International Fertilizer Industry Association

IFA Technical Conference

New Orleans, Louisiana, USA
1-4 October 2000

International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
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EXPERIENCE OF IMPROVING CAPACITY AS WELL AS PRODUCTIVITY FOR GNFC UREA PLANT BY IMPLEMENTATION OF MODERNIZATION CONCEPTS AND DEBOTTLENECKING MEASURES

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Gujarat Narmada Valley Fertilizers Co Ltd (GNFC) est l'une des plus importantes sociétés d'engrais en Inde et dans le monde pour la fabrication de différents engrais tels que l'ammoniac, l'urée, le nitrophosphate d'ammonium et l'ammonitrate de calcium. L'unité d'urée de GNFC a une capacité de production de 1 800 t/j basée sur la technologie du stripping d'ammonium de Snamprogetti, Italie. Pour maintenir la compétitivité sur le marché, il a été décidé de pousser la capacité de l'unité. Ceci devait se faire en étudiant tous les paramètres de fonctionnement et de conception et en identifiant les facteurs limitants de la charge de l'unité ainsi que l'efficacité et la productivité de l'unité. En conséquence, l'équipement et les machines ont été identifiés comme éléments limitants et plusieurs améliorations ont été apportées pour pousser la capacité à 2 350 t/j. Ces améliorations comprennent :

1) Remplacement des plateaux tamis du réacteur de l'unité d'urée par des plateaux à haut rendement
2) Modernisation des pompes d'ammoniac à haute pression
3) Programme de poussée de CO_2
4) Augmentation du débit de la machine de CO_2 par diverses mesures
5) Remplacement du stripper (décomposeur haute pression) par un stripper de plus grande capacité et de conception améliorée
6) Remplacement du condenseur de carbamate à haute pression par un nouveau condenseur de carbamate de conception améliorée
7) Identifications de dépôts métalliques / produits de corrosion sur les tubes des décompresseurs à moyenne et basse pression et actions convenables prises pour éliminer les effets adverses.
8) Changement de matériau de construction de plusieurs appareils par du matériau de construction techniquement supérieur.
9) Augmentation de la capacité et du rendement de diverses pompes par l'installation de propulseurs de conception améliorée, d'autres organes internes ainsi que des moteurs électriques de plus grande capacité et améliorés.
10) Un progrès dans l'identification des fuites dans le revêtement du réacteur par modernisation du trop plein du système de contrôle.
11) Remplacement des plateaux d'absorbeur moyenne pression et de la tour de distillation d'eau résiduaire par des plateaux de meilleur conception
12) Modernisation du compresseur de CO_2 et de la turbine
13) Modernisation des pompes à carbamate haute pression

SUMMARY

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Gujarat Narmada Valley Fertilizers Co. Ltd. (GNFC) is one of the leading fertilizer companies in India as well as in the world for manufacturing various fertilizers such as ammonia, urea, ammonium nitro phosphate and calcium ammonium nitrate. The urea plant of GNFC has the capacity to produce 1800 MTPD based on ammonia stripping technology of Snamprogetti, Italy. To sustain the competitive edge in the market, it was decided to enhance the capacity of the plant. This was to be carried out by studying all operational and design parameters and identifying the limiting factors for the plant load as well as efficiency and productivity of the plant. Accordingly, the limiting equipment and machineries were identified as bottlenecks and various improvements have been carried out to upgrade the plant capacity to 2350 MTPD. These improvements include:

1. Replacing the conventional sieve trays of urea plant reactor by high efficiency trays.
2. Modernization of high pressure ammonia pumps.
3. CO_2 enhancement scheme
4. Increasing CO_2 machine throughput by various measures.
5. Replacement of stripper (high pressure decomposer) by higher capacity, improved design stripper.
6. Replacement of high pressure carbamate condenser by higher capacity, new improved design carbamate condenser.
7. Identification of metal deposits / corrosion products on the tubes of medium pressure and low pressure decomposers and suitable actions taken to eliminate the adverse effects.
8. Changing the material of construction of several equipment by technically superior material of construction.
9. Increasing the capacity and efficiency of various pumps by installing improved design impellers, other internals as well as higher capacity and upgraded electrical drives (motors).
10. A breakthrough in identification of reactor liner leakage through modernization of reactor weephole monitoring system.
11. Replacing the trays of medium pressure absorber and waste water distillation tower by superior designed trays.
12. Modernization of CO_2 compressor and turbine.
13. Modernization of high pressure carbamate pumps.

By implementing these improvements, it is possible to operate the plant at very high level of production with minimum downtime. The implementation of modernization concepts and debottlenecking measures have helped in increasing the capacity of the plant and also in improving the stability as well as efficiency and productivity of the plant. The reliability of GNFC Urea plant has taken a sharp jump after implementation of all these measures.

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1.0 INTRODUCTION

Gujarat Narmada Valley Fertilizers Company Ltd. with 1350 MTPD ammonia plant and 1800 MTPD urea plant was conceived during late seventies and commissioned during 1981. After

that, various industrial chemicals plants and fertilizer plants were commissioned like Methanol - I & II plants, formic acid plant, acetic acid plant, weak and concentrated nitric acid plants, ammonium nitro phosphate plant and calcium ammonium nitrate plant. The urea plant of GNFC is designed based on ammonia stripping or self stripping technology of Snamprogetti. With the continuous efforts of all concerned, various modernization and debottlenecking measures have been implemented. This has helped in increasing the plant capacity from 1800 MTPD to ~ 2350 MTPD. The maximum production from the same plant was achieved 2411 MTPD on June 06, 1990 indicating what a committed team can achieve with highly innovative thinking. This paper describes the modernization concepts and debottlenecking measures implemented at GNFC urea plant.

2.0 IMPLEMENTATION OF MODERNIZATION CONCEPTS

1. Replacing the conventional sieve trays of urea plant reactor by high efficiency improved design trays

   Originally there were 10-number of sieve trays in urea plant reactor in top portion (~ 24 meter portion) of reactor out of total reactor height of 44 meter. These trays are required for inter-phase mass transfer between gas and liquid. It also helps in avoiding the back-mixing of urea product and thus maintain plug flow in the reactor. After various studies, urea technologists found that, the bottom portion of the reactor should also be utilised efficiently by provision of some additional trays and also the design of trays should be changed to have maximum inter-phase mass transfer. So, it was decided to replace the conventional sieve trays (10-number) by new modified improved design high efficiency trays (14-number). This has helped in improving the CO_2 conversion to urea by @ 3 % and thus savings of medium pressure steam (25 Kg/cm^2 pressure and 225 deg C temperature) by @ 100 Kg/Mt urea. The improvement in conversion has helped in reducing the load on downstream sections and thus helped in debottlenecking the limitations for increasing the plant capacity.

2. Modernization of high pressure ammonia pump

   The high pressure reciprocating ammonia pumps were originally with “T bore type straight bore construction”. This type of valve block were giving frequent problems of “O ring” leakage, internal valve failure etc. The new modernized valve block designed is “tandem type”. The tandem type new valve block with plunger retention system and water sealing system has helped in debottlenecking the constraints of ammonia pump, saving the valuable oil and in improving the safety systems of ammonia pump.

3. Replacement of stripper (high pressure decomposer) by higher capacity improved design stripper

   Stripper (high pressure decomposer) is the most critical equipment of Snamprogetti urea plants. It is a falling film heat exchanger in which falling film generates due to tangential flow of process stream through ferrules provided on the tubes. The original stripper was becoming the load limitation for the plant before 1990. Also, the titanium tube thickness reduction along with the problem of damaged tube mouth was causing anxiety. So, during 1990, this stripper was replaced by new improved design stripper having higher capacity and immediately after this, plant capacity could be increased up to 133 % of design capacity.

4. Replacement of high pressure carbamate condenser by higher capacity new improved design carbamate condenser

The original high pressure carbamate condenser was the major bottleneck for increasing the plant capacity due to its tube leakage problem. There were two carbamate condensers in series which were removed from the service during April 1992 and new improved design single carbamate condenser for higher capacity installed. The new design included reversal of the flow path, better material of construction of internals and tubes as well as adoption of precisely calculated surface area. After that, the problem of carbamate condenser had disappeared.

5. Increasing the capacity and efficiency of various pumps by installing improved design impellers, other internals and higher capacity and improved efficiency electrical drives (motors)

After increasing the plant load, many pumps and motors posed limitations and this forced us to run spare pump with the running pump to take care of the plant load. After detailed in-house study, the pumps internals were replaced by higher diameter impellers and high efficiency diffuser, etc., and then suitable trimming of the impellers was carried out and this helped in solving the limitations of pumps. Simultaneously electrical drives were also replaced by higher capacity and improved efficiency drives.

6. Replacing the trays of medium pressure absorber and waste water distillation tower by new better design trays

Medium pressure absorber of Snamprogetti Urea plant is a very important equipment. The performance of the column has been improved by replacement of new improved design trays and that has helped in debottlenecking the problem of medium pressure absorber. Waste water distillation column original valve trays have been replaced by new improved design ballast type valve trays. This has helped in improving the performance and waste water handling capacity of waste water section.

3.0 DEBOTTLENECKING MEASURES

1. CO_2 enhancement scheme

To generate more CO_2 for increasing urea plant load, CO_2 loaded methanol in rectisol wash unit was flashed at lower pressure and low pressure CO_2 thus generated has been diverted to phosphatic fertilizers plant and pure CO_2 is consumed in urea plant.

2. Increasing CO_2 compressor throughput by various measures

To increase the plant capacity from 1800 MTPD to 2350 MTPD, the CO_2 compressor throughput was the limitation. To overcome this limitation, 1^{st} stage suction pressure was raised along with increase of high pressure superheated steam (which is drive steam for CO_2 machine turbine). This required critical operational changes at the urea plant, ammonia plant and steam generation plant. Also, relief valves calibration values as well as other critical aspects of CO_2 compressor were suitably modified.

3. Identification of metal deposits / corrosion products on the tubes of medium pressure and low pressure decomposers and steps taken to eliminate the adverse effects

In the Snamprogetti urea plant, GNFC urea plant is the pioneer for identification of metal scales / deposits on the tube inside surface of medium pressure and low pressure carbamate decomposer. As urea plant is prone to corrosion, this corrosion products has a typical tendency to settle in the low velocity zones i.e. medium pressure and low pressure decomposer tubes. Now it has become a regular practice for almost all Snamprogetti urea plants to clean inside surface of the tubes by high pressure water jet cleaning every year. This innovative idea has debottlenecked the limitations of medium pressure and low pressure section at higher plant capacity.

4. Changing the material of construction of several equipment by technically superior material of construction

The material of construction of several equipment at the design stage was posing the problems of leakage and load limitations. So, at GNFC urea plant, compressor inter coolers tubes, high pressure ammonia pump block, ammonia condenser tubes and shell, vacuum evaporators etc. were replaced from CS material to suitable SS material. The phase wise replacement has really helped at GNFC Urea plant to increase the plant capacity and minimise the downtime.

5. A breakthrough in identification of reactor liner leakage through modernization of reactor weephole monitoring system

For almost all urea plants in world, there are various methods for monitoring and identification of reactor liner weld joint leakage. As urea plants reactors are operated at very high pressure and with corrosive products like carbamate and urea, it is requisite to monitor the conditions of reactor liner. In view of this, an in-house conductivity based weephole monitoring system has been developed at GNFC urea plant which takes care of liner leakage problem on continuous basis. This is a modernized technique to monitor the critical equipment like reactor.

4.0 MEASURES BEING IMPLEMENTED

1. Modernization of CO_2 compressor and turbine

After going into details of design as well as operational aspects of CO_2 compressor and turbine and in view of objectives of enhancing urea plant capacity, the revamp of CO_2 compressor is under implementation stage. In the revamp of the machine, it has been decided to install 3-D impeller in the MCL stage and this will help in minimising the losses and improving the performance of the machine in terms of capacity and power.

2. Modernization of high pressure carbamate pump

Due to various problems related to high pressure carbamate pump, it has been decided to replace the existing pump block of “T bore construction” by “tandem type

straight bore construction" valve block. This is the valve block modernized by the manufacturer to eliminate all problems related to pump.

5.0 CONCLUSION

The implementation of the modernized concepts, debottlenecking measures, innovative ideas and the important modifications have helped in increasing the plant capacity upto 133 %. The daily maximum production figure of 2411 Mt on 06-06-1990 (in the design capacity of 1800 MTPD), the monthly maximum production figure of 71770 Mt (in the design capacity of 55800 Mt/month), the yearly maximum production figure of 717454 Mt (in the design capacity of 594000 Mt/annum) and continuous uninterrupted running of the plant for 167 days are indicators of success and superlative performance at GNFC urea plant.