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Uhde's Key Design and Execution Features in Recent Urea Plants

by

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1. Introduction

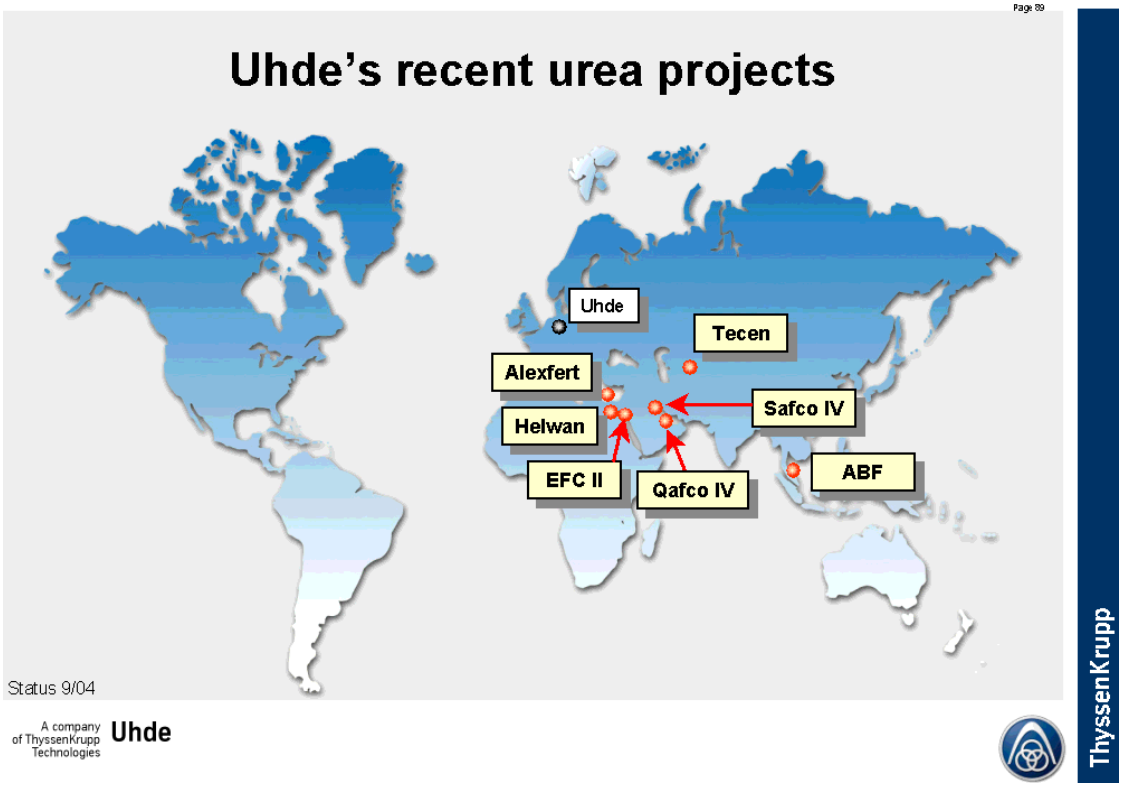

Figure 1: Recent fertiliser projects

During the last two years Uhde was awarded a couple of world scale urea and ammonia plants. All the following projects, presented in this paper, are actually under construction and have their own unique, distinctive characteristic:

Project	**Current Status**
Qafco IV, Qatar	Start-up ongoing
Tecen, Turkmenistan	Start-up Autumn 2004
Safco IV, Saudi Arabia	Detail-Engineering
Alexfert EFC II and Helwan, Egypt	Detail Engineering
Revamp ABF, Malaysia	Start-up Summer 2004

This paper will focus on the special features used in these projects and will discuss the innovative advantages in modern, high capacity urea plants.

2. Qafco IV

Qafco IV is the first large Stamicarbon urea plant of the new generation of 3200 tpd. The start up of this complex is actually in progress.

The plant comprises besides the urea plant a 2000 tpd ammonia plant and a 160000 t urea granules storage with reclaimer and a complete material handling system for 1000 tph urea granules with a berth extension and a urea formaldehyde plant.

Concerning the special features of this plant, the use of a new system of high pressure centrifugal pumps needs to be mentioned.

As the plant capacities are increasing continuously the traditional arrangements of reciprocating pumps for high pressure ammonia and carbamate service in the urea plant reach their limits. For plant capacities of more than 2300 tpd one reciprocating pump plus a stand by arrangement is not possible anymore and a triple times 50% arrangement has to be chosen. This leads to a significant increase in investment costs, thus it is logically consistent to look for alternatives.

Available high capacity pump systems are centrifugal pumps from EBARA and SUNDYNE. We experienced that the mechanical seals of the SUNDYNE pumps are rather sensitive due to the high speed of 13000 rpm or more. Furthermore the pumps allow an introduction of water into the process of about 1 m^3/h, which of course has a negative effect on the performance of the synthesis.

EBARA itself has a restricted sales policy and the pumps were not always available for all projects. Therefore Uhde was faced with the problem to find another solution to be more independent and to not rely on just one supplier.

Another reason for Uhde to be inventive in the field of high capacity pumps was the fact that with the next generation of 4500 tpd-urea plants the conventional centrifugal pumps reach their capacity limits. Years ago Uhde had recognised this trend towards bigger plants and with foresighted planning reacted early on this developments.

In 1999 Uhde developed a new pump and sealing system in co-operation with the Italian company IDP which is now merged with FLOWSERVE and the German mechanical seal manufacturer BURGMANN. Substantial research and extensive long-term tests of the sealing system led to new superior high pressure centrifugal barrel type pumps with horizontal split inner casing. The first result was the HP ammonia pump. It has 7 stages and operates at a low speed with 5440 rpm. The ammonia pump has a tandem dry gas seal flushed by Nitrogen as barrier fluid and is equipped with double-volutes. The sealing system has been tested under on-site conditions for 4200 h with outstanding results.

Using this ammonia pump as a model the 12-stages carbamate pump was developed. It is a heatable barrel type heavy duty carbamate pump, also using double-volutes around the inner transfer of liquid with back to back arrangement for axial thrust balance.

Due to the number of stages the pump needs no gear box and is operated with 2970 rpm. Remarkable and inventive are the double mechanical seals with condensate as barrier fluid. The new sealing system alleviates one of the most critical parts of the carbamate pump. The amount of condensate introduced into the process is less than a thousandth of the former pump types: approximately 1 l/h. The sealing system of the carbamate pump has been tested under operating conditions in a urea plant for 5400 hours. The results were excellent and no wear occurred.

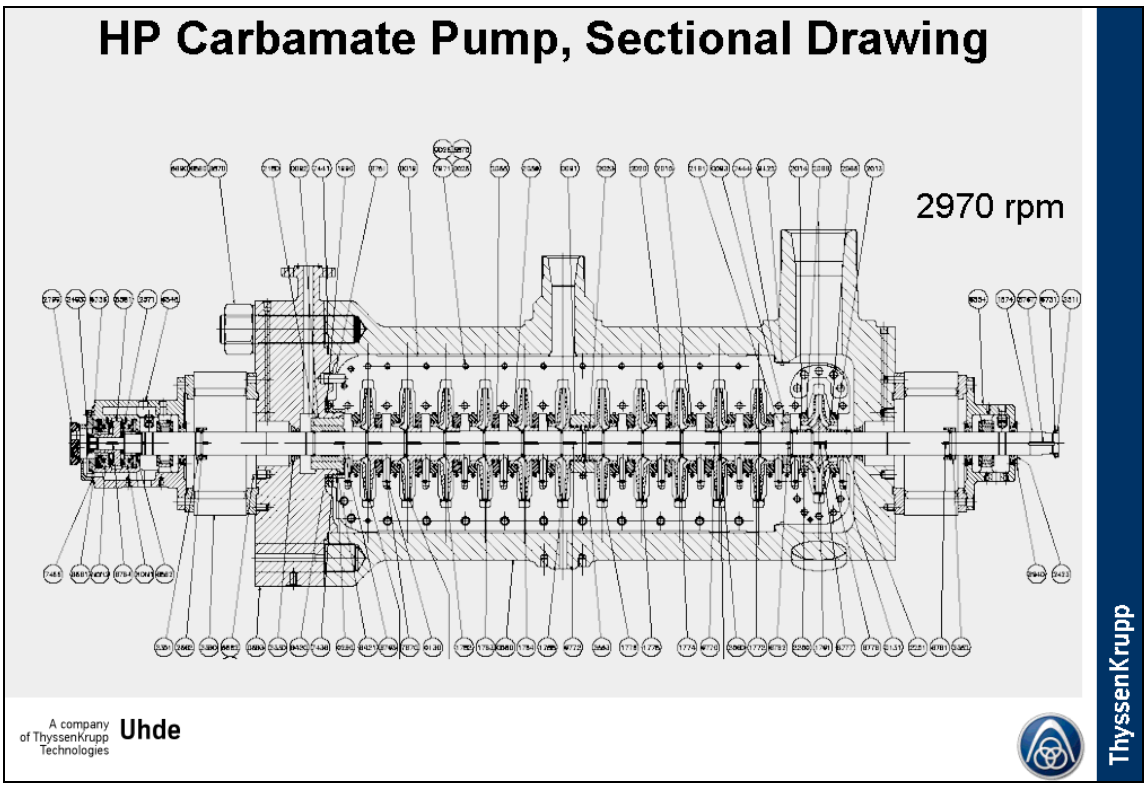

Figure 2: Sectional drawing of the HP carbamate pump

This sectional drawing shows the HP carbamate pump. Both pumps, the carbamate and the ammonia pump, are very similar, but with differences in the number of stages, in the sealing system and used materials.

For the synthesis the state-of-the-art pool condenser technology has been selected to guarantee the high urea production capacity while keeping the reactor in a size feasible to be produced, shipped and erected. It is the biggest pool condenser installed so far. The use of the pool condenser leads to an decreasing reactor volume. Combined with high efficiency trays in the reactor, the reactor volume of a 3200 tpd urea synthesis is smaller than the reactor volume of a conventionally used synthesis of 2000 tpd.

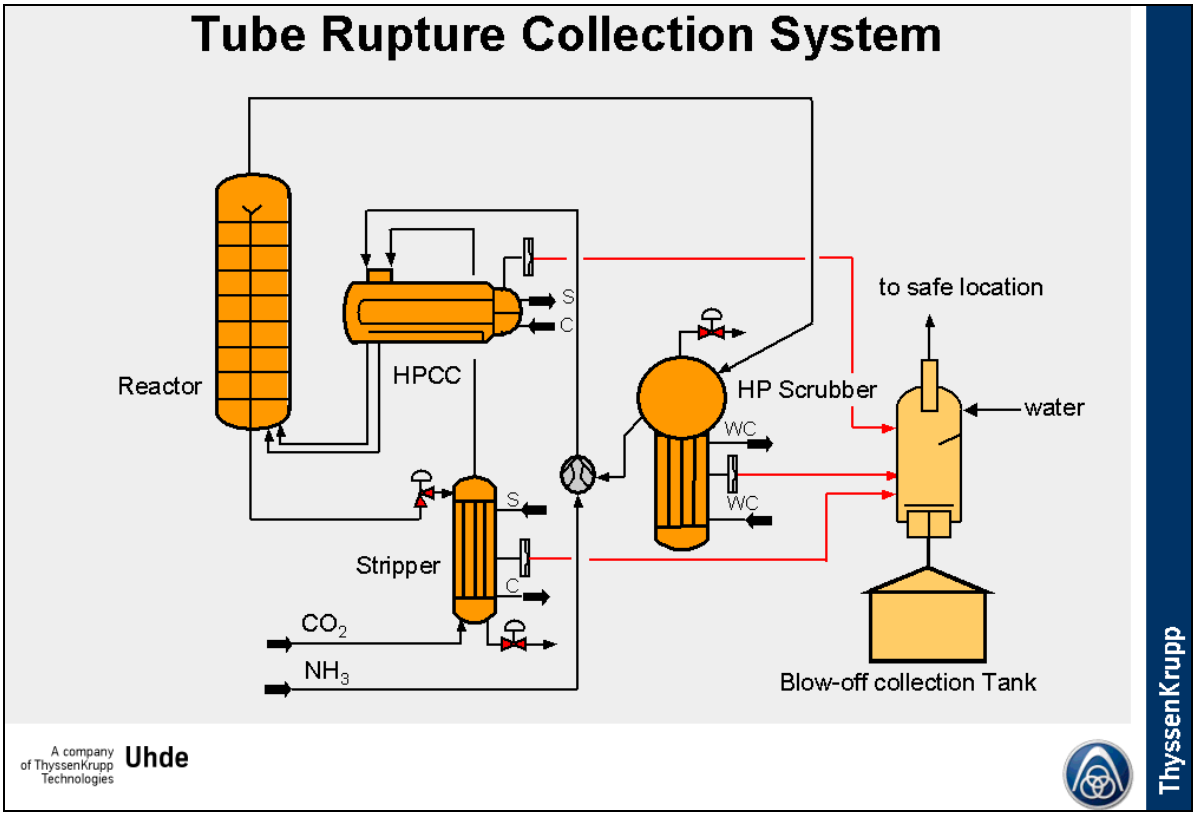

Figure 3: Tube rupture collection system of Qafco IV

One more feature becoming more and more important during the last years is the question of how to control emergency situations in a urea plant. The safety system of the Qafco IV-plant focuses on the very rare case of a rupture disc breakthrough caused by a tube rupture in the synthesis section and the related blow-off of ammonia containing fluids.

In case of a rupture disc breakthrough gases and liquids are routed via a header into a separator. Separated gases are directed via a dedicated stack to atmosphere, while liquids are collected in a tank. For the collected liquid it has to be decided, where it can be directed; either back into the urea plant for recovery or to be discharged.

3. Tecen

Not only large complexes, also small plants request the full competence of a contractor. One actual example for this is the plant Tecen in Turkmenistan which consists of a urea plant with a capacity of 1050 tpd urea granules and the corresponding ammonia plant of 600 tpd including all required offsites and utilities for the state concern Turkmendokunhimiya.

The reason for such a small plant capacity is attributed to the fact, that the production should satisfy just the local markets. For this small capacity a pool reactor is the optimal synthesis concept. Uhde is just the right partner for this purpose because 7 years ago Uhde engineered the first pool reactor plant for Stamicarbon's parent company DSM, which operates to complete satisfaction of the owner.

Figure 4: Shipment routes of the Tecen plant equipment

The real challenge of this project was the remote location. For the transport of the equipment from Europe to Turkmenistan, there are 2 possible routes, both using the Volga-Don-Canal. But due to possible freezing the shipping period is limited to the time between early May to late September. During the rest of the year the canal is closed.

The northern route starts in Antwerp and continues via the North Sea and the Kiel-canal or alternatively via Skagerrak into the Baltic Sea. From there via St. Petersburg throughout Russia into the Caspian Sea. It took nearly 5 weeks to cover the distance of about 7100 km. Heavy loads or oversized dimension goods, like the poolreactor, the stripper and the granulator bottom part, were shipped via this route to the harbour of Turkmenbashi. Other equipment, like the ammonia converter, was shipped from Italy via the southern route which starts in the Mediterranean sea crosses the Black sea and the Volga and ends again via the Volga-Don-Canal in the Caspian Sea.

From Turkmenbashi at the east coast of the Caspian Sea it took about 800 km over land shipping to Tecen, the site of the plant. This way to the interior of Turkmenistan brought up new challenges because of bad road conditions and bridges with rather limited load capacity. Due to these rather poor transportation facilities, the pool-reactor had to be delivered in two pieces. One containing the heat exchanger and the steam collecting chamber with the outer shell as long as the heat exchanger part. The other piece contains the shell of the reactor case. Both parts were combined and welded on site.

Figure 5: Tecen pool reactor in two pieces before welding

4. Safco IV

Saudi Arabian Fertilizer Company (SAFCO) located in Al-Jubail industrial city, in the eastern province of Saudi Arabia has awarded a contract to Uhde for the construction of an ammonia/urea plant on lumpsum turnkey basis (LSTK). The new complex will be the fourth ammonia/urea plant for SAFCO and shall be located adjacent to the existing production facilities of SAFCO III, but will be the first one to be built by Uhde.

SAFCO IV is the project of superlatives:

There is no bigger urea synthesis in the world (3250 tpd), the urea granulation (3600 tpd) is the biggest fluidisation granulation plant in the world in one stream and the Uhde ammonia plant is by far the biggest in the world (3300 tpd) in one line.

Furthermore the special features of the Safco IV-plant are:

Safurex® as material for the entire synthesis equipment and piping as a novelty in this field:

This is the first urea synthesis in the world which is manufactured in Safurex®. SAFCO and Uhde investigated very carefully this new material with respect to reference, availability, welding procedure, price impact, etc. and came to the conclusion that the time is ready to go for Safurex®. This material has a couple of significant advantages:

- It is more corrosion resistant than any other conventional material used up to now and consequently the life time of the plant will increase.
- The use of Safurex® leads to smaller wall thickness than using conventional material, consequentially the weight for transportation, construction and erection is decreasing.
- Another important consequence which is based on the excellent corrosion-resistance of Safurex®, is the reduction of the oxygen demand for passivation air in the synthesis. As a result of the lower amount of inerts in the synthesis the capacity can be increased and the effluents reduced.

Since this is the first plant manufactured in Safurex® the plant is designed with respect to passivation air in the conventional way, that means including passivation air facilities and including hp scrubber. After start up the passivation air will be reduced gradually and the advantage with respect to increased capacity and less effluents can be gained.

5. Alexfert, EFC II and Helwan

During the last year Uhde was awarded the contract for three plants in the same size as already built for Abu Qir Fertilizers and Chemicals Co. (AFC) in Alexandria/Abu Qir and Egyptian Fertilizer Company (EFC) in Ain Sukhna a few years ago (1200 tpd ammonia, 1925 tpd urea granules). With the Alexfert complex at Abu Qir and the EFC II complex at Ain Sukhna a long tradition of valuable and successful co-operation is continued, they are the fourth plant built by Uhde in Abu Qir, and the 2nd plant in Ain Sukhna for EFC. The first plant of EFC has already been a blueprint copy (duplicate) plant of AFC III in Abu Qir, with the exception of the desorber section. Both customers AFC and EFC are satisfied with their plants so much, that they and the new company Alexfert decided to have a blueprint plant again.
The third plant is ordered by the Helwan Fertilizer Company (HFC), Cairo and is also nearly identical with the other Egypt fertiliser projects. Our new customer trust the knowledge of Uhde and the positive experiences of our other Egyptian clients.

Apart from the granulation, the three new complexes are exact copies of the well proven process of AFC III / EFC I. Naturally designing blueprint plants and utilising the same vendors - where possible - results in a lot of advantages:

- Less investment cost: Because engineering and management effort can be drastically reduced.

- Proven design: Normally each plant has a tailor made design and a unique selection of vendors, which inevitably bear a certain risk of unexpected issues during start-up and/or later operation. Even though Uhde as an experienced urea plant contractor together with Stamicarbon can keep those risks on a very low and acceptable level, the remaining small risk can be further reduced by a blueprint plant.

- Shorter construction period: Because the equipment is already specified and can be ordered immediately. This is a very important point especially in consideration of long delivery items!

- Easier & better Training: The operators for the new plant can be trained in an existing plant which is identical to the new one. This is the best training they can get and it is nearly free of charge.

- Better operation staff & know-how: The operators are already long-term experienced in operating such a plant. This is a big benefit because no learning process is required, the full capacity can be gained earlier and the reliability and safety of the operation is enhanced.

- Better maintenance staff & know-how: Furthermore the maintenance staff is already familiar with such a type of plant and the spare parts belonging thereto. These facts lead to a reduction in maintenance time & cost and to an improvement of the plant reliability.

- Flexible operator staff management: The operating and maintenance staff of the plants can be exchanged. The result will be a higher flexibility in staff management.

- Spare parts pool: The spare part storage can be used for both plants, the old one and the new.

If at the same time 2 or more identical plants are designed and constructed together there are even more advantages. The engineering time and delivery periods for the second and third plant are significantly reduced. The contractor can order the same equipment 2, 3 or more times at the same vendor and thus achieve a price reduction due to higher efficiency of the manufacturer. These are of course savings of the customer!

Finally it has to be mentioned that a 100% blueprint is only possible if all conditions, like raw material, utilities and product specifications, climate and environmental conditions, codes, standards and regulations as well as the vendors are or can be chosen identical. Any deviation in those conditions weakens the blueprint concept and requires more or less adjustment. Furthermore the positive effect of copying existing plants will be reduced as time is passing by since the original plant was engineered and built, because many vendors provide a discounted price for a duplicate item only for a few months. Furthermore, engineering tools, codes, standards and regulations are often changing faster, than wanted.

As already mentioned before the granulation technology has been chosen different for the new plants compared to the previous plants AFC III / EFC I. This main deviation from the blueprint concept needs further explanation:

Because the original granulation technology of Hydro Fertilizer Technologies (HFT), Belgium (now Yara), was not available at the time of bidding and contract signature, Uhde and the customers jointly selected the Stamicarbon granulation licence for the three plants. For the first time the Stamicarbon granulation is built in a new plant. This leads to the advantage, that the entire urea-technology package is granted by Stamicarbon and there are no interfaces between the synthesis and the granulation sections.

After thorough investigation Uhde is convinced that the Stamicarbon granulation technology is competitive in investment and performance and as reliable as the HFT granulation and the right choice for these plants.

6. ABF, 2nd revamp

Last but not least Uhde is also busy in the field of revamping urea plants. Such a revamp is always a challenge. The ABF plant in Malaysia was originally started in 1985 and was the first and last combination of a Stamicarbon crystallisation with a granulation plant. The original urea plant capacity was 1500 tpd and was revamped the first time up to 1804 tpd.

The purpose of this new revamp is to increase again the capacity and to replace the crystallization unit by an evaporation unit. The task was to increase the capacity to 2250 tpd, which means an increase of 50% above the original capacity. This will be realized mainly by refurbishing the reactor with high efficiency trays and replacing the original stripper by a Safurex® one. These changes will result in an increasing heat exchange area while the outer diameter will remain constant. The original HPCC will be replaced by a bigger one
made of Safurex®.

The crystallisation will be replaced by an evaporation for better operability, maintainability and savings in operational cost. The product specification for the biuret content will remain unchanged with the new evaporation unit.

7. Summary

Compared with former urea plants many innovative features are now coming into operation. Starting with new materials like Safurex®, followed by improved equipment like the new high pressure ammonia and carbamate pumps and up to new processes like the Stamicarbon granulation, progressive technologies are used.

In general a strong trend towards higher capacities can currently be noticed. But also well proven and conservative technologies are popular.

Uhde's philosophy is to flexibly respond to a wide variety of different wishes and needs of our customers and to manage tailor-made design as well as blueprint plants and revamps. The great experience in designing and constructing urea plants based on Stamicarbon technology and our strong commitment to quality, reliability and safety is to the benefit of our customers.