Plant Manager+

This is already the 12th in a series of discussions from a selection of round table topics discussed on the UreaKnowHow.com website. UreaKnowHow.com promotes the exchange of technical information to improve the performance and safety of urea plants. A wide range of round table discussions take place in the field of process design, operations, mechanical issues, maintenance, inspection, safety, environmental concerns, and product quality for urea, ammonia, nitric acid and other fertilizers.
The 12th subject under discussion is oil fouling of the High Pressure stripper in a urea synthesis.

Problem No. 12 Oil fouling of the High Pressure stripper in a urea synthesis

The efficiency of the High Pressure Stripper is a very important parameter in the optimum operation of any urea plant. Fouling of the HP stripper can reduce the efficiency and oil is a typical risk for fouling. Oil can origin from for example oil seal systems of high pressure reciprocating ammonia and carbamate pumps and carbon dioxide compressors. Oil can easily cause fouling of the liquid distributor system in the top of the High Pressure Stripper, where small holes are present as the oil can become thick due the stripping of the light components. How to solve this oil fouling problem and how to clean the High Pressure Stripper ?

Mr. Malik Sohail of Agritech Ltd. in Pakistan introduces to the Round Tables a very interesting practical problem, which has a big impact on the performance of a urea plant: Oil fouling in the High Pressure Stripper

Dear All,
We are dealing with TEC ACES plant and having a HP Stripper design of Stamicarbon.
There was a problem with stripper efficiency and now at shut down we open the ferrules and found about 150+ tubes having oil at stripper bottom (about 10%).
The ferrules are OK and found no blockage of holes but found pitting on it. Oil consumption at NH_3 feed pump was high before the shut down and the HP stripper bottom temperature was on the higher side with high NH_3 slippage.
Now the questions are:
How oil can be removed?
What may be the other possible causes of it?
Procedure to wash the stripper tubes?

Mr. Mark Brouwer of UreaKnowHow.com replies first:

Oil can come from different sources such as HP NH_3 pump, compressors in ammonia plant, ammonia storage tank, ...
Oil in the HP stripper can be removed by a caustic solution, please contact Stamicarbon as they have cleaning procedures available.
Oil fouling can result in a lower stripper efficiency but also other factors can cause it like:
- not an equal liquid distribution of the liquid over all the tubes. Did you check if there is a liquid level difference between the centre and the outside or at different directions at the outside areas ?
- not a good tightening of the ferrules on the tube ends, so that liquid/gas can bypass here.

Mr. Muhammad Farooq of Agritech Ltd. in Pakistan provides more information:

Regarding level at tube sheet: the level was higher on wall side and less in the middle.
Swirls fitting was good as we carried leak test which did not indicated single drop leakage except few tubes, so liquid cannot bypass there.
Stripper efficiency remained lower ? what are the countermeasures to take now ?

Mr. Janusz Maćkowski of ZCh"Police" in Poland provides some solutions:
If you have continuous problem with oil fouling you can apply some of the procedures described in UreaKnowHow.com's Technical paper: 2010 09 Ren Lanhua UreaKnowHow.com Stripper Efficiency problems.
You could also try to wash the stripper by HP water pump during every stoppage.

Muhammad Farooq replies:
Thanks Mr Mackowski,
We have already tried one of the procedure of washing i.e item 4.1 of referred paper. we dismantled stripper and problems are highlighted afterwards.

Mark Brouwer asks for some clarifications:

- You mean with "problems where highlighted afterwards" that the stripper efficiency was even worse after the applied cleaning procedure ?
- How much level difference you did see between centre and wall side ?
- When you have droplets from some tubes with the leak test, it is a sign that some liquid is bypassing. This can result also in gas bypassing during operation. Do you see blue oxide layers on the inside of the ferrules where these are fixed to the tubes ?
- What is your stripper efficiency ? How much lower it is compared to design ?
- Did you do a delta-P test of ferrules ?

I would suggest to contact Stamicarbon to re-check the liquid distributor system based on your findings.

Janusz Maćkowski provides some more valuable suggestions:
Besides mentioned above, you could also check if geometry of the heat exchanger part of the stripper hasn't changed (if tubes are not twisted and still are ideally vertical).
Furthermore, you can check if tubes of the stripper aren't polluted and have the same diameter along the entire length. In these cases stripper couldn't work properly as well.

Mr. Patel Rasikal Dahyabhai of Notore Chemicals Ltd in Nigeria adds his valuable recommendations:
You can clean stripper tubes and ferrules by Teapol (just like soap solution but it must be Chloride free). If oil problem is much bigger in the stripper, it is best to convert the plunger packing lubrication system of HP Ammonia pump (Forced feed lubricator) from oil to flushing water just like HP carbamate pump.
Further clean very well the ammonia surge drum/suction vessel during the annual turnaround.

Mr. Muhammad Kashif Naseem of SABIC in Saudi Arabia contributes to this discussion with his experience and practical solutions:
Dear Muhammad Farooq, Aslam o alakam.
I fully understand the problem that you have described; now I feel I have been right since one year because my evaluation was right when Ii said that our HP stripper has an internal problem due to uneven level of liquid indicated on the swirls.
For oil cleaning I suggest to fill the stripper with condensate from bottom up-to 6 inch above the top of tubes and heat up the condensate up to 120 ^{o}C for 3-4 hours then drain it. Repeat this procedure 5 to 6 times to completely wash out the oil. But in my opinion your problem may be due to internals fitting so again fit them and do the pressure test.

Muhammad Farooq replies with more information:
Dear Mark ,
My observations are given below.

- We carried out back washing during plant start up, however our stripper could not improve.

- after that we had shutdown and we inspected our stripper and then problems were highlighted. our plant is now in operation again.
- The level difference was around 10-12inches towards wall side and 5-7inches in middle as we judged from metal color change.
- Although leak test was ok (zero leakage with 30mm water level on tube sheet) but-around 450/1824 tubes show a blue oxide layer.
- The stripper efficiency (alpha) = 66.5-68.7%
- We haven't yet done delta -p test of the liquid dividers.

Mark Brouwer replies:
Here some advises for the next turnaround: The level difference between centre and outside area seems too high, so liquid divider system should be improved; Perform a delta-P on the ferrules; Check dimensions and tolerances of fittings of ferrules on tube ends.
How much the efficiency is compared to design ?
Did you remove the oil ? if yes, how ?

Mr. Sunil Kulkarni of Mangalore Chemicals & Fertilizers Ltd. in India shares his experiences:
The most effective way to clean stripper tubes is EDTA cleaning. Stamicarbon can give the procedure. Ammonia pumps plunger packing can be changed over to water flushing so that you can eliminate oil ingress. We have done both these at our plant and results are very good.

Muhammad Farooq replies:
Can you please send more details of the system installed for switching to water flushing at ammonia pumps plunger packing?

Mr. Vedantam Srinivas of Safco in Saudi Arabia confirms one of the suggested solutions:
The root cause is to be eliminated once for all. Please take steps to change NH_3 Pump packing sealing system from oil to cold condensate. This will bring many benefits to the plant besides providing pure and clean environment. The stripper and downstream equipments normalize gradually on their own. The cost of the modification is very less. The condensate outlet from the packings can also be collected in drain collecting tank to recover the ammonia.

Mark Brouwer clarifies some topics:
Cleaning procedure with EDTA is for removing oxide-scales, not for removing oil. Seal system for the HP NH3 pump is a water seal system not a water flush system. I believe all HP NH3 pump vendors have a water seal system now as a standard feature, so they have also the information how to do that. The principle is that water is sealed at about 5 bars between the low pressure packing rings and the high pressure packing rings. Any NH_3 leakage through the high pressure packing rings will be absorbed in the water and measured by the temperature difference of the water. The water should be free of solids.
A HP carbamate pump has a water flush system, which washes away carbamate crystals.

Muhammad Farooq replies:
Thank for your valuable guidance. Please tell me the name of vendor for modification for switching oil to water sealing system at our H.P ammonia pump made = PERONI - (ITALY). The injection oil sealing pressure at plunger packing is 33-35kg/cm^2 with discharge pressure of pump=185kg/cm^2.

Mark Brouwer replies again:
I believe every pump vendor has developed the water seal nowadays, so Uraca, Peroni etc. Please check with them.

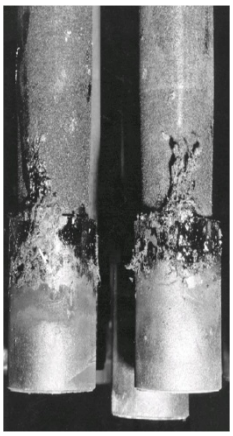
Mr. Le Ngoc Ban of Phu My Fertilizer in Vietnam shares his experiences:

Our plant is doing turn around, we are facing a very hard job to remove oxide-scales inside ferrule and tube side of MP decomposer, could you help me the cleaning procedure with EDTA or any experiences about this work.

Mr. Girish Prakash of Tata Chemicals Ltd. in India asks for some more information.
It will be good if you can post some photos of the ferrules to understand the seriousness of the situation.

Malik Sohail has another concern:
Is there any operational problem with water sealing of HP Ammonia pumps?
If there is wear of stuffing box than water will carry with ammonia and H/C in loop and ultimately urea conversion will effected. What you think which one will damage more oil or water (In case of carry over with ammonia)?

Mark Brouwer replies:



During normal operation the leak of water or oil to the process side should be minimum by proper maintenance procedures. In case of an upset oil fouling can cause bigger problems than water, at least in stripping plants. Even during an upset the amount of water from the pumps is much less than from the carbamate recycle. Please remind the liquid holes in the liquid dividers in the top of the stripper act as a kind of filter for the whole synthesis section. Oil will be stripped also in the stripper at the high temperatures and the heavy boiling part of the oil will collect around the liquid holes.

Sunil Kulkarni shares his experiences.
The oil carry over is mainly due to oil from HP ammonia pumps.
We at MCF Ltd., Mangalore India have changed to water for plunger flushing instead of oil. The results are good. The packing life is around 3 months. The oil, if we eliminate naturally no oil, will be seen at stripper bottom.
We have carried out EDTA cleaning of stripper tubes way back in year 2000 for 316 tubes and results were good. Stamicarbon gave the procedure. Now we also have a Safurex stripper and first inspection we observed no problems.

Mark Brouwer adds another solution to the discussionb:
Into the urea synthesis oil can enter, which origins from the reciprocating HP pumps and CO_2 compressor. Compared to the total amount of reactor solution, it is a small amount of oil and reactor solution and oil form an emulsion. The continuous phase is the reactor solution and the oil droplets form the discontinuous phase. In the top of the stripper (without a special fluid distribution system), the emulsion is relatively quiet, meaning without turbulence. Here, the oil has time to coalesce to larger droplets. These larger droplets rise and form an oil film on the surface. Again and again new reactor solution with oil enters the stripper. More and more oil coalesce and form a thick film of oil. This oil film is polymerized at the surface in the gas phase. Solid particles are formed which may sink due to their larger density. These particles clog the holes in the liquid distribution dividers.
SBN's solution for the above problem is the prevention of coalescence of the emulsion (reactor solution with oil droplets) by keeping the liquid (emulsion) constantly in motion (turbulence). The coalescence of the oil droplets is thus not possible. The oil droplets go with the reactor solution through the holes of the liquid distribution dividers.

This can be realised by installation of a special fluid distribution system above the support plates of the liquid distribution dividers and is proven in several urea plants for many years already.
Please contact Mr. Hermann Kernberger of SBN (H.Kernberger@christof-group.com) for more information.

Malik Sohail asks further:
Can anyone explain the oil circulation (travel) from raw materials (NH_3, CO_2) to the final urea product. We are facing problems of high oil contents in product (250-225 ppm) for 2-3 hrs and our HP ammonia pump injection oil consumption is about 10-15 liter/day. An emulsion can be observed at concentrator level.
I want to know how oil travels from feeding to the product and how much it accumulates in different equipment items ? In general we can observe the oil layer in recovery absorbers only.

To be continued...