubbing liquid. This results in RotaScrub® being up to 10 times smaller than the conventional packed scrubber beds, making it the most compact, robust, and efficient scrubbing solution on the market. Figure 4 explains how the RotaScrub® works.

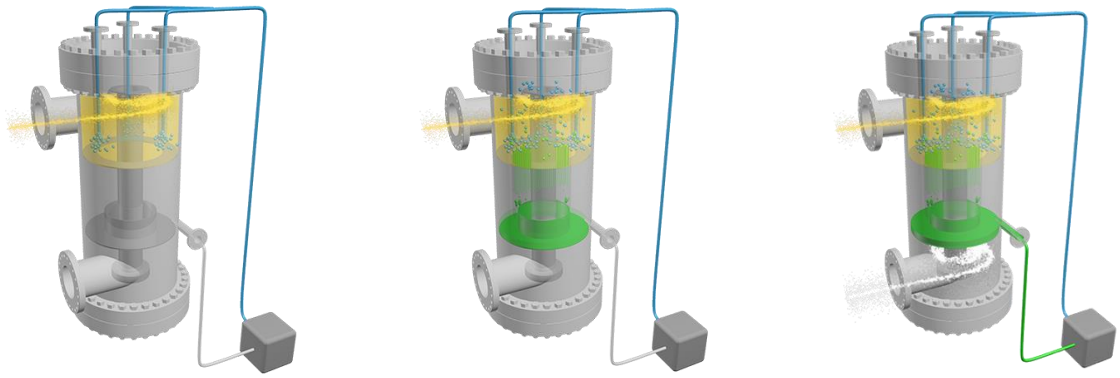

Fig. 4: RotaScrub® in operation (co-current)

Contaminated gas (yellow) enters RotaScrub® together with a washing liquid (blue), where centrifugal forces realize an extremely intimate contact between the gas and liquid phases allowing for a very efficient scrubbing effect. The centrifugal forces throw the contaminated liquid (green) droplets against the housing wall, which are collected and removed through the liquid outlet. The cleaned gas (white) exits the RotaScrub® from the bottom. Figure 4 shows a co-current scrubber, but also counter-current scrubber designs are possible.

RotaScrub® is set to be available in applications like product recovery yield improvement (e.g. methanol) and scrubbing tail gas emissions (e.g. CO_2 emission capturing) in a wide range of industries. SDS Separation has performed a Feasibility Study to Upgrade the Medium-Pressure Inerts Washing System of a Snamprogetti™ Urea Plant by means of the RotaScrub®.

It is proposed to install the RotaScrub® downstream the C-3 column to further reduce the ammonia losses. For a 1500 mtpd Snamprogetti™ urea plant, the inerts flow coming from Medium-Pressure Inert Washing Tower C-3 feeding the RotaScrub® is assumed to be 800 Nm^3/hr containing 2-4 vol% NH_3 (blue arrow in Figure 5).

The RotaScrub® can reduce the ammonia content in the inerts stream to only 0.01 vol% (so with a 99,5% efficiency!) (Red arrow in Figure 5)

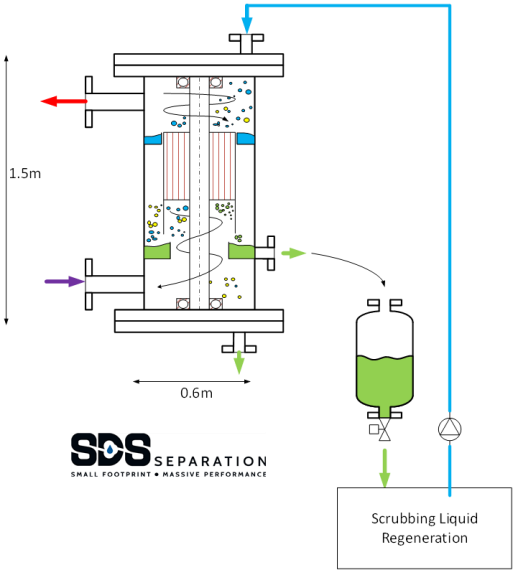

Fig. 5: RotaScrub® design (counter-current)

And only required is 0.5-1.0 m^3/hr condensate (light blue line in Figure 5), which is the same amount as now used on C-3 and thus can be reused on C-3.

Figure 6 shows the RotaScrub® installed downstream the Medium-Pressure Inerts Washer Tower C-3.

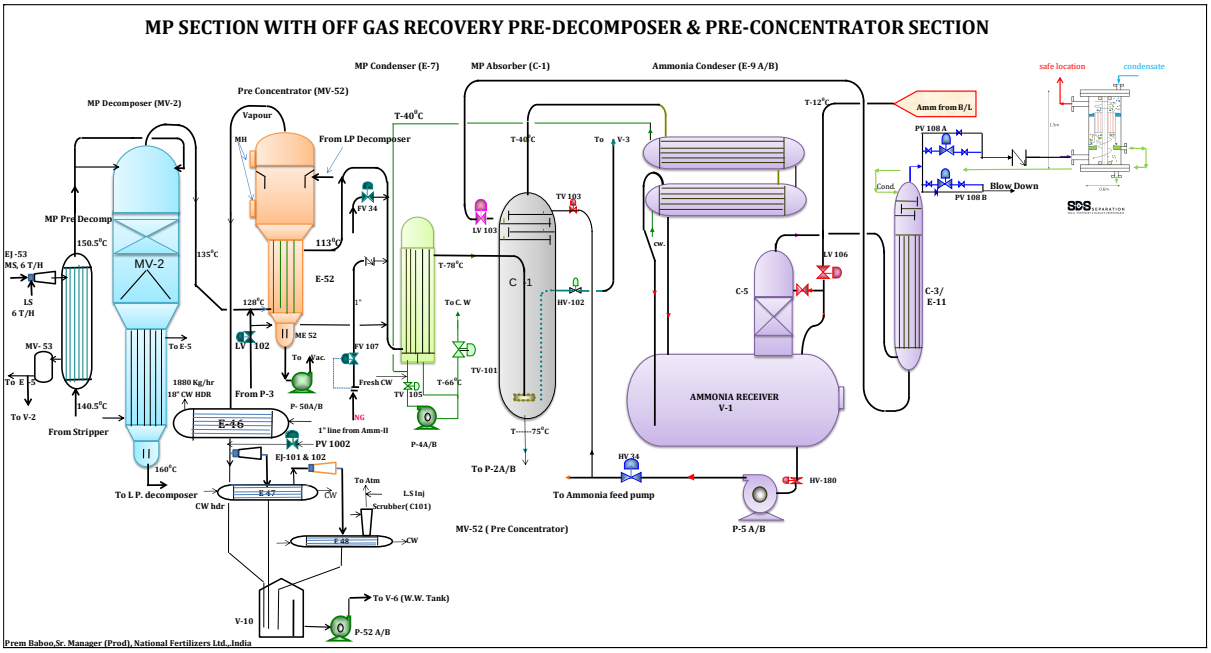

Fig. 6: RotaScrub® installed downstream C-3

The pressure drop over Rotascrub® is some 0.04 bar, so the RotaScrub® needs to be located at a 400mm higher elevation than the condensate inlet in the top of C-3 in order to reuse the condensate without the need for a pump.
Dimensions of the RotaScrub® scrubber are only 1.5m in height and 0.6m outside diameter.
And the RotaScrub® is intrinsically safe from explosions as it has a design pressure of 130 bars. 130 bars are the maximum pressure that can be reached in case of a hydrogen explosion at an optimum (worst case) ratio of hydrogen/air.
Refer to Figure 7 for an example of a typical RotaScrub® scrubber.

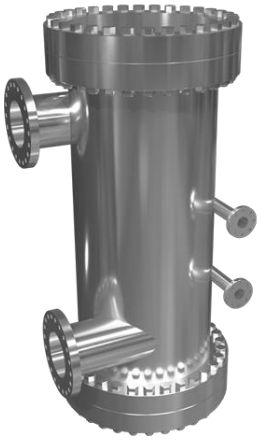

Fig. 7: A typical RotaScrub®

4. Conclusions

The features of the SDS Separation RotaScrub® Scrubber are:

- ✓ Higher scrubbing intensity than trays or packed bed
- ✓ Small footprint (low cost for higher design pressure)
- ✓ Robust and low maintenance design
- ✓ No liquid carry-over

Benefits of the RotaScrub® Upgrade of the Medium-Pressure Inerts Washing System of a Snamprogetti™ Urea Plant are:

- ✓ Increase safety standards (intrinsically safe design against explosions)
- ✓ Reduce ammonia emissions from 2-4 vol% to 0.01 vol% (99.5% efficiency)
- ✓ Reduce NOx emissions in case inerts stream is used as fuel
- ✓ Reduce ammonia consumption figures of your urea plant

Contact us in case you are interested to explore the feasibility of our RotaScrub® Upgrade in your plant.
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Sources

1. 2016 11 Baboo NFL Energy saving and pollution control through Prilling Tower and other equipment, UreaKnowHow.com.