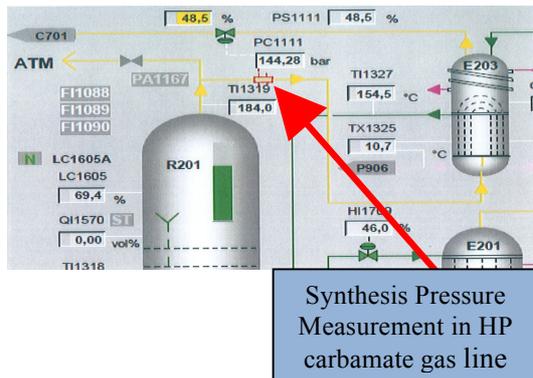


Plant Manager+

This is already the 14th 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 takes place in the field of process design, operations, mechanical issues, maintenance, inspection, safety, environmental concerns, and product quality for urea, ammonia, nitric acid, ammonium nitrate and other fertilizers.

The 14th subject under discussion is the experience of a high synthesis operating pressure, but is it really a high synthesis operating pressure like the title suggests ?

Problem No. 14: High synthesis operating pressure



Operating at a wrong synthesis operating pressure is always a tricky situation for any urea plant operator, knowing that a too high operating pressure will lead to blowing off of the pressure safety valves, which cause not only a significant environmental impact but also a forced shut down of the plant as typically the pressure safety valves do not close anymore properly after blowing. Servicing these valves becomes necessary and because of that not producing any urea can be a costly incident. On the other hand operating at a too low synthesis pressure will lead to lower conversion figures, higher carbamate recycle streams and higher energy costs. Key is to measure the synthesis pressure in a reliable way. Most ideal

would be to measure the synthesis pressure as close as possible to the pressure safety valves so in a high pressure carbamate gas line, but crystallization and corrosion risks are the challenge here. Until recently this was not possible and mostly the synthesis pressure has been measured at locations, where these risks are not or less likely present. Now LESER has developed together with SKW Piesteritz a reliable solution to measure the synthesis pressure in the high pressure carbamate gas lines. But what to do when one does not have a reliable synthesis pressure indication ?

Mr. Kumar Srivastava of Notore Chemical Limited in Nigeria starts up a discussion about a high synthesis operating pressure:

Dear friends,

Our plant technology is Stamicarbon CO₂ stripping technology. We are facing problems of high synthesis pressure when we try to go to a load of approximately 100%.

My observations are as below:

1-In our plant the synthesis loop pressure reference is taken from upstream of the High Pressure (HP) Ammonia Ejector (so in the ammonia feed line) and the instruction is to maintain the synthesis pressure at 150 kg/cm² looking at this HP ejector upstream pressure. The ejector pressure control valve is kept fully open. Whereas from the ejector data sheet we can learn that at normal plant load the differential pressure across the ejector is 15.5 kg/cm².

2-My doubt is that in this pressure measurement and valve opening there might be carbamate building up, which falsely lead to a high synthesis pressure indication. And a poor reactor conversion due to the low reactor pressure (seeing differential pressure), which increases the water recycle in the system, which further results into a poor reactor conversion due to the high water ratio.

3- In our plant there is no gas-chromatograph (or molar N/C ratio analyzer)

I am seeking help: With keeping the HP ejector pressure control valve fully open, is it possible to maintain a differential pressure across the HP ejector as per design value. This HP ejector is installed in HP ammonia pump (7 plunger reciprocating type) discharge line. Is it possible to throttle HP ejector valve to increase the driving pressure, which may help to create a higher differential pressure, which will help to reduce the supposed building of carbamate from the HP ejector ?

Mr. Salam M. Maleh from **North Fertilizer Complex in Iraq** replies:

You can control differential pressure (18bar) by controlling the HP ejector throttle valve (close ejector throttle valve for example 5%).

Kumar comes back with some further clarification questions:

Thanks for supporting me, I hope that your plant have same technology. I don't know what is the capacity of your plant and if you have a HP ejector in your plant. The concept of the HP ejector I understand very well, but I don't have the HP ejector performance curve.

Mr. Shoaib Minhas of **FFBL in Pakistan** contributes to the discussions with his experience: We have a centrifugal type HP ammonia pump and we do manipulate ejector valve to control the back-pressure (ammonia pump discharge pressure). So I think you can as well consider this keeping in mind you have a reciprocating type pump.

Mr. Muhammad Farooq of **Agritech in Pakistan** shares his view: In a Stamicarbon urea plant it is more important to control the N/C ratio and reactor top temperature to control the synthesis pressure. Kindly share your views.

Mr. Majid Mohammadian of **OCI Nitrogen in the Netherlands** asks more details:

Please let me know the followings:

- Plant name plate capacity
- Capacity which you are limited on that
- Synthesis pressure
- Pressure up stream of the H.P ejector
- Scrubber overflow line temperature and level
- Feed ratio and if possible N/C on reactor down comer
- Top temperature of the reactor
- Gas outlet temperature of the H.P scrubber
- Is it vertical HP carbamate condenser or pool condenser type?

Kumar replies:

- Plant name plate capacity 1500 mtpd
- Capacity which we are limited on that >90%
- Synthesis pressure about 140 kg/cm²
- Pressure up stream of the H.P ejector 158 kg/cm²

We have vertical HP Scrubber, solution outlet temperature is 165°C and Reactor vapor temperature is 168°C. This indicates to us high ammonia and we tried to increase little CO₂.

Do you have level indication in HP Scrubber? Why am asking because in our plant there is no level indicator so we could not guess if there is any level rise when there is an increase of carbamate flow. But the way of increase opening of vent valve indicates that there is level increase in HP Scrubber. For this reason I want to operate HP ejector to increase differential pressure across HP ejector.

Majid comes back:

Thank you for the information.

Normally in our Stamicarbon plant there is a level indicator in the Scrubber over flow line to control the level in the line because we need to prevent any gas passing or gas circulation in the synthesis section. So we need to know where is the level is about.

So please let me have the following information:

- With the synthesis pressure transmitter being located and as per your design what should be your synthesis pressure at 100% capacity?
- How much is the temperature of gas outlet from scrubber?
- As per your PFD how much is the inlet and outlet pressure of the ejector at 100% capacity?

Mr. Muhammad Kashif Naseem of **SABIC in Saudi Arabia** likes some further information:

Please tell me the followings to clear you problem:

- HP vent out temperature
- LP steam pressure
- Reactor top /bottom temperatures
- Stripper top /bottom temperature
- Stripper steam pressure

Kumar replies:

We don't have any level indicator in HP Scrubber vessel. Can you please send me the detail of level transmitter in HP Scrubber like the vendor and where it is mounted.

We also have level transmitter issues in 2nd stage evaporator: Presently the level indicator is mounted in suction line of the melt pump and not working. We need to change this level transmitter. In your plant where this level transmitter is mounted and who is the supplier?

Mr. Muhammad Adnan Hanif of **Fauji Fertilizer Company Limited in Pakistan** shares also his experiences and asks some clarifications:

Can you please tell the reactor bottom pressure [any pressure transmitter or local PI installed at downstream of HP ejector or CO₂ inlet line to Urea reactor just downstream of Shut Down valve]? Normally the pressure throttle valve installed on the HP ejector is utilized to regulate carbamate flow. And if your plant N/C ratio is satisfactory or higher than required you may utilize this valve to increase motive fluid i.e. ammonia pressure. However, please note that the delta-P of 15.5 kg/cm² [Between HP ejector upstream and HP loop top vent] will not give your true picture of the available head to move carbamate. You should take reactor bottom pressure and the motive fluid pressure difference. Normally, as in our plant [Saipem technology] it remains > 60 kg/cm² [Delta P between reactor bottom and ammonia header].

To check if there is any liquid passing to downstream sections through overflow of HP scrubber please check its effect on downstream section e.g. sudden decrease in temperature, pressure excursions etc.

Mr. Krishan Harit of **Qafco in Qatar** shares his experiences:

Are you sure your plant is facing a problem due to the HP ejector. Your synthesis pressure tapping is at a wrong location. If you reduce the HP ejector opening than the pressure upstream will increase and more carbamate from the HP scrubber will go to HPCC, which is good. A HP scrubber level indication is not required; generally this indication is not working anyhow. Best way to control is by the HP scrubber outlet temperature. If the temperature is low it means your HP scrubber level is high (166-168 °C is a good temperature) but if the temperature is 165 °C or less it means the HP scrubber level is too high and liquid is going to LP absorber which you can see by LP absorber level opening increase & synthesis pressure increase. Then a closer HP ejector opening will help.

Synthesis pressure indication best place is the HP scrubber overflow line or downstream of the HP ejector in the line to the HPCC.

Mr. Mark Brouwer of **UreaKnowHow.com in the Netherlands** summarizes the discussions until this point:

I realize to do these discussions efficiently more information at the start of the discussion is advisable (as you can see many questions are asked in this discussion. For example include a sketch with pressures, temperatures etc.

Further it is important to know the basic process technology one is referring to as in this case we have to realize that the HP ejector in a Stamicarbon plant has a different function than in a Saipem plant. The challenge to measure the synthesis pressure in a reliable way, so without crystallization and corrosion risks, is different in both technologies. In both technologies one looks for places where these risks are minimum but these places differ between both technologies.

I think one can conclude easily that in this plant the pressure measurement, located upstream the HP ejector, is far from ideal. Depending on plant loads and carbamate flows, the delta-P over the HP ejector can differ significantly (I have seen ranges from 15-35 bars). It is therefore important to have the datasheets of the HP ejector.

In case you are considering a new pressure measurement in your synthesis, please note the presentation of LESER during the next AIChE Ammonia Safety Symposium on September 13, 2012 in Chicago.

Finally I would like to suggest we proceed this discussion by answering the question:

In case one has no synthesis pressure indication available, which other process parameters gives sufficient information about the synthesis pressure that one is able to operate the plant efficiently ?

To be continued ...