THE SNAMPROGETTI UREA TECHNOLOGY

Contents

Process Description

The Snamprogetti urea process is known worldwide.
The process is divided into six sections:

- Synthesis and high pressure (HP) recovery
- Medium pressure (MP) purification and recovery
- Low pressure (LP) purification and recovery
- Vacuum concentration
- Process condensate treatment
- Finishing: prilling

SYNTHESIS AND HIGH PRESSURE (HP) RECOVERY

In addition to the HP machinery required to feed ammonia and carbon dioxide and to recycle ammonium carbamate solution, this section includes: the **reactor** where urea is formed; the **stripper** necessary to strip out as vapours, from the urea solution leaving the reactor, a large amount of ammonia and carbon dioxide not converted to urea in the reactor; the **carbamate condenser** that condenses these vapours; the **ejector** that recycles the ammonium carbamate solution to the reactor. In this equipment the pressures are of a similar level, 150 bar, while the temperatures of the outlet solutions are 188, 205 and 155°C for the reactor, the stripper and the carbamate condenser, respectively.

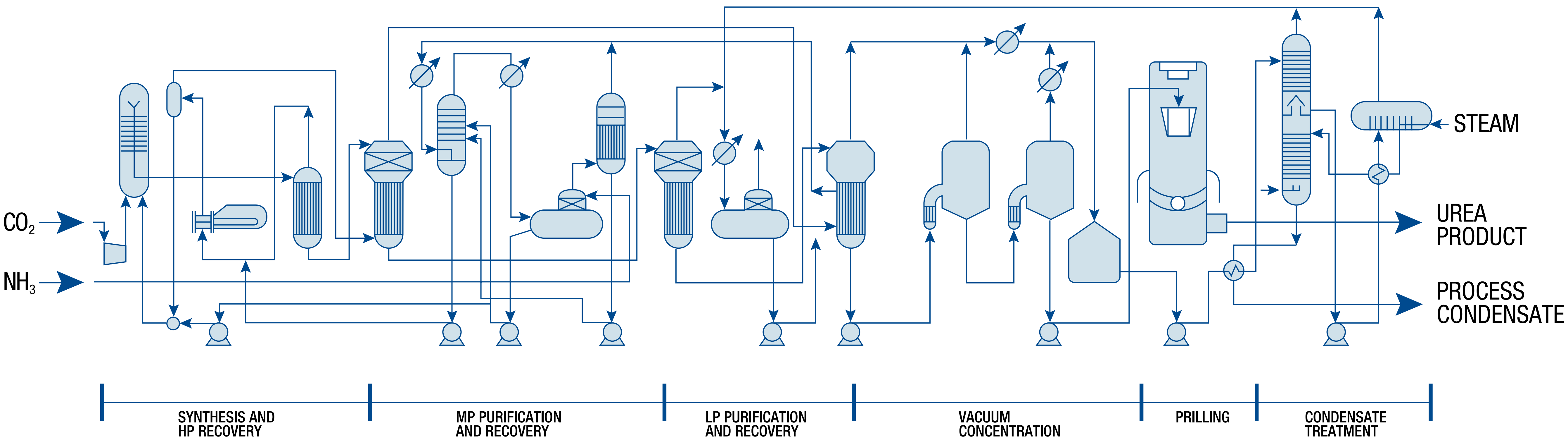
In the Snamprogetti technology, the urea reactor is characterised by a high ammonia-carbon dioxide ratio (NH_3/CO_2 = 3.2 - 3.4 molar) and a low watercarbon dioxide ratio (0.4 - 0.6 molar). Inside the reactor a matching number of trays of a very simple design are installed to improve the conversion. Under these conditions **62÷64%** (conversion) of the total CO_2 entering the reactor is converted to urea. The total carbon dioxide conversion in the HP section (or loop) is 85-90%. All the equipment in this section, the heaviest of the urea plant, is installed at ground level, thus providing a **horizontal layout** with all the relevant benefits.

The stripper and the hydrolyzer in the waste water section are the only two items of equipment in the plant that consume medium pressure steam. The amount of steam consumed in the stripper is practically completely recovered in the carbamate condenser: its pressure is lower but still sufficient to be used in the urea plant itself. Even under severe conditions, all the equipment in this section has a safe life of more than **20 years**. The quantity of oxygen introduced into the plant as air is **0.25%** vol of the fresh feeding carbon dioxide. This minimum amount guarantees, at the same time, **excellent equipment passivation and the absence of explosive mixtures** where the "inerts" are released from the plant into the atmosphere after practically all the ammonia contained therein has been washed.

Thanks to the proper choice of the materials in contact with the process fluids and to the presence of excess ammonia, it is possible, during unscheduled shutdowns lasting only a few days, to bottle-in the high pressure synthesis loop by operating a few valves, thus keeping all the process solutions inside the loop. In this way obvious pollution and start-up problems are completely averted.

All kinds of machinery (reciprocating and centrifugal) is utilised according to local conditions or client requests.

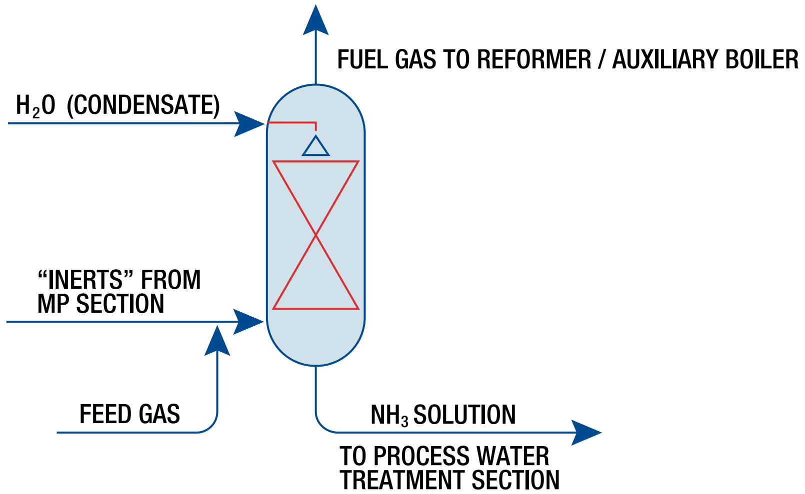
Process Flow Sheet



MEDIUM PRESSURE (MP) PURIFICATION AND RECOVERY

The purpose of this section is to partially strip out the reactants, ammonia and carbon dioxide from the urea solution and, after their condensation in water, to recycle the obtained solution to the reactor, together with the ammonia and carbon dioxide aqueous solution resulting from the downstream sections of the plant.
The ammonia excess is separated in this section and recycled to the reactor separately. A distillation column is provided for this purpose. The operating pressure is 17 bar g. A particular feature is included in this section. Ammonia and carbon dioxide are partially condensed in the shell of a preheater within the vacuum section, thus recovering some energy in the form of **200 kg of steam per ton of urea,** with an investment cost that, even in existing plants, has a pay-back time of less than two years. Another particular characteristic of the MP section is the washing of the so-called inerts (CO, H_2 and CH_4 contained mainly in the carbon dioxide and the passivation air). As already emphasised, the quantity of passivation air in the Snamprogetti technology is very small (one third compared with other technologies). It is therefore easy to recover ammonia from the inerts without the risk of explosion mainly due to H_2/O_2 mixtures. **No hydrogen removal** from carbon dioxide is required. Upon special requests, different washing systems have been designed by Snamprogetti and have already been installed in industrial plants. For the complete abatement of the ammonia contained in the inerts, in **completely safe** conditions with regard to explosions, Snamprogetti has patented a washing method that has already been applied in some plants. This consists of washing the inerts with water after the addition of a quantity of flammable gas, as for example natural gas, in such an amount that after the ammonia has been eliminated, the composition of the inerts is out of the explosive field due to the excess of flammable gas. The washed inerts are sent to a burner together with the natural gas.
It should be emphasised that the presence of the MP section provides **great plant flexibility,** which can be operated over a wide range of NH_3/CO_2 ratios, with excess ammonia present in the urea stream from the stripper being recovered and condensed by the MP section. Furthermore, although in principle the control of the NH_3/CO_2 ratio in the synthesis loop is important, in practice, owing to the presence of the MP section, some fluctuations are acceptable and there is no need for strict control of the NH_3/CO_2 ratio in the Snamprogetti process.

Safe Ammonia Washing from "Inerts"



LOW PRESSURE (LP) PURIFICATION AND RECOVERY

Further stripping of ammonia and carbon dioxide is made in the LP section, operating at 3.5 bar g. The vapours, containing ammonia and carbon dioxide, are condensed and recycled to the reactor via the MP section. An appropriately sized tank is provided in this section to collect all the solutions from the plant when it is shut down for long time. Therefore, **in no circumstances are solutions discharged from the plant.**

VACUUM CONCENTRATION

The urea solution leaving the LP section is about 70% b.w. and contains small quantities of ammonia and carbon dioxide. The final concentration of the urea solution (99.8% b.w.) is made under vacuum in two steps at 0.3 and 0.03 bar abs. for the prilled product, and in one or two steps for the granular product, according to the granulation technology chosen.
An important feature of this section is the preconcentration of the urea solution to about 86% b.w.
The necessary heat is provided by partial condensation of the vapours (ammonia and carbon dioxide essentially) from the MP section evaporator. Particular care is taken by Snamprogetti in the design of this section to minimise temperatures and residence times so as to keep the biuret at minimum values.
A simple solution has been found to the problem of lump formation in the second vacuum separator: **lump formation** is prevented by wetting the internal walls of the separator by means of a small recycle of molten urea.

PROCESS CONDENSATE TREATMENT

The excellent result achieved by Snamprogetti in the treatment of waste water from urea plants has received worldwide recognition.
Snamprogetti's success in discharging the large amount of process water with **1 ppm of urea and 1 ppm of ammonia** shows it is possible to **reduce pollution while obtaining urea at a lower cost** (lower specific consumption of ammonia and reutilization of process water as BFW). All possible and convenient heat recoveries have been introduced into this section in order to minimise energy consumption.

FINISHING: PRILLING

Prilling is the easiest technology to manufacture solid urea with commercially valid chemical and physical characteristics. Molten urea (99.8% b.w.) is sprayed at the top of the prilling tower, at a height of 55-80 m, according to climatic conditions; at the bottom, essentially spheroidal urea particles, namely **prills,** are collected and sufficiently cooled in order to be sent to storage or directly to the bagging section without screening, coating or any other treatment. In a few plants based on the Snamprogetti technology, plant owners have requested that formaldehyde (0.2-0.3% b.w.) be added to the molten urea just before the prilling section in order to improve the free-flowing characteristics of the prilled urea and to achieve a slight increase in hardness. A rising draught of air inside the prilling tower is the cooling medium that removes the solidification heat and cools the prills.
The prilling process, although it is a simple one, conceals some critical problems:

- the bucket must be specially designed to limit the quantity of fine and oversize prills to a negligible value. In fact, the Gauss distribution curve must be as narrow as possible to avoid severe caking problems in storage;
- too much air can cool the product excessively resulting in undesirable absorption of humidity from the air in humid climates, again with possible serious product caking problems in storage;
- too much air can entrain too much urea dust at the top of the prilling tower.

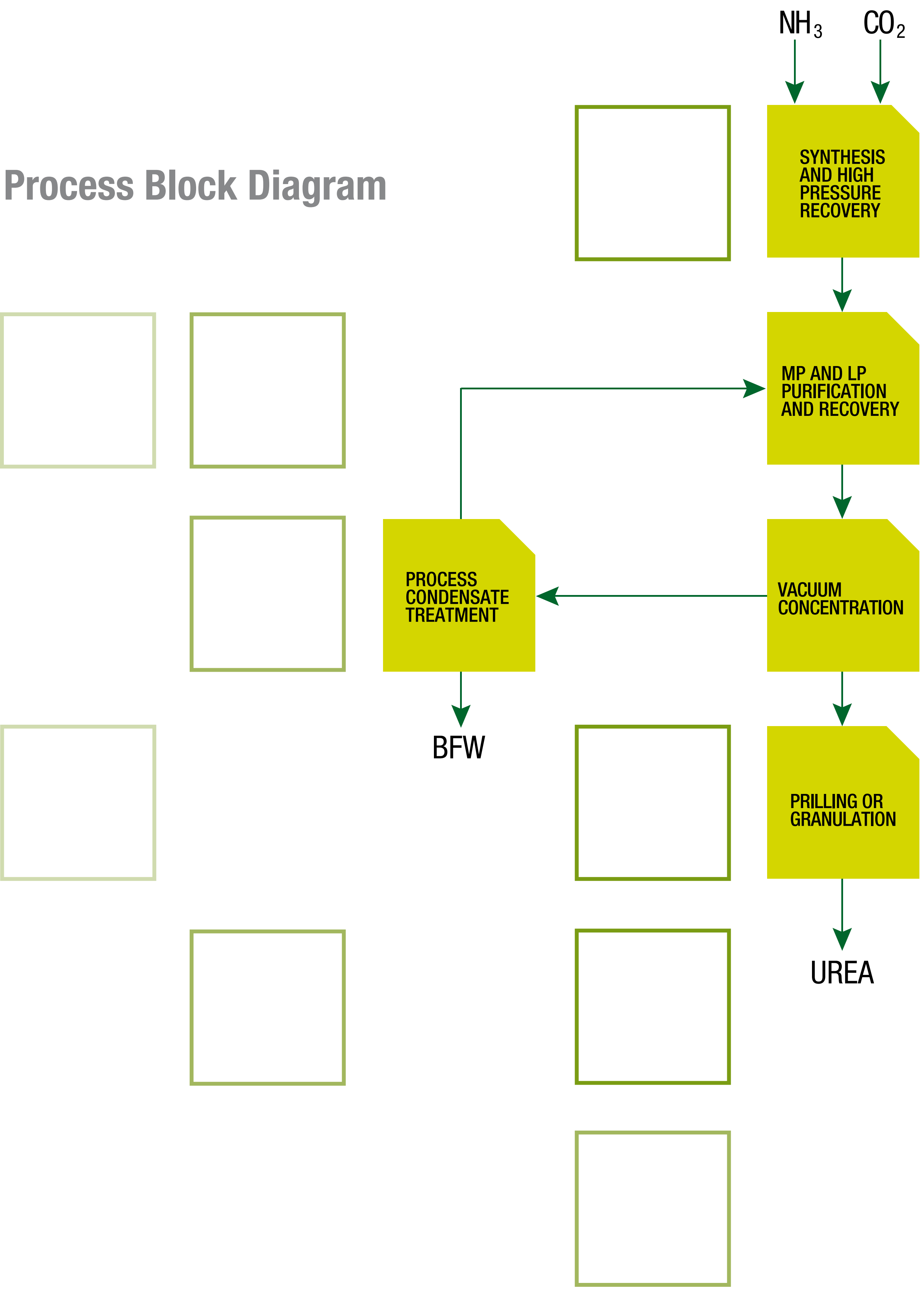
This last problem constitutes an increase in consumption of specific raw materials, which not only means plant inefficiency, but principally represents a **serious pollution problem.** With regard to urea dust, Snamprogetti has its patented dedusting system, already applied in some plants, which is able to reduce urea dust from 40 to 15 mg/Nm^3 of air. In the case of ammonia, the problem is not so easily solved due to the extremely low partial pressure of ammonia in the air from the prilling tower. As for the abatement of ammonia, the only possible method is to wash the air with slightly acidified water. Unfortunately, due to the large quantity of air, such a system has a rather high investment cost as well as a considerable operating cost. Snamprogetti has patented and applied a very simple solution in one plant that consists of **the addition of an inorganic acid** to the urea melt, just before the prilling tower, in order to drastically reduce the quantity of ammonia in the air from the prilling tower. The values obtained are 20-70 mg/Nm^3. An interesting side-result of this method is that the quantity of free ammonia in the prills is greatly reduced and there is a drastic reduction in the presence of ammonia in the work environment (conveyor belt chutes, storage). Of course the prilled urea contains about 2,000 ppm of relevant salt, with no detrimental effect on the use of urea as a fertiliser and other industrial uses.

Technological Advantages

All industrial urea production plants are based on direct synthesis between ammonia and carbon dioxide according to the following exothermic reaction:

$$2\,NH_3 + CO_2 = \underset{\displaystyle NH_2}{\overset{\displaystyle NH_2}{\overset{|}{\underset{|}{CO}}}} + H_2O$$

Process Block Diagram



The Snamprogetti process leads to a urea solution of about 70% b.w., which is followed by a finishing step in order to obtain the solid product, either prilled or granular.
Although simple, the reaction has several complex aspects:

- The reaction is governed by an equilibrium requiring the removal and recycle of the reactants not transformed into urea.
- The temperatures and pressures are rather high.
- The solutions are very corrosive.
- The physical and chemical characteristics of the solid urea are critical.
- A urea plant can be a source of air and water pollution.

Snamprogetti has completely solved all the above problems by providing high quality solutions that are the strong points of its technology, i.e.:

- **High process efficiency (low raw material consumption, low energy requirement).**
- **Sustainable environmental pollution.**
- **High quality product.**
- **Process condensate recovery as BFW.**
- **The stripper.**
- **High reliability (easy and safe operation, low corrosion, high on stream factor).**
- **Easy maintenance - Horizontal layout - Ejector.**
- **First-rate client assistance.**
- **Intensive R&D support - Mathematical modelling.**

The first industrial urea plant based on Snamprogetti's NH_3 stripping technology was put into operation in 1971. Since then more than 100 urea plants based on this technology have been in operation or are currently being implemented. There has been a steady increase in the demand for urea over the last few decades. Snamprogetti has responded by designing urea plants with increasingly higher capacities. For the first time in 1998, a plant was designed with a capacity greater than 3,000 t/d. The Profertil plant in Argentina designed by Snamprogetti has a **single line design capacity of 3,250 t/d**. The plant was started up in 2001 **and has demonstrated a yearly average capacity of 3,600 t/d, reaching a record production of almost 1.2 million tons of urea per year.**
On the basis of this experience, Snamprogetti has already started designing a new generation of large-scale **single line** plants that will cross the threshold of **5,000 t/d**. Performance meets the most stringent requirements for energy conservation and environmental control. The unique features of the Snamprogetti technology are the result of continuous and intensive R&D work with feedback from plants operated by its licensees and tests made on the same plants, regarding the process itself, construction materials and the size of equipment and machinery. Snamprogetti makes its urea technology available worldwide to all sectors of the industry (soil and leaf fertilisers, cattle feed, resin manufacturing, etc.) by:

- Licensing directly or through selected contractors.
- Performing plant engineering and construction entirely within its organisation, from basic design to turnkey jobs.

Snamprogetti urea technology can be used for plants of any capacity, in addition to revamping existing plants.

HIGH PROCESS EFFICIENCY

The process is extremely efficient as regards both raw material consumption and energy requirements. Almost the entire quantity of raw materials, namely ammonia and carbon dioxide, is transformed into urea.
This means **low consumption of raw materials,** as close as possible to the theoretical value and, at the same time, **sustainable environmental pollution** (more than 99.8% of the ammonia is transformed into urea).
The high NH_3/CO_2 ratio in the reactor ensures a high conversion of ammonium carbamate, an intermediate compound in the reaction, to urea (up to 64%). This result, together with the highly efficient ammonia-stripping operation, drastically reduces the recycle of unconverted carbamate and the size of equipment in carbamate decomposition and recovery sections. Some important heat recoveries have been introduced, with a pay-back time of less than two years. High conversion, high stripping efficiency and heat recoveries minimise **the energy requirement**, i.e. steam, electric power and cooling water consumption.

SUSTAINABLE ENVIRONMENTAL POLLUTION

Over the last decade, pollution control has become a basic parameter in the design of new urea plants and in the management of existing plants. In both cases it is necessary to comply with antipollution regulations in order to obtain permits required for building new plants and operating existing ones.
Snamprogetti has anticipated the increasingly restrictive antipollution regulations with excellent patented and tried solutions that reduce pollution to sustainable values. The values of pollutants are shown in table 1. Here are a few remarks we feel are worth making:

- a particular feature of the Snamprogetti technology reduces to nearly zero the quantity of ammonia in the plant vents where the so-called inerts are discharged into the atmosphere. This result is also facilitated by the fact that the quantity of passivation air introduced into the plant is very low compared with other technologies;
- the proprietary design of the natural-draught prilling tower guarantees urea dust emission lower than **40 mg/Nm³ in air without a provisional dedusting system**;
- process water discharged from the plant with **1 ppm of urea and 1 ppm of ammonia** is an important result in reducing water pollution, considering the huge quantity of process water discharged from urea plants.
  For example, a prilled urea plant with a capacity of 2,000 t/d discharges about 1,100 t/d of process water.

HIGH QUALITY PRODUCT

Urea is mainly produced as a solid product, prilled or granular. The difference in quality between the two solid products is significant: both are round, but the first product **(prills)** has a smaller shape and lower hardness, while the second one **(granules)** has a bigger shape and higher hardness. For both products, Snamprogetti assures excellent free-flowing quality that prevents caking in bulk storage and guarantees easy handling downstream of the production plant. Excess ammonia in the high pressure synthesis loop and the right choice of process conditions minimise biuret formation, an undesirable by-product in urea.

SOURCE OF POLLUTION	UREA CONTENT	NH_3 CONTENT
Process water	1 ppm	1 ppm
From prilling tower	15 mg/Nm³	20 mg/Nm³
From granulation stack	15 mg/Nm³	20 mg/Nm³

Table 1 - Values of pollutants from the plant.

PROCESS CONDENSATE RECOVERY AS BFW

As stated above, process water can be discharged with a content of 1 ppm of urea and 1 ppm of ammonia. Snamprogetti obtained this outstanding result at the beginning of the eighties, as demonstrated by a long list of operating plants achieving this result. This applies not only to nearly all the plants based on the Snamprogetti technology, but also to plants based on third party technology to which the Snamprogetti technology has been applied. With such negligible values of pollutants, three simultaneous targets are reached which contribute to reducing the cost of urea: specific consumption of ammonia is decreased, environmental pollution is also reduced and the possibility of reusing the process water is guaranteed for several technical purposes such as **BFW** for the production of steam at pressures reaching as high as 110 bar.

THE STRIPPER

The stripper is the primary piece of equipment in any urea stripping technology. Its function is the decomposition of carbamate into ammonia and carbon dioxide from the urea solution leaving the reactor. This separation is made at practically the same pressure as in the reactor, in severe and unfavourable conditions: high pressure, high temperature, high corrosiveness of the solution and in the presence of both liquid and vapour phases, which is always a potential source of corrosion. The stripper consists of a vertical tube bundle with the process solution flowing down along the internal walls of the tubes so as to ensure low residence time (to prevent biuret formation) and obtain high heat transfer coefficients. In the Snamprogetti technology, the separation of ammonia and carbon dioxide is made in the presence of ammonia as the stripping agent while the necessary heat is supplied by condensing steam in the shell. In the first industrial plants Snamprogetti used titanium as the tube material. At the end of the eighties titanium was replaced with **bimetallic.** The bimetallic tube consists of two coaxial tubes: an external tube made of 25-22-2 Cr-Ni-Mo and an internal tube made of zirconium. The two tubes are produced separately according to Snamprogetti specifications. They are then assembled and drawn to obtain a proper mechanical bonding.
No welding is required.
New options have been recently developed and implemented for the stripper design:

- **The full Zirconium Stripper**
- **The OMEGABOND® Stripper**

Both of these strippers can withstand more severe conditions (in terms of bottom temperature) allowing long life of equipment, optimisation of plant operating conditions and minimisation of required maintenance. In the full Zirconium Stripper, both lining and tubes are made of zirconium, which has proven to be perfectly resistant to erosion and corrosion. The OMEGABOND® Stripper takes advantage of the long experience from the Titanium Stripper, overcoming its limits due to erosion of full titanium tubes by the use of the OMEGABOND® tubes (developed in collaboration with ATI Wah Chang, USA) obtained by extrusion of titanium (external) and zirconium (internal) billets, forming a metallurgical bond of the two materials.

HIGH RELIABILITY (EASY AND SAFE OPERATION, LOW CORROSION, HIGH ON STREAM FACTOR)

The plant is very easy to operate without any particularly strict control. As a matter of fact, the presence of the Medium Pressure section (17 bar), a buffer for any upsets of the High Pressure synthesis loop, assures greater **flexibility.** The possibility of **blocking-in** the process fluids in the High Pressure synthesis loop (i.e. without discharging them from the plant) during emergency shutdowns greatly simplifies plant restart. Corrosion has been one of the main problems ever since the beginning of the development of industrial urea plants based on the direct reaction between ammonia and carbon dioxide. Excess ammonia, the mild composition of process fluids, and the right choice of construction materials guarantee **low corrosion.** Flexibility, blocking-in, low corrosion and the right choice of machinery and control instrumentation assure a high **on stream factor.** Explosive mixtures have always been a serious problem for urea plants: in some cases, serious explosions have resulted in the loss of human lives and plant damage. Explosive mixtures are due to the simultaneous presence of flammable compounds (CH_4, C_2H_6, H_2), introduced into a urea plant with the raw materials (ammonia and carbon dioxide), the presence of oxygen that enters with passivation air and the NH_3. When all these so-called "inerts" are released from the plant to the atmosphere, their compositions are typical of an explosive mixture. In the Snamprogetti technology, excess ammonia, jointly with the use of a particular material (zirconium) in the stripper, minimises the oxygen (as air) required for passivation, thus avoiding the formation of explosive mixtures. Indeed **no explosion** has ever occurred in plants based on the Snamprogetti technology. Removal of hydrogen by catalytic combustion from the carbon dioxide feedstock is not necessary. Furthermore, no mechanical failures have ever occurred thanks to the particular mechanical solutions and controls required by Snamprogetti during equipment construction. All of these special features account for the Snamprogetti technology being **fully reliable,** which is extremely important for urea plants. The excellent reliability of urea plants based on the Snamprogetti technology is essentially due, not only to the soundness of the process, but also to accurate engineering, improved equipment design and equipment material choice. Solid technology coupled with good maintenance can assure safe operations for up to a year with an on stream factor of over **350 days/year,** on average, including plant shutdowns for scheduled maintenance.

EASY MAINTENANCE - HORIZONTAL LAYOUT

Maintenance has an important impact on the urea plant on stream factor and consequently on the cost of urea.
Urea plants based on the Snamprogetti technology have an annual maintenance cost that is lower than 1.5% of the investment cost. Good maintenance improves the stream factor of the plant and in particular can avert plant shutdowns due to unexpected equipment failure. Preventive maintenance has been introduced with new methods for non-destructive testing of the equipment. This allows equipment condition to be checked during and, in some cases, between scheduled shutdowns, and to forecast the status, particularly the remaining lifetime of equipment, thus making it possible for the most appropriate action to be taken. Of Snamprogetti's urea technology, the most critical items (i.e. High Pressure synthesis loop equipment) are located at ground level thus facilitating inspections and repairs if necessary. The recycle of unreacted NH_3 and CO_2 to the reactor is ensured by **an ejector:** a simple, static and maintenance-free device that has ammonia as its driving fluid. **Horizontal layout** is the key element in Snamprogetti's technology. Besides substantially reducing both investment and maintenance costs, it results in **easier and safer plant operation and maintenance.** In fact, all the heavy equipment (reactor, stripper, carbamate condenser) is installed at ground level, contrary to other technologies where the same equipment is installed high up on the structure (vertical layout).

FIRST-RATE CLIENT ASSISTANCE
Exchanging information with clients to keep the plant in optimum operating conditions and to support Snamprogetti's continuous research and development work is one of the most important aspects of our client assistance programme. Assistance also covers maintenance and equipment inspection. Snamprogetti Urea Users Symposiums are organised periodically (worldwide or limited to certain areas of the world) to further exchange know-how and experience.

INTENSIVE R&D SUPPORT - MATHEMATICAL MODELLING
Leadership in technology is ensured only by continuous efforts in development work. That is why Snamprogetti conducts ongoing research and development tests in plants based on its technology in order to improve the process, equipment design, construction materials, machinery, etc. Close contacts are maintained with all qualified manufacturers for this purpose. This ensures that not only the latest, but also fully proven technology is provided to clients. The investment made by Snamprogetti is of paramount importance for developing a mathematical model to simulate the performance of the High Pressure synthesis loop equipment, i.e. the reactor, stripper and carbamate condenser. Through the solution of differential equations, the model enables the calculation of the material and heat balance of two mono-dimensional streams in a non-equilibrium status, gaseous and liquid, in:

- equi-current bubbled (reactor);
- counter-current falling film (stripper);
- equi-current bubbled, plug, slug, film, mist (carbamate condenser).

The model takes into account the process of mass transfer between the various components, as well as the heat exchange between the different phases, through appropriate transfer coefficients relevant to the fluid-dynamic and geometric conditions. Kinetic aspects related to the formation of urea from carbamate are simulated on the basis of equations available from literature. The thermodynamic model is based on over one hundred experimental data items obtained from literature (Kawasumi, Durish, Inoue), as well as on experimental data derived from dedicated tests performed in the laboratory upon Snamprogetti's request.

PERFORMANCE DATA
Expected product quality, raw materials and utilities consumption, recoveries, referred to 1,000 kg of urea product are given below.

		PRILLING		GRANULATION	
Expected Product Quality					
Nitrogen	% b.w.	46.4		46.3	
Biuret	% b.w.	0.85		0.7	
Moisture	% b.w.	0.3		0.25	
Prill size (average diameter)	mm	2		3.2	
Formaldehyde	% b.w.	-		0.45	
Crushing strength	kg_f	0.8	(on 2 mm)	3.5	(on 3 mm)
Raw Materials and Utilities Consumption		**A**	**B**	**A**	**B**
Ammonia (as 100%)	kg	566	566	563	563
Carbon dioxide (as 100%)	kg	733	733	731	731
HP steam (110 bar g, 510°C)	kg	-	840	-	810
MP steam (23 bar g, 220°C)	kg	620	-	620	-
Cooling water (DELTA T=10°C)(1)	m^3	85	95	85	95
Electric power	kWh	120	23	160 (4)	75 (4)
Recoveries					
LP steam export (3.5 bar g, 147°C)	kg	50	- (5)	150	- (5)
Total condensate export	kg	900	1,100	720	900
Effluents					
• Process condensate					
- Ammonia	ppm b.w.	<1		<1	
- Urea	ppm b.w.	<1		<1	
• Air emission					
- Urea dust	mg/Nm^3	40 (2)		15	
- NH_3	mg/Nm^3	20 (3)		20 (3)	

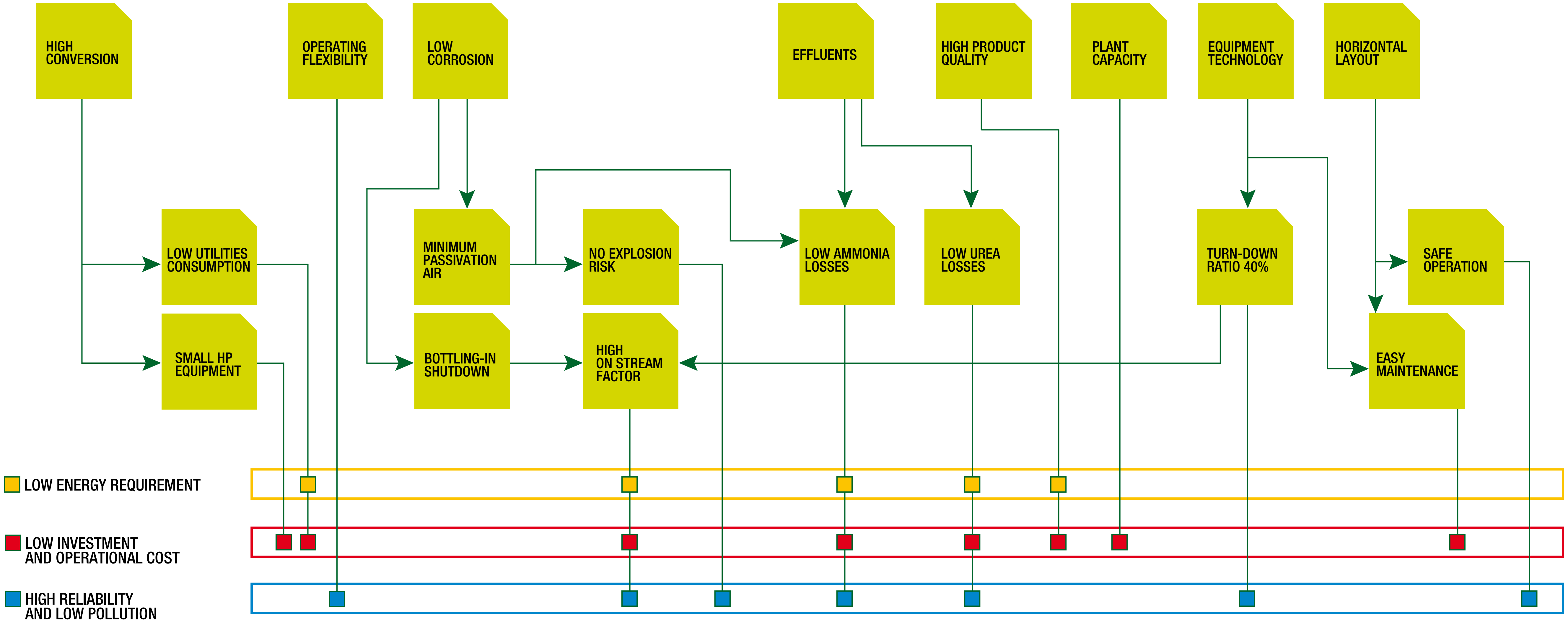
(1) Including c.w. consumption for CO_2 compressor intercoolers and turbine condenser.
(2) 15 mg/Nm^3 with dedusting system.
(3) With acidification.
(4) Climatic local conditions can affect electricity consumption. NH_3 refrigeration system is included.
(5) Injected into steam turbine.

(A) CO_2 compressor driven by electric motor.
(B) CO_2 compressor driven by steam turbine.

Table 2 - Product quality, raw materials and utilities consumption, recoveries.

Make Urea at Lower Cost in a Highly Reliable Plant

When illustrating urea technology, steam consumption (or even sometimes energy consumption) is not infrequently the only parameter taken into consideration. It would be more accurate to talk about the **cost of urea**, which is affected by several parameters (including steam consumption). The diagram below shows all these parameters, i.e. the advantages of the Snamprogetti urea technology and their impact on the cost of the product together with high plant reliability.



Revamping

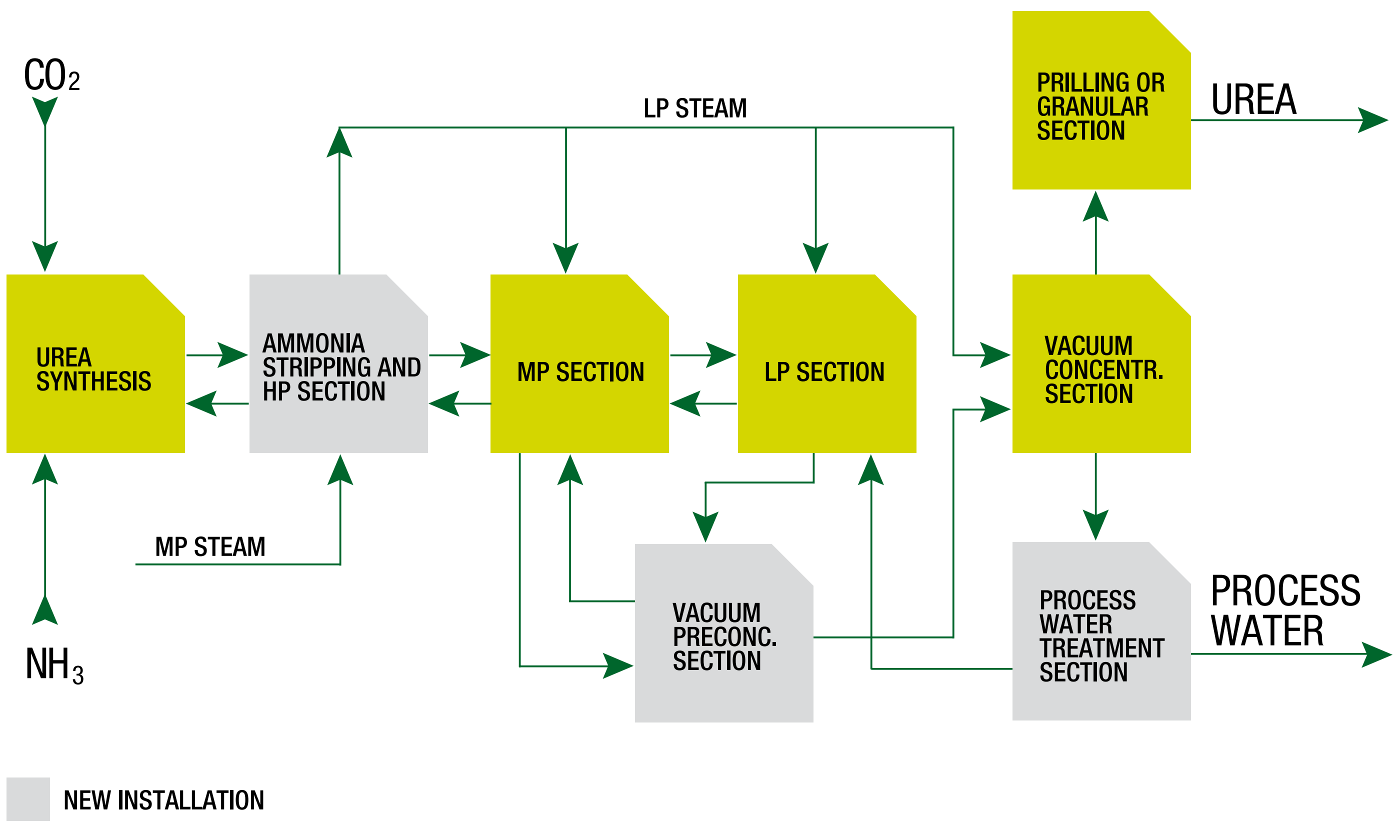
A new urea plant often requires a huge capital investment and the price of urea is usually not sufficient to justify a new unit. In nearly all market situations, manufacturers are considering the revamp of their existing plants.

A revamp ordinarily reduces the cost of the product, does not require an excessive investment and has a shorter payout time than that required for a new plant.
Revamping a plant usually includes one or more of the following changes:

- Increasing production capacity
- Reducing raw materials and utilities consumption
- Reducing pollution
- Reducing maintenance costs
- Increasing the on stream factor
- Reducing labour
- Improving product quality.

Some of these changes can be in mutual conflict: improvement of one element can entail deterioration of another.
The Snamprogetti ammonia stripping technology appears to be particularly suitable when stripping and conventional total recycle plants are to be revamped.
An increased production capacity of at least 20-30% over the design capacity of the plant can be regarded as a standard goal to achieve through unit revamping, and in particularly favourable machinery conditions, the capacity increase can easily be much higher than the above-mentioned value: even a 50% increase in capacity has been obtained together with lower utilities consumption and reduced pollution. The status of existing conventional total recycle plants is particularly favourable for reducing steam consumption. To strongly reduce steam consumption in these examples, it is sufficient to introduce the typical step of the Snamprogetti HP stripping and recovery section. In fact, the steam consumed in the added stripper is almost entirely recovered in the added carbamate condenser, at a lower pressure, yet sufficient for use in the existing downstream sections of the plant. For example, steam consumption can be reduced from 1,300 kg down to 700 kg per ton of urea. These results cannot be generalised because **each revamp should be reviewed on a case-by-case basis.**

Revamped Conventional Total Recycle Plant

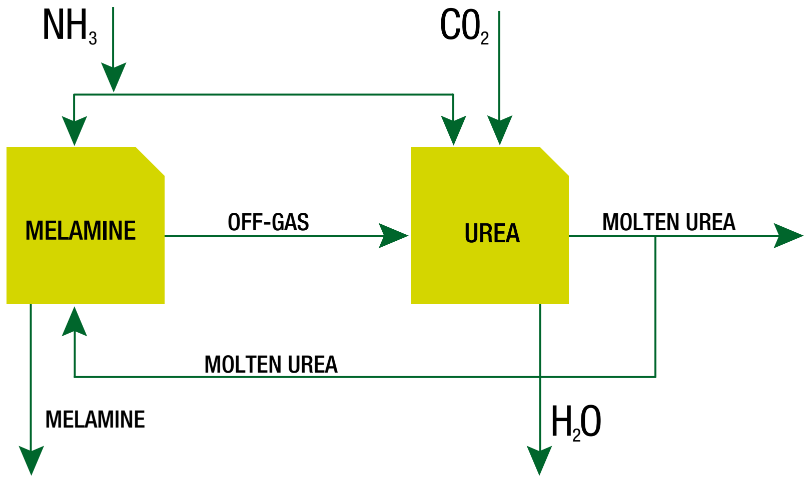


Integration with Melamine Plant

Ammonia and urea are the raw materials used to produce melamine with melamine plants having an output of melamine and vapours **(off-gas)** containing ammonia, carbon dioxide and water.

The composition and pressure of these vapours vary depending on the melamine process. Ammonia must be recovered from these vapours either through a selective process or by sending the vapours to a neutralisation plant with the consequent production of an ammonium salt. Another way to recover ammonia and carbon dioxide simultaneously from the off-gas is to make urea from them, and then to recycle this urea as molten urea to the melamine plant.
In this case the urea plant can be regarded as a **recycle unit** of the melamine plant: if the ammonia content in the off-gas is higher than the stoichiometric one, then the urea production unit will also release ammonia, which can be recycled to the melamine plant. A further hypothesis may be contemplated with a urea plant that produces urea, not only from off-gas, but also from fresh ammonia and carbon dioxide. In this case, urea is ready to be partially disposed of and partially recycled to the melamine plant. The Snamprogetti urea technology can be applied in all of the situations outlined above. One particularly interesting scenario entails excess ammonia in the off-gas. This excess is released by the MP section of the urea plant. Depending on the melamine technology used, the off-gases may be released at different pressures: low, medium and high at about 3, 20 and 150 bar g, respectively. They may be condensed in
the LP, MP or HP section of the Snamprogetti process, in a condenser in parallel to the existing one or directly in the existing one. This possibility is particularly interesting when the off-gas is at 150 bar g and contains a small amount of water; it can be condensed at such pressures with the small amount of water favouring conversion in the urea reactor. In the intermediate case (for example 80 bar g), the off-gas can be condensed and then pumped as a solution into Snamprogetti's HP section.

Melamine and Urea Plants Integration



Licensing

Snamprogetti's urea technology license and know-how are available to urea manufacturers.

The technology, based on the ammonia stripping process, has already been proven in more than 100 plants throughout the world for capacities ranging from a few tenths to **nearly 4,000 t/d** in one line. The majority of these plants were engineered by Snamprogetti, a factor which greatly contributes to improving the technical details, especially those relating to equipment and machinery. Several plants engineered by **Authorised Contractors** are available worldwide to meet all specific needs such as financing, local engineering, procurement, etc. The issue of a **Customised Basic Engineering Package** enables the appointed contractor to perform the detailed engineering and all other project implementation. In principle, the CBEP includes the following documentation:

- process flowsheet with mass balance of process fluids and utilities;
- P&I diagrams;
- equipment specifications with material of construction;
- quality and quantity of effluents;
- suggested layout;
- area classification;
- instrument data sheet and interlock system;
- computer controlled plants (DCS);
- data for safety valves;
- vendor list;
- commissioning and operating manual;
- recommendations for maintenance;
- checking of some detailed engineering;
- performance test-run procedures;
- analytical manual;
- training programmes for client personnel;
- commissioning services.

During the design stage of detailed engineering, Snamprogetti is in close contact with the Authorised Contractor for the above-mentioned checks and for the selection of the main equipment and machinery. Assistance at the vendor's workshop is provided on request. Tailor-made training programmes for client personnel include "on-the-job" and "hands-on" training. The most up-to-date training aids such as dynamic simulators are available.

After Sales Service

Snamprogetti is proud to be a leader in the field of urea technology and makes every possible effort to maintain its high-ranking status.

Accordingly, its ongoing goal is to update and improve its technology on the basis of increasingly more appropriate calculations, taking advantage of mathematical models that have been verified by a considerable amount of screened data collected from client operating plants. This data is continuously collected by Snamprogetti during visits to the plants in operation, or supplied by clients themselves, in the frame of the already mentioned "Client Assistance" or the **"After Sales Service"** programme offered by Snamprogetti in order to:

- keep clients constantly informed of developments;
- provide revamping to achieve the objectives described in the section entitled "Revamping" i.e. increase capacity, reduce raw materials and utilities consumption, reduce pollution, etc.;
- inspect equipment;
- troubleshoot any problem.

Symposiums are an ideal way to foster the exchange of information between clients and Snamprogetti or directly between clients. These information and experience exchanges greatly benefit both Snamprogetti, in improving plant design, and clients, in improving plant performance.

We are ready
to design 5,000 MTPD
single line urea plants.

The Urea Team