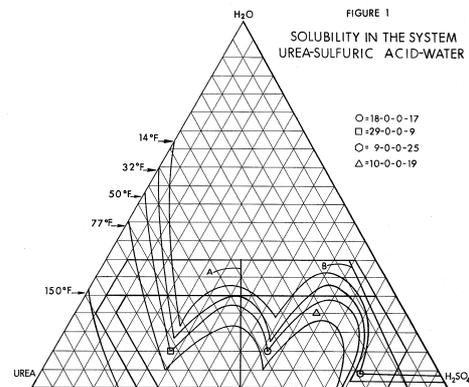


Plant Manager+

This is the fifth 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 fifth subject to be discussed is an experiment injecting H_2SO_4 in the urea melt.

Problem No. 5 H_2SO_4 injection in urea melt

The Urea Industry continuously strives to reduce Ammonia and Urea dust emission from urea plants. The previous reported Round Table discussion (No.4) did collect the different solutions actually applied in urea plants to reduce the gaseous Ammonia and Urea dust emissions. This time a new interesting and challenging possible solution, injecting sulphuric acid (H_2SO_4) in the urea melt, will be discussed. This solution was tested at Phu My Fertilizer plant in Vietnam and immediately a lively discussion started up in our Round Tables. In the early 1980's mixing urea with sulphuric acid was already subject of research programs and the information available in the public domain was helpful to understand better the observed phenomena.



Mr. Le Ngoc Ban of Operations of Phu My Fertilizer plant in Vietnam introduces to the Round Tables a very interesting experiment:

Today I did inject H_2SO_4 98 wt% into the urea melt solution to the prilling top. The injection point is at the suction of the urea melt pump, but the problem is the current and discharge pressure of the pump is decreasing gradually when the acid flow rate is increasing gradually. What happens with the melt pump? Does it cavitate? Do you have experience with this?

Mr. Muhammad Farooq of Pak-American Fertilizer Limited in Pakistan rightfully asks for some clarifications as this experiment is quite unique in the industry.

Can you tell us for what reason 98 wt% H_2SO_4 has been injected to urea melt?

What are expected benefits?

Please describe some details of your experiment.

Mr. Mark Brouwer of UreaKnowHow.com in The Netherlands also likes to receive some more information and provides some first suggestions.

Interesting experiment you are doing!

How much sulphuric acid you did inject?

You want to reduce ammonia emission from the prill tower? Or you want to produce urea/AS product?

I would expect formation of ammonium sulphate, which is able to dissolve in a urea melt until a certain percentage. I guess the density increases when injecting H_2SO_4 which should lead to a higher current at the same flow rate. But maybe gas formation occurs...Did the flow decrease when you injected H_2SO_4 ?

Did temperatures change?

Mrs. Saima Abdul Rasheed of Pak-American Fertilizer Limited in Pakistan replies with valuable information:

The reaction between sulphuric acid and urea is highly exothermic (US Patent # 4445925 & 4310343). Some vapour formation might have occurred.

Mr. Le Ngoc Ban replies the questions raised earlier:

@Muhammad Farooq:

The purpose of this injection is to reduce ammonia content in the prilling top as per environment requirements.

@Mark Brouwer:

- Flow rate of H₂SO₄ injection is 0.11 m³/h (design), but when I did this test, I increased the flow rate in three steps: 0.04 m³/h; 0.08 m³/h; 0.11 m³/h.

- yes, I want to reduce ammonia emission from prill tower exhaust

- yes, the urea melt temperature increases about 2.7 - 3 °C resulting in a biuret increase!

When I increase the acid flow rate, the current of the melt pump decreases so I think the density of the urea melt decreases, you said that gas formation occurs but what is the gas?

When I stop the acid injection the current and discharge pressure of the melt pump increase again

Steps: 0.04; 0.08; 0.11; 0.00 m³/h

Current: 117; 115; 113; 119 A

discharge pressure: 13.4; 13; 12.8; 14.5 bar

biuret content: 0.97; 1.07; 1.09; 0.95 wt%

The plant load did not change

Mr. Muhammad Farooq suggests an alternative to bypass the problems.

I would like to suggest you to inject H₂SO₄ in the discharge line of urea melt pump near prilling bucket by using an acid dosing pump.

Do you have any washing/scrubbing system at top of your prill tower ?

Mr. Muhammad Naeem of the Technical Services Department of Pak-American Fertilizer Limited in Pakistan contributes to the discussion with a valid remark:

I think the proper way is to inject any kind of fluid whether that is UF-85 or H₂SO₄ at the suction of urea melt pump to have a better mixing of the both fluids.

Mrs. Saima Abdul Rasheed replies to the question of Mr. Le:

The vapours formed are water and the acid.

Mr. Mark Brouwer further elaborates:

Yes and urea can also decompose into the gasses NH₃ and cyanaric acid (HNCO): this reaction might also be promoted when H₂SO₄ reacts with NH₃.

Plus when the temperature increases also more vapours form.

Mr. Le Ngoc Ban raises some more questions:

Do you have any document about H₂SO₄ injection into urea melt?

What kind of side reaction happens in this solution?

How to explain the biuret content increasing?

And why urea melt pump cavitates?

Mr. Mark Brouwer replies:

Please study carefully the patents indicated by Saima Abdul Rasheed.

These patents mention exothermic reactions and even explosion risks.

As by-products CO₂, NH₃ and toxic components like ammonium sulphamate and sulphamic acid are mentioned. Be careful thus.

When ammonia concentration reduces due to reactions with sulphuric acid, the biuret formation reaction: 2 urea <=> biuret + NH₃ goes to the right side. This leads to more biuret. More gasses cause cavitation of the pump.

Mr. David Herrero of Operations of Fertiberia, S.A. in Spain gets involved in the discussion and provides valuable new information.

One can find several patents on the web regarding sulphuric acid injection into urea melt. They claim ammonia emission from the prilling tower could drop to 5 mg/Nm³ without further air treatment. Biuret content will go slightly higher and the final content of Ammonium Sulphate would be around 0,5%. Water content would not be affected if 98% sulphuric acid is used. The point of injection is at the pump suction line to assure correct mixing and reaction with the free ammonia. If enough gases are present due to the reaction, cavitation, of course, will appear. The AS content makes this urea is only valid for agriculture (not industrial grade). As far as I know

there was limited real experience (I guess this would have been an extended practice if it have had plenty of success)

Did you run the trial during enough time to measure the ammonia emission? If so, what were the values you got?

Mr. Ahsan Muhammad Sarfraz of Fatima Fertilizer Ltd in Pakistan

Really interesting experiment but may I know what is the present level of ammonia emission at your prilling tower which you are trying to control. Beside this what was the impact on the ammonia emission of tower during the time you have dosed the acid (did you measured the impact?).

What is the emission level you are aiming upon as usually TEC and Stamicarbon prill towers operate around 25 mg/Nm³. We are operating at 14 mg/Nm³.

Mr. Le Ngoc Ban replies:

The test lasted 7 hours, from 9 am to 4 pm.

Steps: 0.04; 0.08; 0.11; 0.00 m³/h

NH₃: 78; 49; 89; 94 mg/m³

Actually, ammonia level at prilling tower depend on location where you take the sample. In our case, the highest level is 94 mg/m³ and the lowest level is below 60 mg/m³. My target is to reduce the level of ammonia to below 60 mg/m³.

By the way, do you think the prill hardness can improve after H₂SO₄ injection?.

Mr. Basheer Al-Awami of Safco in Saudi Arabia introduces some new interesting aspects in the discussion.

It is interesting subject. Injection of H₂SO₄ or AS is going to improve the mechanical strength of urea prills and also reduces the ammonia emission. However, one should be worried about the corrosion that may occur in the prilling tower structure. Also the colour of the final product may appear to be yellowish which may be not accepted by farmers.

Mr. Vedantam Srinivas of SAFCO in Saudi Arabia contributes to the discussions with an interesting alternative to reduce the ammonia emission.

You were doing a good experiment.

Do you have dedusting arrangement in the prill tower top?

What is the height of the tower and flow of air through the tower.

Based on the above, we may think of using water or H₂SO₄ as scrubbing media, Ammonium Sulphate can also be produced as a byproduct.

Mr. Le Ngoc Ban replies:

We have not dedusting system in the prilling tower top.

Mr. Gh. Serpoush of R&D of Shiraz Petrochemical Company in Iran confirms the biuret increase and raises another question.

OK, the urea melt temperature increases about 2.7 - 3 degree Celsius, which increases the biuret content.

What is ratio(mole H₂SO₄/mole urea) in your test or how much metric ton urea was prilled at test time?

Mr. Le Ngoc Ban replies:

The plant load when I did the test was about 99 ton/h, you can calculate H₂SO₄/Urea mole ratio. Now we are waiting result of prill hardness test, we hope the hardness will be improved.