

IFA Technical Conference

Paris, France

5-8 November 1984

G. Brusasco, R. Monaldi, G. Pagani, M. Santini
(FERTIMONT, ITALY)

SUMMARY

The IDR process, the latest version of Montedison's urea technology, has been in commercial operation for the past two years at Fertimont's 300 MTPD plant at San Giuseppe di Cairo. The process flow sheet and main features were described on the occasion of the 1980 IFA Technical Conference (1).

After two years of operation, the process has proved to require very low energy consumption and to consent easy and stable operation; moreover, no corrosion of the equipment was observed, although it is well known that corrosion conditions are critical for the strippers.

Following is a description of the policy which has been adopted by Fertimont to further reduce the overall steam consumption from the present 600 Kg/t urea to 300 Kg/t urea, and possibly even less.

Furthermore, a new urea granulation process has been developed which is based on multiple curtain drum spraying, the drum having a small volume.

A good quality product is thus obtained; the process is characterized by low investment and energy costs and easy operating conditions.

In the chapter covering ammonium nitrate the performance of a pressure reactor is described, which is highly energy saving and has been operating on industrial scale.

A description is also provided of the improvements in the 1,500 MTPD ammonium nitrate plant at Porto Marghera. An interesting feature of this process is that the 26% N product is sent to storage at a temperature of 75 °C and is kept in unconditioned warehouses.

This is possible thanks to the use of special conditioning agents.

UREA PLANT

Evolution of the urea production technique towards ever lower steam requirements

On the occasion of the IFA Conference held in Vienna in 1980, the Montedison new IDR urea production process was introduced for the first time. The process was later successfully tested and perfected on industrial scale (300 MTPD) in 1981 at Fertimont's San Giuseppe di Cairo factory.

Starting from 1982, the plant was added to the factory's production cycle, thus fully meeting data which indicated steam requirements of 600 Kg/t urea, that is to say an appreciably lower figure than was obtainable with the consolidated technology available at that time.

A brief description of the process's characteristics is given hereunder.

Figure I shows the scheme of the new process regarding the high pressure section.

The high conversion yield in the reactor is obtained through operation with high ammonia/carbon dioxide ratios in the reactor whilst the recycling of the major part of the unreacted matter, mostly ammonia, is carried out in two strippers working in series at the same synthesis pressure and using ammonia and carbon dioxide respectively as stripping agents.

The innovative aspect of the process is the removal of excess ammonia in the urea solution mainly achieved through using carbon dioxide in the stripping operation (differently to what has been done till now). The main results achieved over the past few years (the plant was started up in 1981) can be summarized thus:

- a significantly lower heat consumption in comparison to consolidated technologies.

Consumption of about 600 Kg/t steam at medium pressure, plus a recovery of about 100 Kg/t steam at low pressure. This means lower energy consumption of about 40% compared to those achieved employing the best technologies available on the market;

- complete absence of corrosion after operating three years.

This outstanding result has been achieved due to a particular passivation technique of the surface of the strippers.

For further details please see the literature mentioned in the footnote hereto (2), (3).

It should be stressed, however, that considerable improvements can be achieved through this process. Such improvements are currently at an advanced stage of realization at Fertimont's San Giuseppe di Cairo factory.

They involve also a new philosophy of plant operation aimed at minimizing power requirements rather than at exploiting the strippers' high efficiency.

In a cycle such as the IDR cycle, the reaction heat plus the heat supplied to the strippers are found again in the carbamate condenser

in the form of recovered steam, at such a level (7-9 bar) as to consent its use for the distillation of the downstream solution. The use of the double effect technique between the MP distiller (20-30 bar) and the first distiller under vacuum makes it possible to cut down the requirements of recovery steam, a portion of which is made available for other uses.

The new evolution philosophy of the IDR process can be summarized as follows:

- consolidation of high conversion yields inside the reactor (more than 70%);
- reduction of the steam flow to the second stripper, so that part of the NH_3 is stripped as a result of the co-production of an equivalent quantity (from the point of view of heat) of carbamate;
- expansion of the double effect area so as to decompose this additional carbamate with recovery steam at high efficiency condition;
- distillation of the formation waters, using low value heat such as the vapours from the low pressure stage (4-6 bar).

By doing so, a reduction of the MP steam consumption is obtained, whereas the recovery heat consumption is increased.

The optimal solution consists in closing the cycle with a minimum MP steam consumption, thus securing the availability of recovery steam for all the remaining finishing operations.

One can easily realize that, in a situation such as this, the recovery steam is precious and its consumption must be optimized to the utmost. This is exactly what is being done at Fertimont's San Giuseppe di Cairo factory.

Fig. 2 shows a complete diagram of the IDR plant at San Giuseppe di Cairo, as modified according to these new criteria.

The double effect covers the low pressure distiller, plus a portion of the first distiller under vacuum. It is thus possible to expand the latter's field of operation, even beyond 300 Kg recovery steam/t of urea to be conveyed to the MP distiller.

The presence of a kind of post-condenser at lower temperature such as the one on the first stage under vacuum permits to maintain a pressure level at the MP stage which is compatible with the use of recovered steam.

This expansion of the double effect's field of operation will consent to bring the "overall" steam requirements down to values of about 300 Kg/t.

A further optimization of the recovery steam consumption may be obtained through partial use of the heat content in the steam from the LP distiller.

It has in fact been ascertained that this heat may be utilized to distill the formation water (containing a small quantity of NH_3) from the condenser under vacuum, as well as to preheat the NH_3 to be used for feeding.

Through this additional optimization, it seems possible to obtain "overall" steam requirements under 200 Kg/t urea.

As mentioned before, both these improvements are being perfected at Fertimont's San Giuseppe di Cairo factory, and should be added to the production cycle within the first months of 1985.

In conclusion, thanks to a rationalization of the steam consumption in the finishing section, and to a different philosophy of operation of the high pressure IDR cycle, it is possible to cut down to very low (almost negligible, we dare say) values the steam requirements in urea manufacturing.

The multiple curtain drum granulation process

Over the past few years, it has been Fertimont's aim to enlarge its products' range. Consequently, a drum granulation process was perfected, so as to meet market requirements as there is an ever increasing demand for granulated urea.

As regards the granulation technique, the results of past experience were borne in mind, as well as other important factors such as : low invest cost, utilization of existing equipment and low energy consumption. Fertimont's plant at Porto Marghera was characterized by the fact that prilled urea was conditioned in a subsidiary plant (CNA process) in order to obtain free-flowing prilled urea; this unit is based essentially on a coating drum and on a final fluid bed cooler which employs air subcooled by a refrigerating cycle.

The plant, as plotted in fig. 3, was modified as shown in fig. 4, mostly using existing equipment and realizing a typical granulation cycle (4).

The inside part of the existing drum was modified with the addition of multiple curtains on which the 99,5% solution is sprayed. This onion-skin granulation system is very effective and is easy to operate.

The importance of the crystallization heat removal in an "onion-skin" type granulation system is well known: in the case of drum granulation this importance has been stressed by TVA, who have presented a drum granulator, falling curtain type, cooled inside by means of a water injection system (5).

In Fertimont's case, the heat is removed by recycle (averagely 3:1).

The granulation process is carried out at a temperature of 100-105 °C; and all the product in the cycle is cooled down to 45-50 °C.

The granulator has a very high capacity if related to its small volume (abt 0.4 t urea/h/cu.m); the small volume is compensated by an original system of falling curtains which the molten urea is sprayed onto. Furthermore, the high length/diameter ratio has proved to be an important factor in order to obtain high quality product.

Table 1 shows the characteristics of the granular urea produced by FERTIMONT.

The total cost of plant modifications at Porto Marghera was US\$300,000.

Basing on the results obtained with the experimental plant, a new plant was designed using the same flow-sheet.

Following are the data concerning the calculated energy consumption for a 500 MTPD granular urea plant, referred to one ton of granular urea produced with air at 27 °C.

- electric power	24	kWh/t
- L.P. steam	30	Kg/t

The battery limit investment estimate is US\$ 1,800 million.

AMMONIUM NITRATE PLANT

In the ammonium nitrate plant, energy saving criteria are connected with the use of the reaction heat, since the reaction between ammonia and nitric acid is highly exothermic, and with the granulation system, which must yield a product having the required characteristics and obtained with the use of the lowest possible energy.

In the case of a new plant, the process which we consider to be optimal for the production of 26% N ammonium nitrate (the only grade available on the Italian market) is based on a pressure reactor followed by a drum granulation process.

The pressure reactor

The pressure reactor, which had been used by Montedison on a large scale before 1940, and had later on been discarded to adopt, for safety reasons, the atmospheric pressure reactor, was re-designed in 1973 together with Compagnie Neerlandaise de l'Azote (C.N.A.) in order to secure energy savings and clean effluents with safety margins equal to those obtainable with the atmospheric pressure reactor (6).

Fig. 5 shows the flow-sheet of the section producing 95% solution.

Gaseous ammonia and nitric acid are fed to a reactor operating at a pressure of 4-4.5 bar and at a temperature of 175-180 °C; the reaction occurs in the presence of 73 to 75% ammonium nitrate solution.

The highly exothermic reaction causes the evaporation of water; the generated steam is separated from the liquid phase and used, after washing with recirculating diluted solution, to concentrate the produced nitrate solution up to 95% in a single-stage concentration operating under vacuum.

The excess reaction heat is converted to pure steam by circulating the reaction solution through a boiler; the amount of exported steam is plotted in fig. 6 as a function of nitric acid concentration and temperature.

The washing of the vapours from the reactor permits to obtain condensates containing less than 30 ppm NH_3 and 30 ppm NH_4NO_3 .

Safety is connected mainly with low concentration in the reaction loop and with a well tested and reliable system for temperature and pH control.

The pressure reactor process has already been in operation since 1977 at CNA's factory in Sluiskil (Holland) on a 1,500 MTPD line and at Quimigal's Lavradio factory (Portugal) on a 500 MTPD line.

At Fertimont's 95% ammonium nitrate solution plants, all based on atmospheric pressure reactors, the necessity had arisen of using both energy recovery and environmental protection criteria without erecting a new plant, as would have been the case had Fertimont intended to apply the pressure reactor technology in full.

Consequently, other principles were followed.

For example, in the 1.500 MTPD 26% N ammonium nitrate plant of West Porto Marghera, all the reaction heat was recovered using steam from the reactor to preheat demineralized water for the boilers in the neighbouring plants (i.e. nitric acid, sulphuric acid and ammonia) and to preheat up to 90 °C the drying air for the ammonium nitrate granulation plant.

In the North Porto Marghera area, where the 95% ammonium nitrate solution is used for NPK production, steam from the ammonium nitrate reactor is utilized to concentrate phosphoric acid from 28% P_2O_5 to 42% P_2O_5 in the neighbouring phosphoric acid plant. This permits to save an equivalent quantity of LP steam. In order to reach this goal, the working pressure of the ammonium nitrate reactor was increased to 1.3 bar and the carbon steel shell of the phosphoric acid concentrators was replaced with one made of AISI 304 stainless steel.

This initiative brought about considerable economic results, since, with an investment cost of US\$ 800,000, an annual return of US\$ 1,300,000 is being achieved.

Drum granulation

Drum granulation technique on molten salts (such as ammonium nitrate and urea) had already been developed by Montedison as far back as the '50; actually, a pan granulation plant for ammonium nitrate production has been operating in Peru since 1957.

The Porto Marghera plant was constructed in 1965, with a design capacity of 700 MTPD of 26% N ammonium nitrate. Later on, the plant was improved and revamped on several occasions and currently a 1,500 MTPD 26% N ammonium nitrate production is obtained on one line only.

Fig. 7 shows the flow-sheet for the drum granulation production of 26% N ammonium nitrate.

Table 2 reports the specific consumptions obtained during the commissioning tests in 1968 in comparison with to-day consumptions and the calculated figures of an ideal plant based on drum granulation and pressure reactor; it can be seen how close are the to-day figures to the ideal ones.

A special feature of Fertimont's plant is that the granulation process occurs in the presence of specific surfactants which, affecting the crystals' morphology, cause a diffused porosity which facilitates work in the subsequent drying stage.

The surfactant mixture that is being used is not in contrast with the granulation operation which, in this specific case, is of the "onion skin" and coalescence type.

Obviously, it is necessary to control the process parameters and to remain within well defined ranges, i.e.:

- the concentration of the solution must be such as to obtain, by recycling also the flows from the ecological unit, a water content in the product between 0.6 and 0.8%; usually, the concentration is 95.5-96.5%;
- the temperature shall range between 114 °C and 118 °C;
- the recycle ratio is usually 2-3.

A particular spraying technique was adopted so as to control the granulation process through a special arrangement of sprayers; the drum dimensions are: 4 m diameter x 5 m length.

The granules' physical characteristics, with particular regard to diffused porosity, permit to obtain after the drying stage water content values in the range of 0.10-0.15%, with acceptable drying volumes (3.6 cu.m./t/h).

After screening, the product is cooled down to 70-75 °C, as one of the advantages of the process consists in the fact that it may be stored at high temperatures in unconditioned warehouses without any caking problem.

The only treatment that follows is anti-caking spraying with anionic surfactants bound with high polarity wax. This results in the formation of a waterproof coating which resists the water exchange action in the saturated solution so that no salt's surface re-crystallization occurs.

Table 3 shows the product's chemical, chemical-physical and particle size characteristics.

The figures relating to caking and dusting are within the limits of those of other products available on the market, which are both cooled down and treated with amines.

The methods applied for the determination of the physical characteristics and of technological tests have been laid down at Fertimont's Fertilizer Research Centre and can be supplied on request.

Phase III stability under storing conditions is obtained thanks to the limited water content: this is due to the fact that no conditioning agents such as magnesium salt etc. are added, which normally increase the product's hygroscopicity.

The final treatment with anionic surfactants and high polarity wax minimizes the risk of water migration between granules and in the environment.

Moreover, the high temperature inside the product's heap results in drying conditions since the relative critical humidity is higher than the ambient relative humidity.

It will therefore be sufficient to avoid air changes in excess within the storing area to avoid water absorption at heap surface. This will save costly air conditioning of the warehouse.

The economic advantage consists in the fact that cooling can be limited to 75 °C rather than the 32 °C required to reach Phase IV, and that no air conditioning in the storing area is necessary. The energy required for these operations can therefore be saved.

The battery limit investment for the construction of a 1,500 t/d 26% N ammonium nitrate plant is US\$ 9,500 million, of which 35% covers the preparation of the 96% solution.

REFERENCES

1. G. Pagani, "Contribution to energy saving: a new process for urea production".
ISMA Technical Conference, Nov. 11-13, 1980
2. G. Pagani, "New process gives urea with less energy"
Hydrocarbon processing, Nov. 1982
3. G. Pagani, "IDR technology cuts to a minimum the energy consumption in urea plants"
Nitrogen No. 145, Sept - Oct. 1983
4. G. Pagani, R. Majer, "Parallel production of granular and prilled urea in an existing prilling plant"
R & D in energy conservation in fertilizer industry research centres", New Delhi, Feb. 16-17, 1984

5. A.R. Shirley, L.M. Nunnally and F.T. Carney, "Melt granulation of urea by the falling-curtain process"
TVA, Ind. Eng. Chem. Prod. Res. Dev. 1982, 21, 617-620
6. G. Pagani, G. Brusasco and G. Gramatica, "Minimizing Energy Consumption in Fertilizer Nitrogen Production: the Montedison R & D Programme in Progress"
Paper presented at "The British Sulphur Corporation's Fourth International Conference on Fertilizer Technology"
London, 19-21 June 1981

TABLE 1

CHARACTERISTICS OF GRANULAR UREAChemical characteristics

- Total N		46	% wt
- formaldehyde content		0,28	" "
- biuret content	less than	1	" "
- H ₂ O		0,2	" "
- pH (10% solution)		8	

Physical characteristics

- Hardness (2,5 mm)		2,8	Kg
- Porosity		2,8	cm ³ /100 g
- Dusting		200	ppm
- Caking		free flowing	

Particle size

more than 4 mm		5 - 14	% wt
4 - 3 mm		25 - 35	" "
3 - 2 mm		65 - 50	" "
less than 2 mm		2	" "

SPECIFIC CONSUMPTIONS AND RECOVERIES

Referred to the production of 1000 Kg of Calcium Ammonium Nitrate 26% N

		P.Marghera plant commissioning da ta (1968)	P.Marghera plant to-day data (1984)	Ideal plant
<u>Production capacity, MTPD</u>		800	1500	1500
<u>Consumptions</u>				
- ammonia,	Kg	166	163 1)	161
- 56% nitric acid, as 100%,	Kg	605	598	595
- ground limestone,	Kg	245	250	255
- sulphuric acid,	Kg	1	2,5	2,5
- coating agent,	Kg	-	1,5	1,5
- L.P. steam (8 bar),	Kg	230	190	30
- Electric power,	kWh	33	27	27
- cooling water,	m ³	40	20	15
<u>Recoveries</u>				
- L.P. steam (5 bar),	Kg	-	-	50
- Recovered heat as steam in the sulphuric, nitric and ammonia boilers (equivalent steam at 8 bar)	Kcal (Kg)	-	110,000 (170) 2)	-

Remark : i) Lower consumptions of NH₃ and HNO₃ have been obtained by improvements in the effluent abate-
ment systems.

2) M P steam is produced in the sulphuric acid, nitric acid and ammonia plants boilers; an higher
quantity of steam (10 MTPH) is produced by boiler feed water preheating in the A.N. plant.

CHARACTERISTICS OF 26% N AMMONIUM NITRATEChemical characteristics

Total N	26	% wt	
Free H ₂ O	0,09	"	
Total H ₂ O	0,12	"	
SO ₄	0,30	"	
Ca(NO ₃) ₂	0,20	"	
Organic matters (as C)	0,20	"	(1)
pH (10% solution)	7,3		

Physical characteristics

Hardness	3,0	Kg	
Porosity	12,0	cm ³ /100 g	(2)
Dusting	200	ppm	
Caking	free flowing		

Particle size (3)

more than 4 mm	10 - 15	% wt
4 - 3 mm	70 - 75	"
3 - 2 mm	10 - 15	"
less than 2 mm	0	"

(1) 50% is due to surfactant and anticaking materials.

(2) The figure is 10-15% higher than in the case of granular products obtained without the addition of surfactants.

(3) The sieves have opening which meet customers' requirement.

THE NEW IDR UREA PROCESS

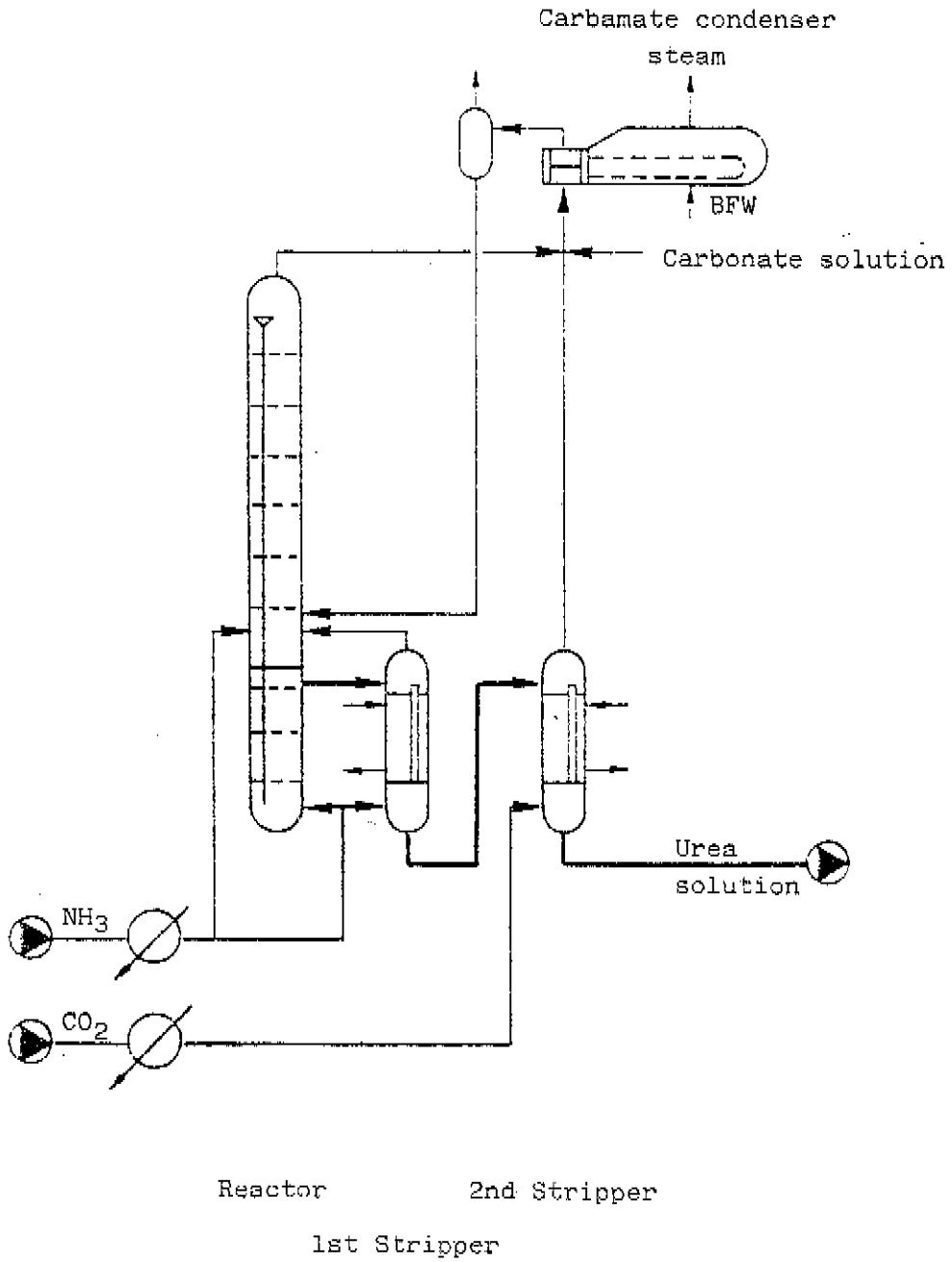


FIG. 1

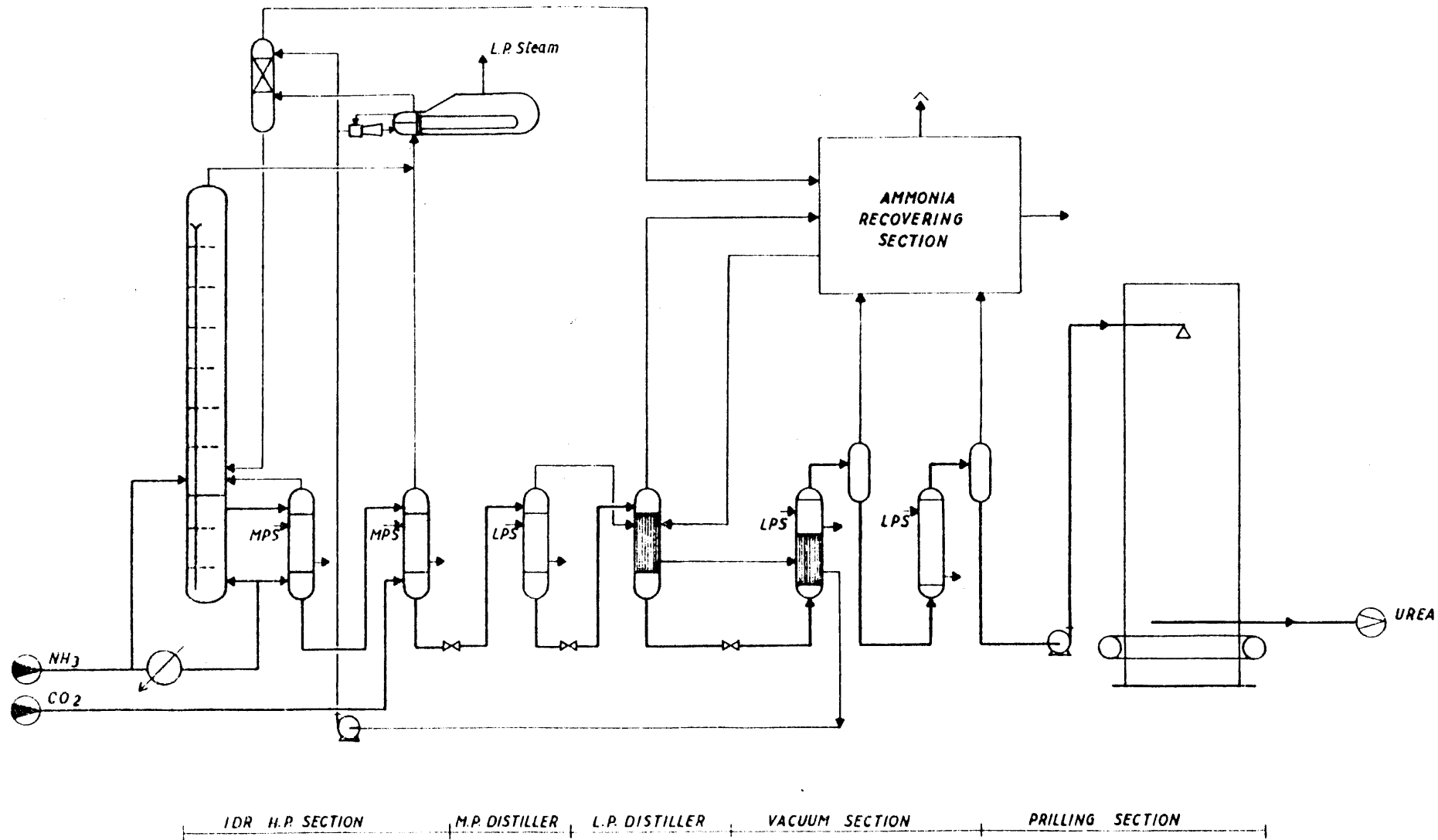
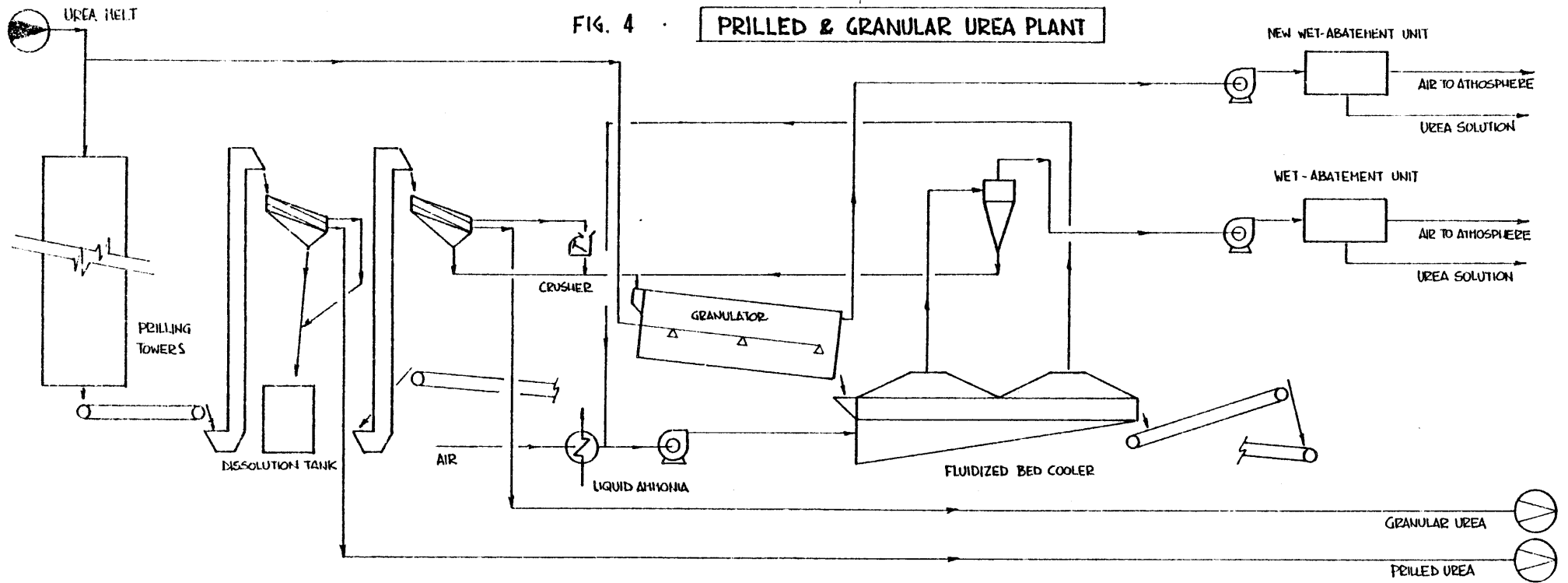
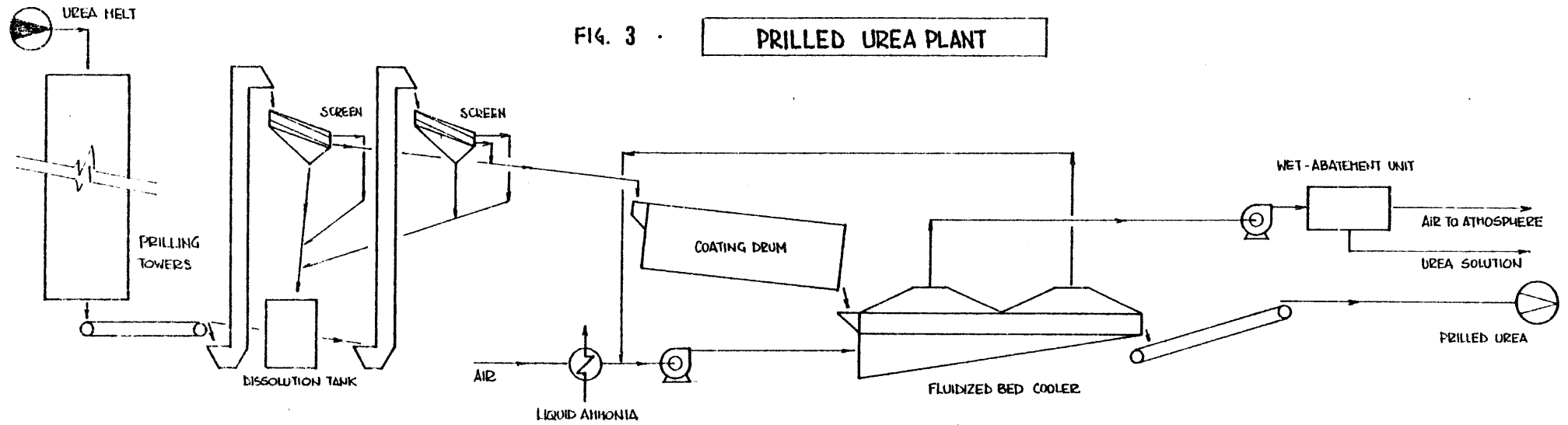


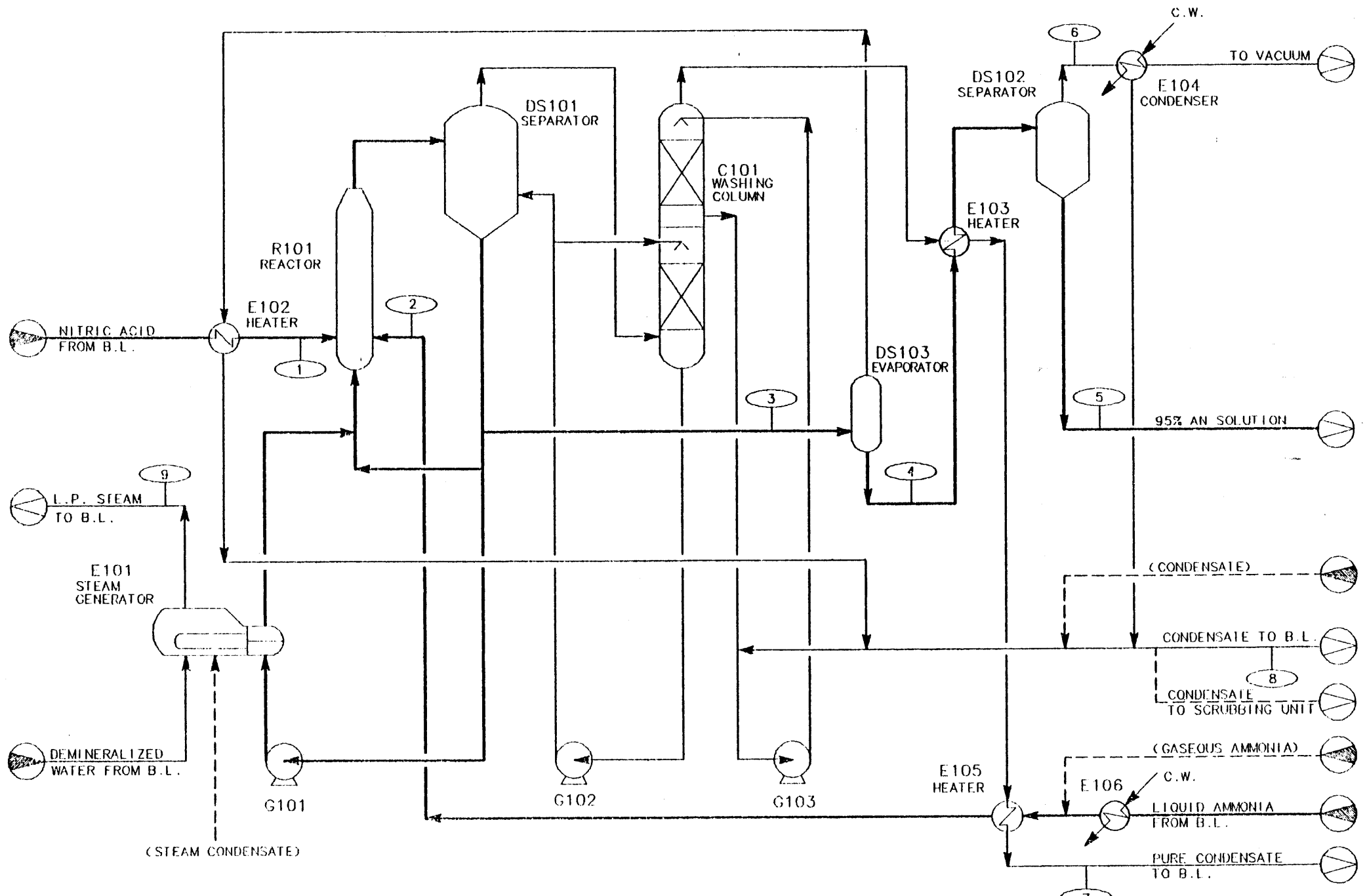
FIG. 2

MONTEDISON IDR UREA PROCESS

MPS = Medium pressure steam
LPS = Low pressure steam



AMMONIUM NITRATE SOLUTION AT 95% NH₄NO₃
 FLOW DIAGRAM FIG 5



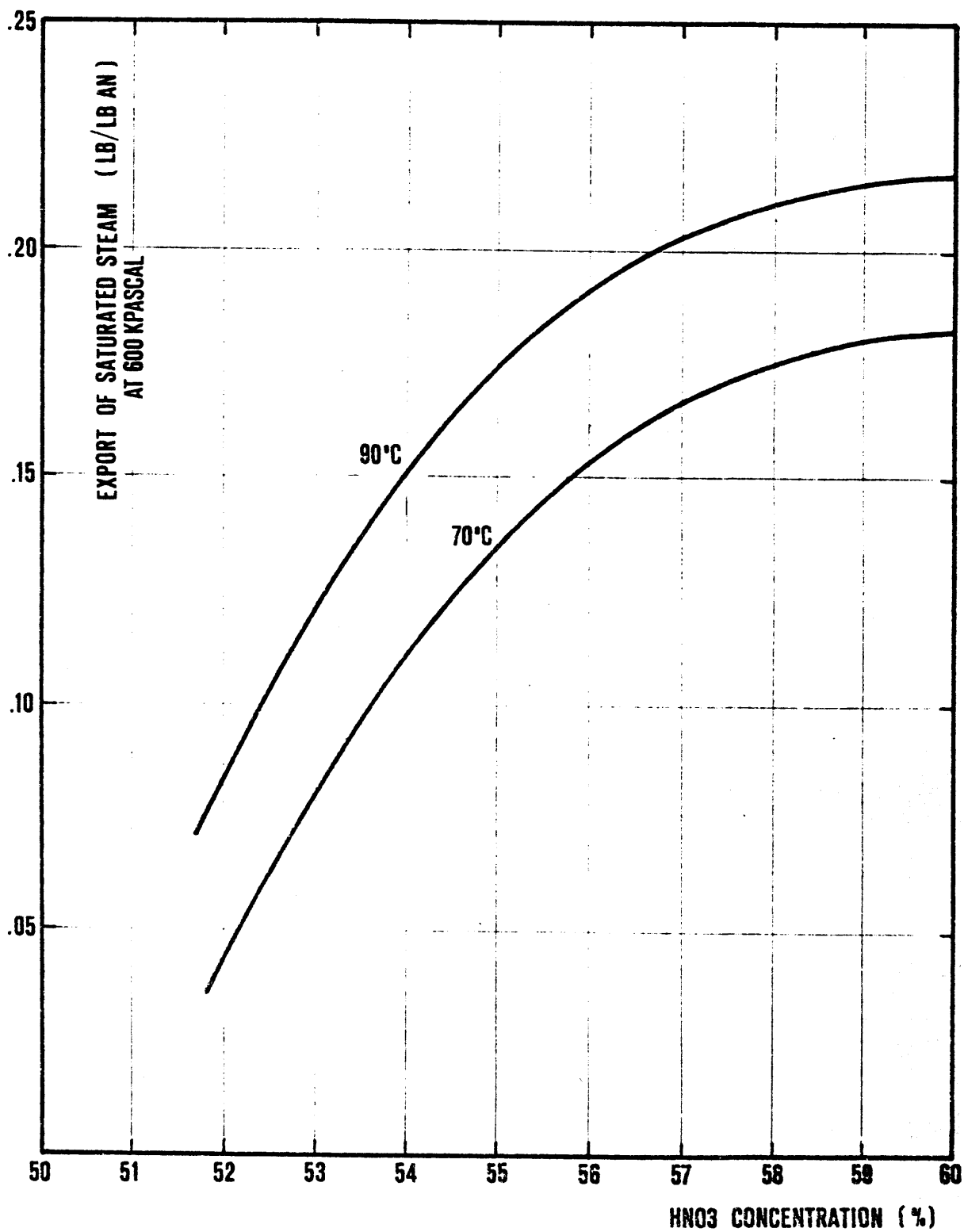
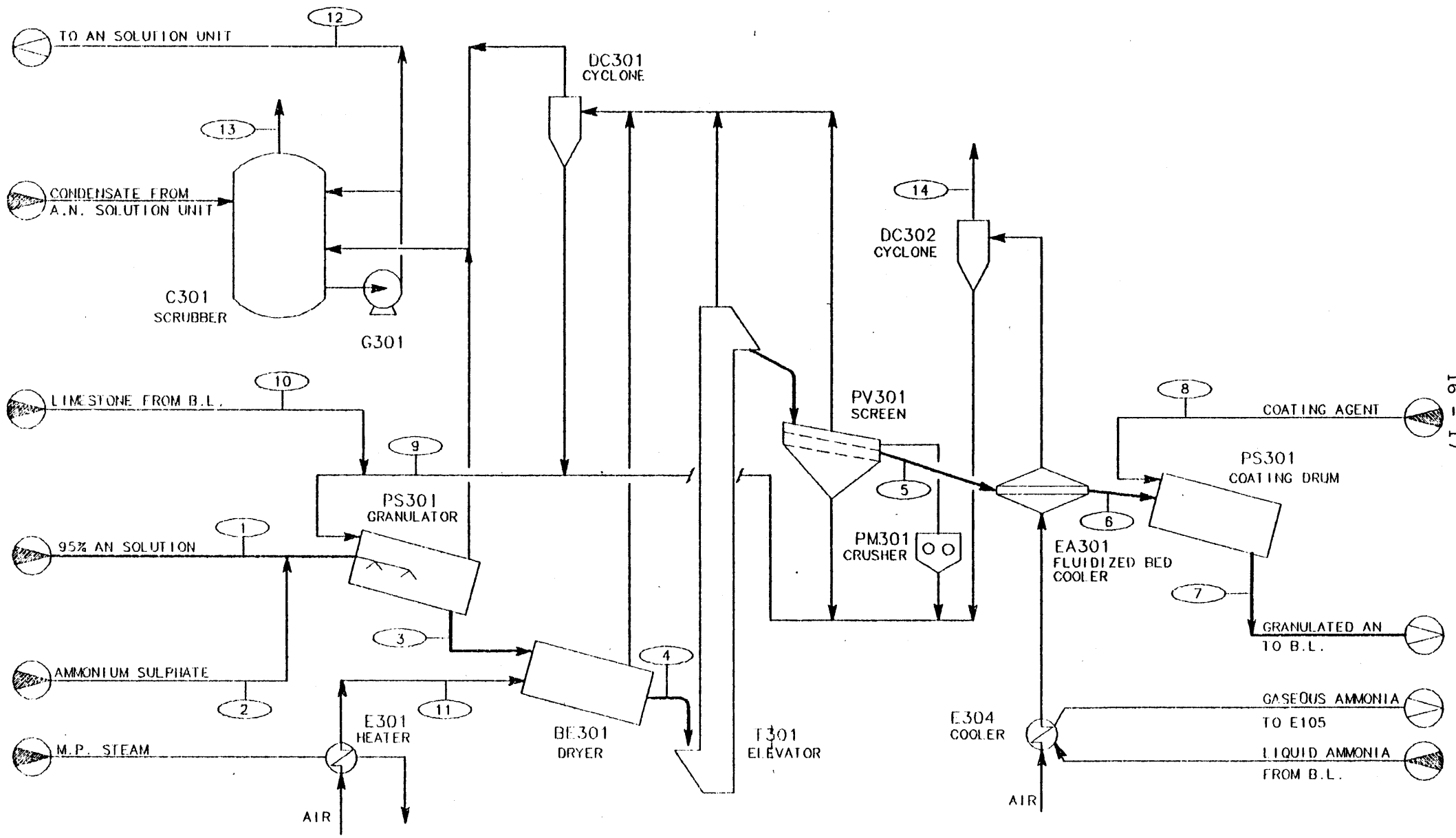


Figure 6 - Effect of HNO₃ concentration and temperature on pure export steam (95% AN solution)

FLOW DIAGRAM FIG 7



16 - 17

TA/84/16 Energy saving in urea and ammonium nitrate plants by G. Brusasco, R. Monaldi, G. Pagani & M. Santini, Fertimont SpA, Italy

DISCUSSION: Rapporteur J.E. REYNOLDS, Grace W.R. & Co, USA

Q - Mr. J.D. CRERAR, Norsk Hydro Fertilizers Ltd, United Kingdom

The ammonium nitrate granulation process shows that the drier is heated indirectly using steam. We use direct heating with natural gas combustion. Would Fertimont do the same with a new plant today?

A - Porto Marghera plant has been designed using steam at 8 bar for heating the drying air at a maximum temperature of 160°C; at that time the decision was connected with safety reasons. With a new plant, we consider important the energy saving connected with the use of the steam coming out from the AN reactor as indicated in the paper; nevertheless we consider feasible the use of natural gas with the proper safety devices.

Q - Mr. P. CHINAL, CdF Chimie AZF, France

In figure 5 of your paper, it seems that the scrubbing of the mist out of the reactor is done with a nitrate solution at the same concentration as that of the reactor. Is it the case?

In this scrubber, do you introduce make up nitric acid? If so, how is it controlled?

What is the operating pH of the reactor and of the scrubber?

A - The washing of the vapours from the reactor operates in two steps inside the column C101:

- in the first step AN solution at 15-25% and pH = 1 is recirculated;

- in the second step AN solution at 2-3% is recirculated.

Nitric acid is added with a pH control in the reactor and in the lower part of the column. The pH value in the reactor is 3.

Q - Mr. Z.H. PAN, CNCCC, China

1. If H₂S and H₂ contents in CO₂ are about 10 mg/Nm³ and 0.8% (vol.) respectively, is your special passivation technique still applicable and does the explosive atmosphere exist in your new process? If it does, where? And how to avoid explosion?

2. What is the minimum load at which the new IDR section can still be operated?

3. What are the factors which influence the performance of the 2nd stripper?

A - 1. H₂S must be reduced through an appropriate adsorbant to 1 ppm maximum.

The content of 0.8% vol. H₂ in the CO₂ may give the same problems due to the presence of O₂. In our case we use two types of passivation agents:

- the first one is a liquid oxidizing agent in order to protect the strippers' surfaces. No problem for this substance;
- the second one is air for passivating all the remaining parts of the plant.

In order to avoid any operation near or in the explosion field due the contemporary presence of O₂, H₂ and NH₃, (that can occur during the inert gas washing) we operate in the H.P. scrubber always in the presence of an ammonia excess; it means out of the explosion field. In the M.P. scrubber we add nitrogen before the final washing of inert gas in order to reduce the H₂ and O₂ concentration below the inferior flammability limits.

2. The minimum operation load of the IDR plant is about 40-50% of the design figures.
3. The performances of the second stripper of the IDR process are affected mainly by:
 - temperature of inlet solution that must not exceed 210°C. We prefer to operate in the range 200-205°C;
 - NH₃/CO₂ ratio of the inlet solution. We operate quite well when this ratio is equal or higher than 3.8-4 (by weight).

Q - Mr. F.A. KARS, Stamicarbon, Netherlands

1. On page 2, §4 in the english version of the paper is stated: "the innovative aspect of the process is the removal of excess ammonia in the urea solution mainly achieved through using carbon dioxide in the stripping operation". I always believed that we were the true inventors of the CO₂-stripping process in which CO₂ at synthesis pressure is used to remove excess ammonia but also non-converted carbamate from the urea solution. Can some clarification be given?
2. How do you compare your process with Mitsui Toatsu's ACES process? And is your process and/or your patent situation, if you have any, not in conflict with M.T. patents or others?
3. Is it correct that you have no commercial experience with the scheme as given in figure 2, such as:
 - the ejector added to the carbamate condensor
 - the high pressure scrubber that replaces the separator of scheme 1
 - the heat exchange in the L.P. distiller
 - the heat exchange in the vacuum system?

4. . Is your anticipated steam figure based on full heat removal with cooling water in the ammonia recovery system and
 - . Is it the difference between import and export steam, if not, what is your anticipated export steam figure?
5. Is it correct that your anticipated steam figure is based on a plant with an electrical driven compressor, and do you agree that the energy picture is completely different for a plant with cogeneration in which the compressor is steam driven?
6. Modern granulation technologies have lowered investments and utility costs in comparison to earlier technologies by reducing recycle ratios and air requirement by evaporation of water. Can you explain to us why it is advantageous to move in the opposite direction again?
7. Is your multiple curtain granulator, without water spray nozzles, more or less identical to TVA's falling curtain granulator?

A - 1. The main innovative aspect of our process is the stripping of ammonia by CO₂ in a urea solution very rich in free ammonia, without significant change of the carbamate content in the solution. In this way, it is possible to recycle big quantities of ammonia to the reactor directly in the H.P. loop and this permits to obtain very high conversion in the reactor and, in consequence, low energy consumption.

This is completely different from the STAMICARBON process, in which mainly carbamate is stripped by CO₂. In the last version of IDR process, our philosophy is to produce carbamate in the stripper evaporating ammonia in order to cut the M.P. steam consumption. It is clear that our process is completely different from STAMICARBON CO₂ stripping process both from a conceptual point of view and for the final results.

2. Our process has been patented on May, 1977, that is before the ACES MITSUI-TOYO Patent. In any case, our process is different from ACES process. In consequence, our patent situation is good.

3. We have commercial experience on:

- the ejector added to carbamate condenser. This ejector has been operating for 3 year in the S. Giuseppe di Cairo plant with good results.
- high pressure scrubbers are in operation at 80 bar in our Ferrara factory and in several other plants.

No problem to operate at higher pressure (for instance 200 bar).

- The double effect technique between M.P. distiller and L.P. distiller has been operating in commercial scale since 1967 in our S. Giuseppe di Cairo factory, in the conventional urea plant.

- The double effect technique between M.P. distiller and 1st vacuum distiller is in commercial operation from June 1982 in the IDR plant of S. Giuseppe di Cairo factory.
- 4. Our steam figures are overall M.P. steam duty from our side. No imported LP steam is needed and no exported LP steam is foreseen.
- 5. The steam figures are process figures and don't take into account the possible driving with steam turbine of the CO2 compressor. For this subject, please see our article "IDR technology cuts to a minimum the energy consumption in urea plants" - NITROGEN 145 Sept-Oct 1983.
- 6. Our consumption figures are on the same level as other granulation processes. Presently our recycle ratio is about 2 without affecting the product quality. According to our opinion, advantages of our process are simplicity of operation and low investment cost.
- 7. Fertimont has experience in the curtain granulating drum since fifties. In comparing our drum with the one of TVA we have these differences:
 - melt is sprayed on two or more parallel curtains in order to reduce the drum volume, without affecting the quality of the product. In consequence, we have a very high length/diameter ratio in the drum with relevant low investment cost;
 - the crystallization heat is removed mainly by cold recycle.

Q - Mr. L.K. RASMUSSEN, Superfos A/S, Denmark

What is the amount of $(\text{NH}_4)_2\text{SO}_4$ per ton in your 26% AN and why do you add AS?

A - The maximum amount of $(\text{NH}_4)_2\text{SO}_4$ is 4 kg/t 26% AN. We add ammonium sulphate in order to prevent the reaction between limestone and nitric acid to form $\text{Ca}(\text{NO}_3)_2$; this reaction occurs mainly in the scrubbing step with the limestone contained in the entrained powders.

Q - Mr. N.D. WARD, Norsk Hydro Fertilizers Ltd, United Kingdom

The storage temperature for 26% N ammonium nitrate of 70-75°C seems very high. It is surprising you have no caking in storage. Can you comment further particularly:

1. Storage time before bagging
2. Temperature at bagging?

A - The storage time before bagging varies between 1 and 5 months depending on the shipment programs.

The bagging temperature is less than 45°C in winter; summertime it can be sometimes more than 45°C.

Q - Mr. C. HOEK, UKF, Netherlands

What is the bulk density of ammonium nitrate and urea granules?

A - - AN 26% bulk density is 0.8 t/m³; real and apparent density are respectively 1.86 and 1.49.

- granular urea bulk density is 0.76 t/m³; real and apparent density are respectively 1.32 and 1.26.

Q - Mr. P. ORPHANIDES, PFI, Greece

What is the recycle ratio in your granulation AN 26% process?

A - The recycle ratio in the AN plant is in the range 2-3.

Q - Mr. G. CALIS, UKF, Netherlands

Do you expect any disadvantageous effects on product quality of ammonium nitrate, due to the III to IV transition, occurring during transportation and handling?

A - No. We have tested the same resistance to thermal shock in the cooled products.

Q - Mr. J. MOELLER BIKERBAEK, Superfos A/S, Denmark

What is the maximum acceptable particle size of limestone fed to the AN-granulator?

A - The limestone size is 60% passing through a 400 mesh screen; rather than the size, we consider the outside specific surface, that is more than 5000 cm²/g.

Q - Mr. D. IVELL, Norsk Hydro Fertilizers Ltd, United Kingdom

What is the concentration of ammonium nitrate in the granulation plant scrubber?

How is granulation controlled:

- by addition of steam?
- by control of on-size material as recycle?

A - The concentration of ammonium nitrate in the granulation plant scrubber is 50% by wt.

Granulation parameters controlled are the recycle of on-size material and solution concentration in order to keep in the fixed range temperature, humidity and size of the granulated material.