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SUBSTANTIAL CAPACITY ENHANCEMENT IN A DI-AMMONIUM PHOSPHATE PLANT[1]

S. Stalin, R. Muthu Manoharan and C. Chockalingam
SPIC, India

SUMMARY

Southern Petrochemical Industries Corporation Ltd. (SPIC) has its fertilizer division located at Tuticorin. The complex has facilities to manufacture 1600 TPD of urea and 1350 TPD of DAP in two streams.

DAP I plant was retrofitted with pipe reactor technology and its design capacity was increased from 500 TPD to 850 TPD. DAP II plant is based on conventional process by Tennessee Valley Authority and Nissan HZ. The conventional process has its own limitations / drawbacks and it is very difficult to increase the plant capacity in a substantial manner due to its inherent nature.

An attempt to augment capacity enhancement by retrofit needs a close scrutiny as it requires capital investment. Hence, possibility of revamping the conventional plant as done in DAP I as well as modifying the existing plant without any major investment were considered. SPIC undertook a thorough study on the potential capacities of its plant equipment for possible augmentation in production.

A major breakthrough was made by changing the operational philosophy and by carrying out minor modifications to the equipments. This resulted in higher production levels of around 1000 TPD and this high level of production is sustained.

RESUME

SPIC a sa division engrais située à Tuticorin. Le complexe dispose d'installations produisant 1600 t/j d'urée et 1350 t/j de DAP en deux lignes.

DAP I a été réhabilité avec la technologie du réacteur tubulaire et sa capacité théorique est passée de 500 à 850 t/j. L'unité DAP II utilise le procédé classique Tennessee Valley Authority et Nissan HZ. Le procédé classique a ses limites / inconvénients propres et il est très difficile d'augmenter substantiellement la capacité à cause de sa nature même.

Un essai d'augmentation de la capacité par réhabilitation doit être considéré avec soin car il implique des investissements importants. Aussi la possibilité de réhabiliter l'unité classique comme dans le cas de DAP I ainsi que la modification de l'unité existante sans investissement majeur, a été considérée. SPIC a entrepris une étude complète des capacités potentielles de l'équipement existant pour augmenter la production.

Une percée majeure a été réalisée en modifiant la philosophie opératoire et en effectuant des modifications mineures de l'équipement. Il en résulte des niveaux accrus de production d'environ 1000 t/j et cet accroissement se maintient.

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Southern Petrochemical Industries Corporation Limited (SPIC) has its Fertiliser Complex located at Tuticorin, India. The Complex has the following production facilities:

Ammonia	:	1100 TPD
Urea	:	1600 TPD
Sulphuric Acid	:	470 TPD
Phosphoric Acid	:	165 TPD
DAP-I	:	50 TPD
DAP-II	:	500 TPD
Aluminium Fluoride	:	8 TPD

[1] *Augmentation importante de la capacité d'une unité de phosphate diammonique*

The fertiliser complex has been awarded with the Sword of Honour and five star rating for its performance on safety, health and environment from British Safety Council, UK. It has been accredited with ISO 9002 for its systems and procedures.

Both the trains of DAP are based on conventional TVA Process and engineered by Hitachi Zosen. DAP-I Plant has been retrofitted with Pipe Reactor Technology supplied by M/s. KREBS, France and its design capacity has increased from 500 TPD to 850 TPD.

Though the DAP-II Plant is designed to produce 500 TPD, the capacity has been enhanced to about 900 TPD on a sustained basis. This has been achieved without any major modifications to the over-all design of the plant but by measures, such as, improving the operation and maintenance techniques and optimization of process parameters in each section.

PROCESS DESCRIPTION

In the TVA Conventional Process neutralisation of phosphoric acid and sulphuric acid with ammonia takes place in an agitated neutralizer tank. The resultant slurry is then pumped into the ammoniator-granulator. Fines from recycle system are also added into the granulator. Ammonia is further added into the bed of granules through special spargers and the heat of reaction aids in removal of water vapour from the slurry.

The granules are discharged into a rotary, co-current, direct heated dryer. Screening is done after enough drying, thereby separating the oversize and fines. Oversize granules are ground and recycled back to the ammoniator-granulator along with fines. The product is cooled with air in a counter-current, rotary cooling drum.

CAPACITY ENHANCEMENT

This Plant was producing around 500 TPD since commissioning and later stabilised at about 650 TPD. Possibility of revamping the conventional plant with pipe reactor technology as done in DAP-I Plant, as well as modifying the plant, without any major investment were considered. An in-house study on possible enhancement in production capacity was carried out.

Certain modifications which resulted in considerable increase in the production level are described below:

MODIFICATIONS TO EQUIPMENTS

ENHANCEMENT IN SCREENING AREA

This Plant is equipped with single deck, two stage linear type screens. There are two streams of screens and each stream is designed to separate oversize in one set of screens and to separate fines through another set of screens. Oversize separation section consists of two identical screen units with a total screening area of 6.3 m^2 per unit. Fines separation section consists of two identical screen units with a total screening area of 4.2 m^2 per unit. Three screens are assembled per unit in oversize unit whereas two screens are assembled per unit in fines unit. This offers a screening area of 0.252 m^2/MT and 0.168 m^2/MT in oversize and fines units respectively. The lower screening area increased the recycle ratio more than the required and resulted in variation in the product size distribution.

Hence, suitable structural and chute modifications were carried out and another screen was integrated in both oversize as well as undersize units thereby enhancing the screening area by 2.1 m^2 in each unit.

ENHANCEMENT IN RETENTION TIME

Ammoniator-granulator dam plate height was increased from 400 mm to 450 mm to increase the retention time and hence aiding better granulation.

OPERATING EXPERIENCE

The slurry from the neutraliser is sprayed inside the Ammoniator-granulator (AG) over the recycle fines. Of the two slurry headers inside AG, one was normally used for spraying slurry and other was a stand-by. After incorporating the modifications described earlier, both slurry headers were lined up with increased recycle material in an effort to increase the capacity of the Plant. Size distribution at the outlet of granulator was monitored for its distribution viz., oversize, fines and product. It was found to be satisfactory and hence, recycle material quantity was gradually increased and in proportion, slurry flow to granulator was raised. Screening performance as well as granulator outlet material size distribution were checked for the enhanced plant load.

The slurry flow was increased to a maximum of around 36 m^3/hr against the earlier maximum of 21 m^3/hr and all the process parameters were monitored. Size distribution was found to be poor compared to the previous pattern, and generation of fines was observed to be more. Optimisation of process parameters was done and slurry flow of around 32 m^3/hr was found to be giving a steady run with improved size distribution.

When the plant is being run at such higher load, the following problems are encountered:

I Upset in mole ratio / slurry density leading to choking of slurry headers.
II Build up inside AG and blockage in ammonia spargers.
III Over-granulation.
IV Poor ammoniation.
V Ineffective screening
VI Limitation in recovery section.

I. Influencing Role of Mole Ratio / Slurry Density

Conventional granulation plants have to operate with proper slurry mole ratio (MR) and density. Otherwise it results in either choking of headers or frequent blockage of strainers provided at the upstream of slurry nozzles. Good granulation also depends on optimum mole ratio. Care is required to overcome this problem by monitoring the flow rates of PA/NH_3 to neutraliser.

Proper instrumentation in association with effective analysis of the slurry for MR/density will give the desired neutralisation at higher flow rates with out any problems. The above parameters are being analysed with utmost care and periodicity of analysis was kept on hourly basis to avoid upsets and to achieve higher level of production.

II. Granulator Build ups - Dislodging

Granulator reversal in a DAP Plant once in a shift or once in a day is normal practice for dislodging the build ups and it depends on the following:

- Acid quality
- Influencing role of nozzles
- Adoption of water jetting

Acid Quality

Acid quality and its impurities play a crucial role in maximising the plant throughput. Acid produced by Hemihydrate process is around 42% concentration and at this concentration the solubility is less. It results in less impurities carryover along with the acid whereas in dihydrate process impurities will be more since the acid produced is of less concentration. This further influences the recovery section operation and its efficiency level.

About 900 TPD of P_2O_5 is required to meet the requirement of both the trains of DAP Plant. It is being met by both imported and own acid in the ratio of 3:1.

In our operating experience, it was found that imported acid from Jordan is giving minimum build ups inside AG since hemihydrate process route is adopted for acid production. Operating philosophy was changed and the conventional granulation plant is being run with the above acid only. By this, the build up of material was reduced, resulting in continuous running of the plant.

Influencing Role of Nozzles

Nozzle fixation and its orientation are critical and its slurry spray pattern towards bed plays a crucial role in granulation as well as avoidance of oversize / fines formation. Oversize material if any, is to be crushed and returned as recycle material. Hence, recycle load will limit higher load operation of the plant if either higher oversize or fines is maintained at granulator outlet. Moreover, oversize mills crushing capacity may be another limitation if uniform desired size distribution is not achieved at granulator outlet.

In this context, umbrella type nozzles were replaced with sheet type nozzles in order to improve the spray pattern and to obtain better geometry granules.

The nozzle orientation and its projected length from the slurry header is checked during plant stoppages and required length is kept at each nozzle. It ensures good spray pattern over the recycle material and minimises formation of either oversize or fines.

Further, the acid circulation in the slurry headers is being carried out once in 25 days, as a preventive measure to remove the scales thereby ensuring choke-free operation.

Adoption of Water Jetting

Complete elimination of build up inside granulator is not possible, even with all these operational changes. Water jetting is the very simple and effective method for dislodging the lumps. Water jetting is done at a pressure of around 150 ksc for a duration of 5-10 minutes, to remove lumps with out stopping the granulator. It has totally eliminated granulator stoppage and down time due to this factor is drastically reduced from 60 min to 15 min per day. Moisture content at AG outlet is kept at low level by ensuring minimum water addition, while carrying out the above operation. To ensure this, water jet nozzle is carefully designed and its opening is kept at 1 mm only.

III. Overgranulation

It is mainly due to the following factors:

a. The retention time is relatively high with respect to recycle material quantity. The slope of granulator is 2/100 and the speed is 8 RPM.

b. The size distribution of the seed material fed to the granulator itself is found to have wider variation as against the design.

	Design	Actual
Fines	60%	25%
Product	40%	70%
Oversize	-	5%

c. Build up of material around ammonia sparger.

It is evident that existing plant runs with higher rate of oversize and hence the existing mills designed to crush the material are running at their peak levels. Moreover, mills crushing capacity decrease between the two cleaning cycles and hence the limitation on plant load is experienced. An additional mill similar to the existing one is required and installation of the same will overcome this problem in near future.

IV. Ammoniation

Granulator outlet mole ratio is one of the key parameters, based on which ammoniation, to a larger extent, is being carried out. The mole ratio is around 1.65 as against the design value of 1.8. Size distribution with proper ammoniation plays a crucial role and it determines the pattern of oversize and fines at the granulator outlet. Less ammoniation results in more wetness and enhances the oversize formation. Excessive ammoniation results in complete evaporation of moisture from the product and leads to attrition which results in generation of fines. Then screening will be the limiting factor for higher load operation. Optimisation of the process parameters such as ammonia addition, slurry density at granulator was tuned to achieve the desired ammoniation. This has helped to maintain the wetness of the material inside granulator at a lower level to minimise oversize formation.

As a corrective measure, ammonia spargers were checked for their opening to ensure proper ammoniation and less ammonia slip from granulator. Sparger openings were re-oriented, as shown in Figure II, thereby enhancing the ammoniation efficiency level with minimum ammonia escape from granulator. This resulted in better mole ratio control at granulator outlet and the condition of the product at granulator exit has improved remarkably.

V. Ineffective Screening

Screening is one of the important steps adopted in obtaining required product size as well as recycling back the fines. After enhancing the screening area by 4.2 m^2, screening problems and material overflow at screens were reduced to certain extent. However, the existing screens limit the plant load even for minor upsets. Hence, an add-on unit for the capacity of 115 tons per hour is being considered. Feasibility of installing one more set of screens in the existing lay out and its loading on civil structures are being worked out. It will augur well not only for the existing load but also to improve the production level further.

LIMITATION IN RECOVERY SECTION

The recovery section consists of fume scrubber, dryer scrubber and dust scrubber system. Fume scrubber and dryer scrubber are divided into two portions namely - venturi and cyclonic portion. Scrubbing is primarily being carried out in venturi to the tune of 90%. The left out gases are scrubbed in cyclonic portion. All exhaust gases from neutraliser and granulator are sucked by means of fume scrubber fan. Dust laden air from dryer is sucked by dryer fan and the scrubbing is carried out in their respective scrubbing system.

The tail gases which are leaving this section are sent to dust scrubber for absorbing the traces of ammonia, fluorine, etc. Dust scrubber is being operated at a lower pH and sulphuric acid is added in order to absorb ammonia. This ensures that the gases are leaving the chimney with low ammonia and fluorine content.

Normally the recovery section is efficiently operated and the emission of ammonia and fluorine is restricted within the allowable limits to have an environmental friendly atmosphere. With the enhanced load, this section needs close scrutiny to keep the emission below the stipulated levels.

To ensure effective operation, fume scrubber solution and dust scrubber solution are analysed for mole ratio and density hourly. Critical review of this parameter results in avoidance of upsets. Provision of polypropylene balls in order to improve the contact area and to have better absorption is being considered to improve the efficiency level of the recovery section.

MAINTENANCE MANAGEMENT SYSTEM

The Plant availability and high onstream efficiency play an important role in maximising production. Predictive and preventive maintenance system are given topmost attention to improve the performance and availability of critical machineries like elevators, granulator and dryer. A well-proven condition monitoring programme based on the past history and the present condition is followed up in a systematic manner to prevent any unforeseen failures.

CONCLUSION

Detailed analysis of plant parameters and capacity of the equipment is the first step in enhancing the plant capacity. The in-house study made the task effective and cost efficient. Some of the sections which are at the brim of its capacity, such as screens, will be modified to take care of the transient conditions and also to improve the capacity further.

PROCESS FLOW DIAGRAM (CONVENTIONAL)

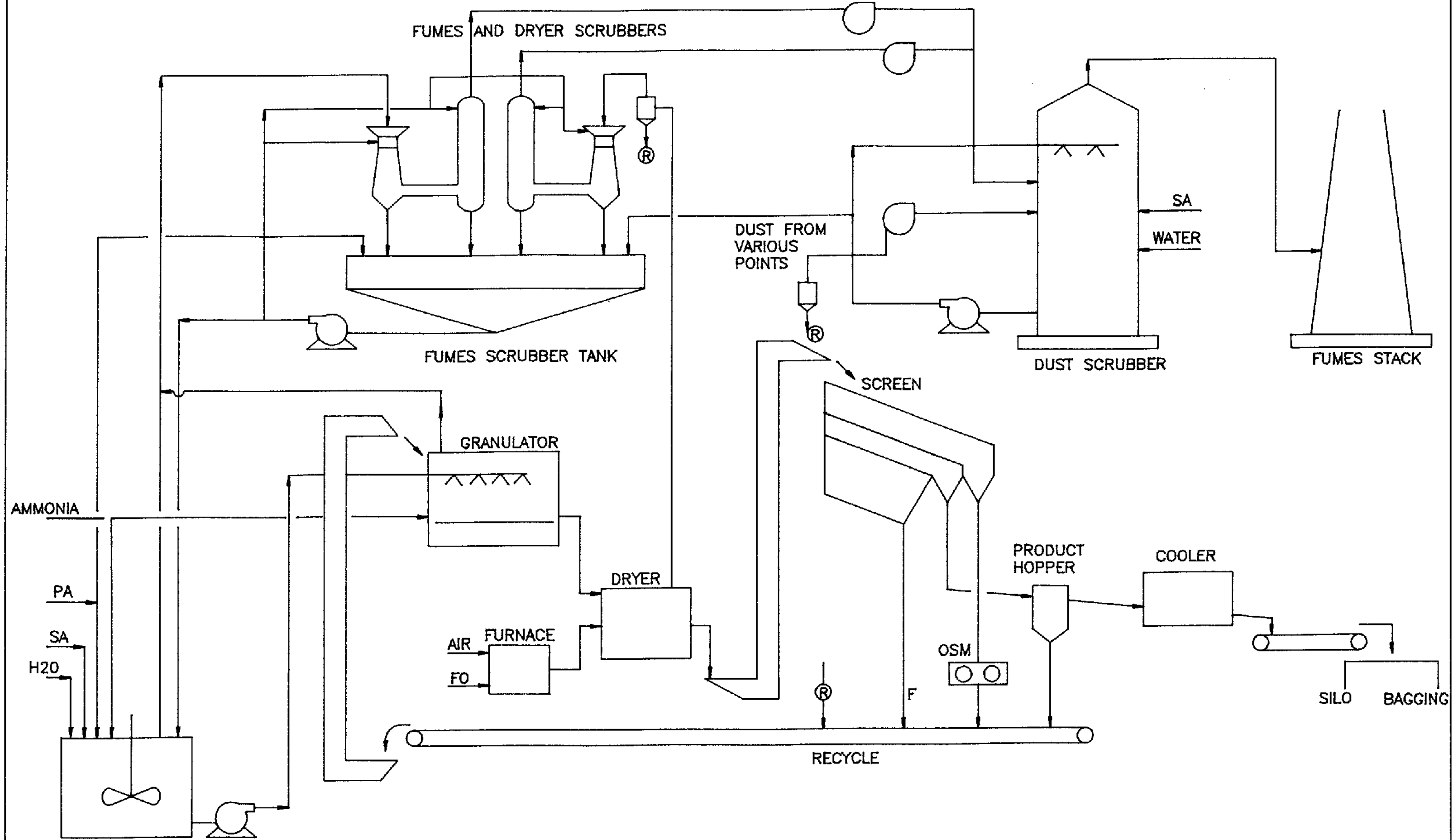
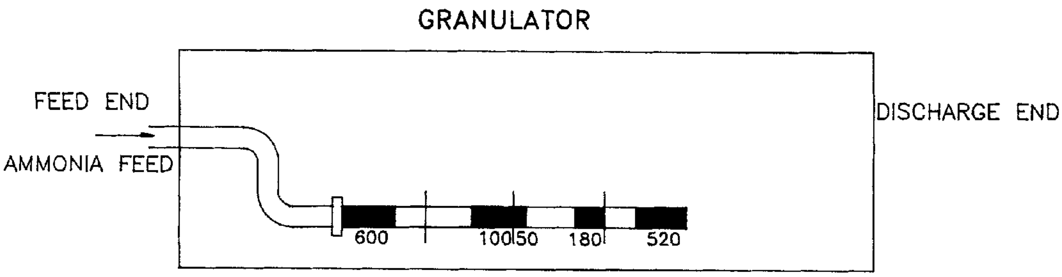


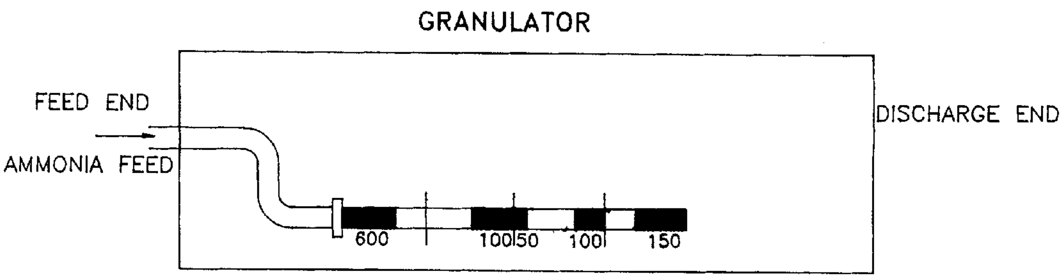
FIG (I)

AMMONIA DISTRIBUTION SYSTEM

OLD SYSTEM



MODIFIED SYSTEM



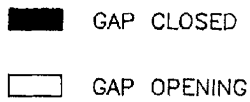


FIG (II)

SLURRY SPRAY DISTRIBUTION EACH HEADER HAVING FIVE (5) NOZZLES

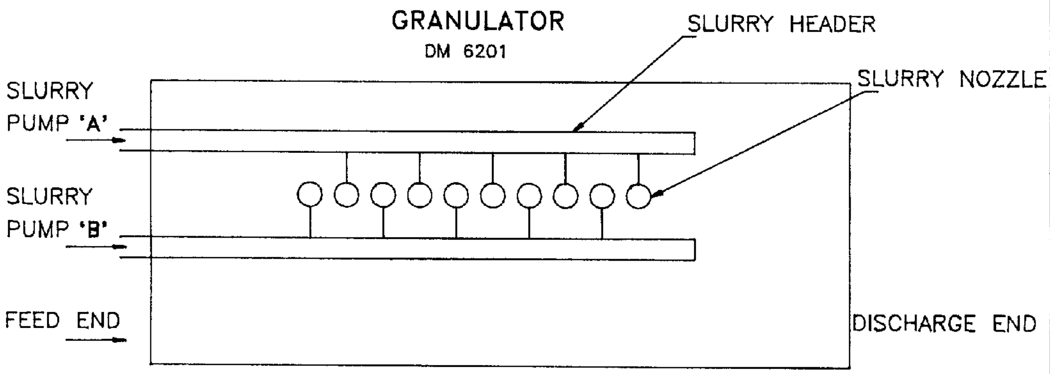


FIG (III)

ACTUAL PROCESS PARAMETER AROUND GRANULATOR

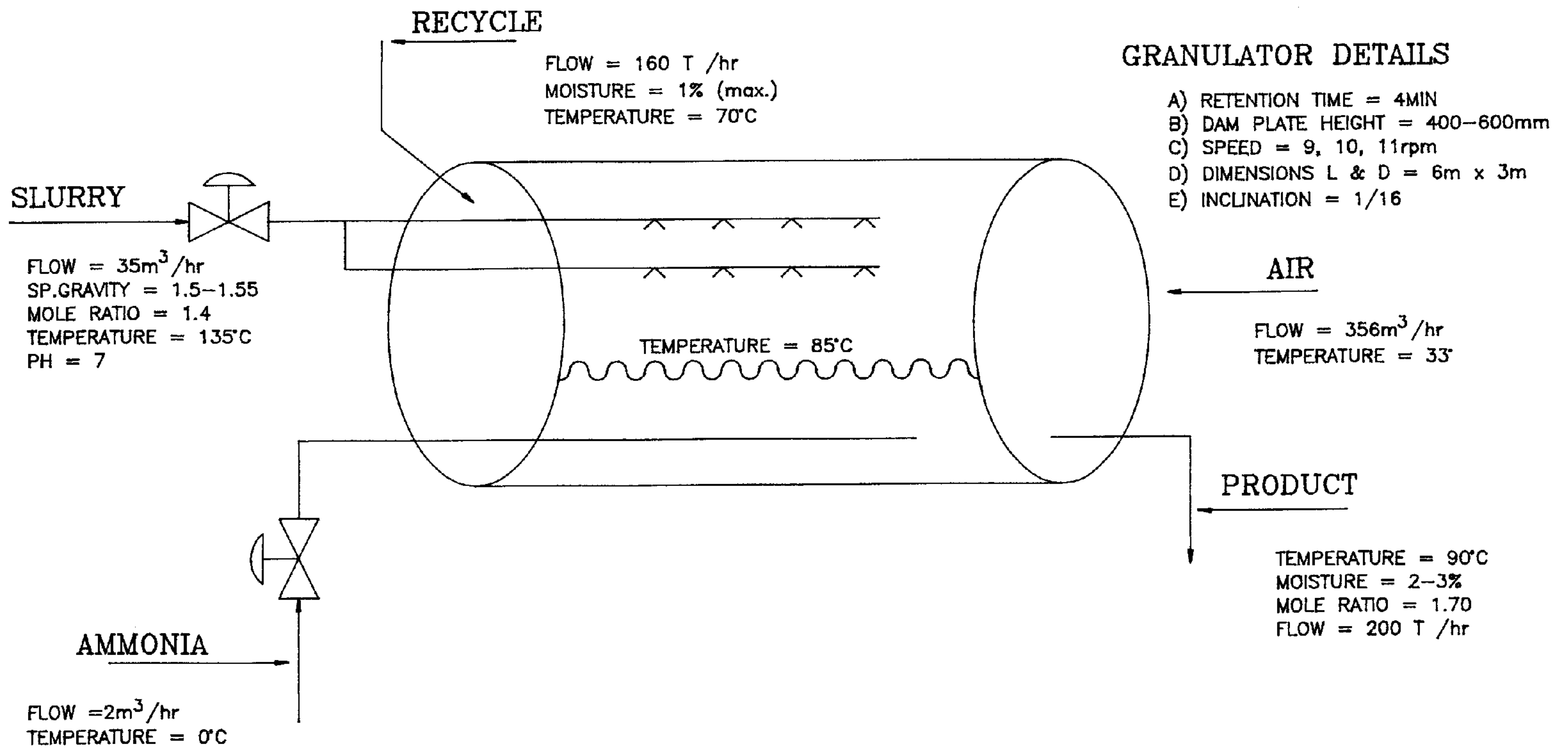


FIG (IV)