Oil contamination

at

Khorasan Petrochemical Company, Iran

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Preface

This paper by Mr. Majid Mohammadian describes in detail a large disturbance in a urea plant. Reactor pressure rises suddenly, stripper outlet temperature increases, the product brownish... Quick and effective troubleshooting is required, the plant is operating at maximum capacity and every ton of product is valuable. This paper describes the process of troubleshooting and the author hopes this experience can be useful for the smooth operation of other plants.

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1. Introduction

This paper describes the experience of oil contamination from the ammonia plant to the urea process at the Khorasan Petrochemical Complex in Iran.

The Khorasan Petrochemical Complex is located in Bojnurd, Khorasan, north east of Iran, not far from the border with Turkmenistan. The plant has a design capacity of 1500 mtpd prills according the Stamicarbon CO_2 stripping process with a falling film condenser, constructed by MW Kellogg, London. It has Uraca reciprocating High Pressure ammonia & carbamate pumps. The ammonia plant is a 1000 mtpd Kellogg design, constructed by MW Kellogg using natural gas as feed stock. It has a Top Fired Reformer and a Benfield CO_2 Removal section.

The complex started up in 1996 and holds the world record of the longest continuous operations run of 866 days. In 2003 the urea plant was debottlenecked to 1700 mtpd including the integration of the carbamate recycle of melamine plant by Urea Casale. The 30.000 tons/year Eurotecnica melamine plant was constructed using 70% urea solution feed stock. It has reaction, purification & crystallization sections.

This paper describes the process disturbances which indicated to the plant staff the presence of oil in some equipment items and pipelines. Further this paper will describe the impact of oil in the downstream equipment items and the low pressure section.

The decision making process in a urea plant, which is operating at maximum capacity, may be difficult and recognizing quickly the cause of the disturbances is very important. This case study can be useful for urea plant operators in order to chose the right actions for stabilizing the plant in these kind of situations.

We hope that this experience can be useful for smooth operation of other urea plants.

2. Process disturbances

Some abnormal indications appeared in the process, which alerted the operators that something was wrong.

First of all, the synthesis pressure increased sharply, the pressure ascending trend was sharp and in a different manner from the case of variation in NH_3/CO_2 or H_2O/UREA ratios; when we have change in the mentioned ratios (e.g. NH_3/CO_2 ratio changes from 3.2 to 3.15 or 3.10) the pressure changes only slow.

Secondly, the gas outlet temperature of HP scrubber decreased.

Next we faced an increase of liquid outlet temperature of HP stripper, which was also very sharp plus all the conditions of the synthesis indicated that the stripping process was disturbed (pressure fluctuation of the synthesis pressure, temperature fluctuation in the liquid outlet of stripper and NH_3/CO_2 ratio fluctuation).

Another indication came from the bulk storage personnel that the prill product color in the warehouse has changed to brownish. This color change became apparent only by comparing with an earlier produced product pile in the warehouse and it could not be recognized easily on the belt conveyor of the urea unit.

Further there was some foaming in the urea melt, which was seen by the operator in the site glass at the suction of the urea melt pump.

Finally, the desorption section, especially the hydrolyser, was disturbed and the temperature of the hydrolyser tower could not be increased anymore and the tower had a high level of liquid, which may be because of clogging of tower trays holes.

The above process disturbances and the counteractions will be discussed in the next section.

3. Description, theories and actions

In this section we describe the details of process disturbances, the theories and the actions which were taken by the operators.

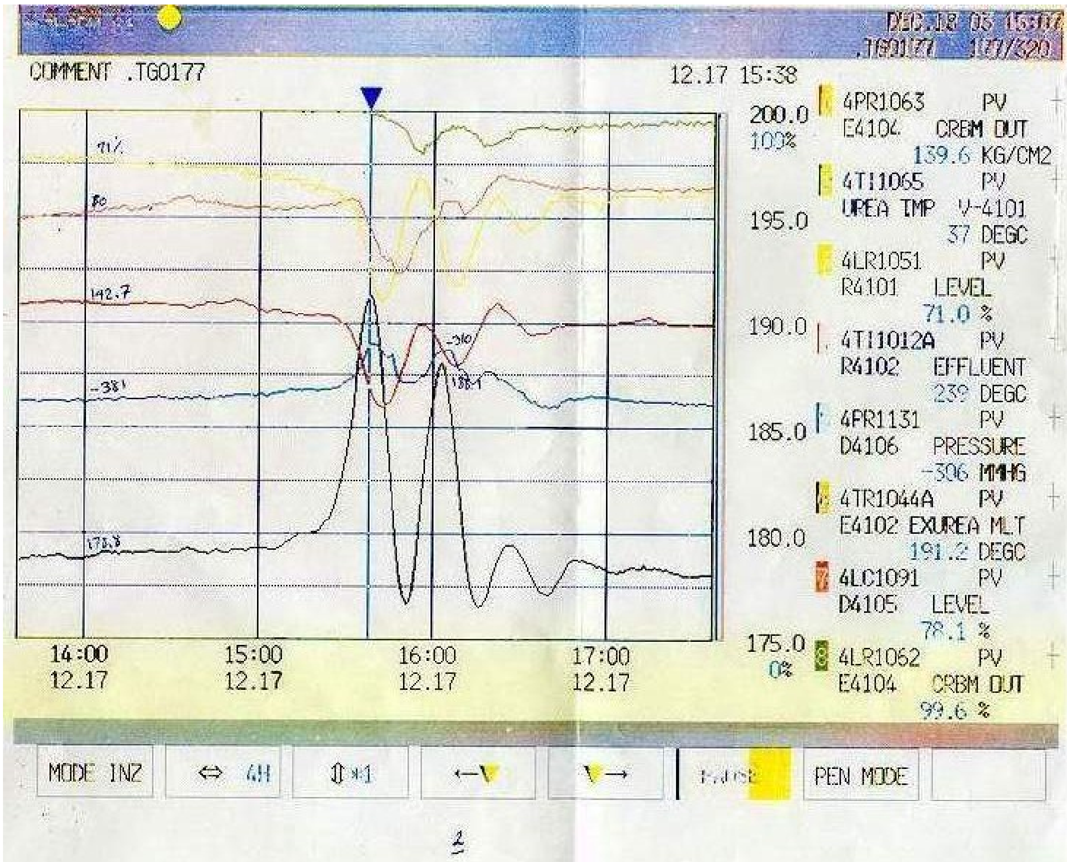
The increase of synthesis pressure and the simultaneously decrease of the HP scrubber gas outlet temperature including the decrease of the temperature of the tempered cooling water loop of the HP scrubber brings up the idea of a partial blockage of the outlet gases of the HP scrubber. We know that this blockage can occur at lower N/C ratios (figures of 2.7 and less) but at that time the synthesis ratio was about 3.2, so the blockage in outlet pipe of HP scrubber was firstly rejected.

Graph 1 shows:

- Increase of synthesis pressure (4PR1063)
- Decrease of HP scrubber gas outlet temperature (4TR1063)
- Decrease of tempered cooling water loop temperature (4TR1286 and 4TC1284)

Graph 1: Trends of important process parameters part 1.

The liquid outlet temperature of HP stripper (4TR1044A) increased from 178°C to 191°C as can be seen in Graph 2.



Graph 2: Trends of important process parameters part 2

Graph 2 also shows that the increase in the liquid outlet temperature of the HP stripper happened at the same moment as a sharp decrease in the reactor level (4LR1051).

We know that a high temperature of the stripper liquid outlet can be caused by one of the reasons:

- High steam pressure in shell side of the HP stripper
- High liquid level in the bottom of HP stripper
- Disturbance in liquid film of the stripper tubes

The third one must have happened in our case because the HP stripper liquid level and shell side steam pressure were constant at that time.

A decrease of liquid outlet temperature of the HP stripper could not be observed unless the inlet valve was closed and we saw that when we close the inlet valve from the reactor to the HP stripper, the liquid outlet temperature of the HP stripper comes down. This confirms the high level of liquid in the top of the stripper, which disturbs the liquid distribution to the tubes. We understood the reason of this phenomenon was caused by plugging of liquid divider holes with oil mixtures.

In the desorption section, the temperatures of the hydrolyser didn't increase and the liquid level of the tower was high this means that we have a different mixture in the tower caused by contamination with oil. In this condition the liquid outlet valve was fully open and overhead gas outlet valve had a minimum opening (all in automatic mode). This shows that vapors were prevented to flow upwards leading to no contact between steam and the process condensate. This might be caused by oil mixture clogging of the holes of the sieve trays in the hydrolyser column.

The product color change brought in mind the theory of active corrosion in the synthesis section, however the delta Nickel test in the synthesis equipment and in the product rejected this theory. Presence of 10 ppm oil in the product and 50 ppm oil in NH_3 feed showed oil contamination in the ammonia feed to the urea process.

After being aware of the presence of oil in the NH_3 feed, we changed the NH_3 path to cold ammonia (from the storage). The source of the oil appeared to be from the sealing oil control system of the refrigeration compressor in the ammonia plant. After shutting down the compressor and repairing it the problem was solved.

Stopping the oil entering the urea plant and running the urea plant at low capacity (70%) solved the synthesis section problems. Further steaming of the hydrolyser removed the oil fouling of the trays in this tower.

4. Conclusions

One of the most important control parameters in a urea plant operation is the synthesis pressure, and a sharp increase of this pressure is very dangerous for a urea plant. The synthesis pressure can be influenced by many reasons such as:

- variation in the NH_3/CO_2 ratio
- losing the liquid seal in the down comer from the reactor to the HP stripper
- overfilling of the HP scrubber and any fluctuation in the gas scrubbing system

In this paper we introduce a new reason for an increase of the synthesis pressure: Oil contamination into the urea process which causes many abnormal variations in several sections of the plant.

This root cause of this disturbance can be confirmed taking a sample from the NH_3 feed and checking the color change of the urea product. These actions can avoid many confusions in finding the root cause of the several process disturbances.

We decreased the plant capacity to 70% and slowly the process conditions improved. After some 24 hours the urea plant reached again 100% capacity.

Majid Mohammadian

Mr. Majid Mohammadian holds a B.S (Chemical Engineering) degree from the Abadan Institute of Technology in Ahwaz, Iran.

Majid Mohammadian has a working experience of 15 years in Fertilizer plants.

From 1994 until September 2007 Majid did work at Khorasan Petrochemical Co., Khorasan, Iran where he was involved in Operation, Optimization, Revamp and Melamine integration projects.

From September 2007 until September 2008 Majid did work in Ghadir Urea & Ammonia Co., Assaluye, Iran where he was involved in the Pre-commissioning, Commissioning, Start up and Operations. The Ghadir Urea & Ammonia Co. consists of a Kellogg Ammonia Plant, constructed by Toyo Engineering Corporation,. It is a 2050 mtpd Ammonia plant using Natural Gas Feed Stock and has a Top Fired Reformer, Water jacketed Transfer line & Secondary Reformer, a-MDEA CO_2 Removal section and a Molecular Sieve Dryer. The Stamicarbon Urea Plant was constructed by Chiyoda and is a 3250 MTPD Urea Pool condenser plant. It has a Hydro Fertiliser Technology Fluid Bed Granulation, Safurex High Pressure Equipment, High speed centrifugal HP Ammonia & HP Carbamate Pumps, a big size ware house with Reclaimer and an automatic Bagging system.

Presently Majid Mohammadian works at NPC (National Petrochemical Company) PIDEMCO in Tehran responsible for the new ammonia/urea complex, Lordegan Petrochemical Company. This project consists of an Ammonia Casale 2050 mtpd Ammonia plant and a Stamicarbon 3250 mtpd Urea plant that is in the basic engineering phase.

Majid is 39 years old, is married and has two children.