

EXECUTIVE SUMMARY

1. Cyanuric chloride is a white crystalline solid which is highly reactive, toxic and hazardous. It was discovered in 1827, but gained commercial importance after 1950. I.G. Farbenindustrie, W. Germany, were the world leader in commercial production of cyanuric chloride. It is a basic intermediate for the manufacture of reactive dyes, optical brighteners and weedicides. It also finds applications in diversified fields such as pharmaceuticals, plastics, rubber, explosives and surfactants.
2. Indian consumption of cyanuric chloride for 1988-89 is estimated at 1250 MT. and is expected to grow upto 1875 MT. by year 1994-95. At present application-wise consumption of cyanuric chloride in India is 70% for reactive dyes, 20% of optical brighteners and 10% for weedicides and other applications.
3. The world demand for 1988-89 was 1,20,000 MT. and which is expected to grow upto 1,50,000 MT. by year 1994-95. Production of reactive dyes in the developed part of the world is being phased out because of strict pollution control laws and their demand is likely to be met through imports from developing part of the world where pollution laws are comparatively less stringent.
4. Cyanuric chloride is manufactured by a two step process. In the first step chlorine is reacted either with HCN gas directly or by in situ generation of HCN from sodium cyanide and an acid to give cyanogen chloride and hydrochloric acid. HCl produced is of 5-8% concentration and may be either discarded after treatment or steam-distilled to give 19% or 33% concentrated HCl. In the second step, dry ClCN vapours are trimerized in the presence of a catalyst, preferably activated charcoal, to give cyanuric chloride. The process requires expertise from the view-point of material of construction, equipment design, process engineering, safety, pollution and handling aspects as hazardous chemicals are involved.
5. Sodium cyanide route was preferred earlier as HCN was not commercially available at all locations and transport of HCN was not permitted because of its highly toxic nature. NaCN which is manufactured from HCN is easily transported and it was, therefore, preferred. This route has now become obsolete in the advanced countries as it adds to manufacturing cost. In developing countries, like India, NaCN route is still preferred as HCN is not manufactured at the location and its transport is not permitted. In the developed countries, most of the cyanuric chloride manufacturers have in-house source of HCN and downstream products manufacturing facilities which make their products price competitive.

6. Suhrid-Geigy (SG) Chemicals were the first to start commercial production of cyanuric chloride in India in 1966. The process know-how for a 300 TPA, NaCN route plant was supplied by Ciba-Geigy Limited, Switzerland and engineered by Lurgi, W. Germany. A need for expansion of the existing unit was felt because of increasing market demand for downstream products. SG Chemicals, therefore, intensively searched for the latest technology on a global basis but were not successful as the technology is closely held. In absence of a suitable process collaborator, the plant capacity was doubled by duplicating the existing plant. Indian Dyestuff Industries Ltd. (IDI) purchased SG Chemicals in 1983-84 with a licensed capacity of 600 MT. per year and installed capacity of 675 MT. per year. IDI is the sole manufacturer of cyanuric chloride in India today.
7. Gujarat Alkalies and Chemicals Ltd. planned for utilising HCN by-product of acrylonitrile plant from their adjacently located IPCL and in-plant produced chlorine from their chlor-alkali unit. But as their prospective collaborator, Maurer, Switzerland had no reference plant to show and train GACL'S staff the proposal did not materialise. Few others—Gwalior Rayon, Madhya Pradesh; SICOM, Maharashtra and Western India Erectors, Maharashtra had applied in the past for manufacturing cyanuric chloride, but have not been able to move ahead with the project.
8. Hindustan Development Corporation Limited (HDC) have an approved foreign collaboration and Letter of Intent. They plan to set up a 300 TPA-demonstration plant and 1650 TPA of commercial plant at their Olpad, Gujarat site in collaboration with Raphael Katzen Associates International Inc., USA (RKAI). RKAI is a prestigious consultancy firm having experience in the field of cyanuric chloride. HDC plans to start production from the demonstration plant by 1991 end and that from commercial plant by 1993-94.
9. In India, R & D work on cyanuric chloride has been done only by the Indian Institute of Chemical Technology (IICT), Hyderabad. In 1970's they had developed one Kg. per hour NaCN route pilot plant which was licensed to Amar Dye-Chem Ltd., Bombay on a non-exclusive basis. After that, IICT did not do any further work on cyanuric chloride manufacturing process. ADC have a licence for 250 MT. per year but have no plans for implementing the same.
10. Subsequently, Atic Industries Ltd., Atul, Gujarat (AIL) approached IICT for cyanuric chloride technology. IICT have completed sponsored bench scale study for Atic Industries Ltd. (AIL), Gujarat and have designed a 10 Kg. per hour pilot plant which is under installation. A commercial facility will be designed based on process data from the pilot plant operation.
11. Cyanuric chloride manufacturers are also process licensors. However, because of slow growth rate of cyanuric chloride, they are unwilling to part

with the manufacturing know-how based on HCN route to protect their world-wide marketing interests. Existing manufacturers have a very tight hold on market and technology through cross-licensing and business arrangements. Hence, it is very difficult to procure latest technology from them.

12. There are a few design engineering groups who have designed, engineered and operated cyanuric chloride plants based on HCN route. But these were based on know-how obtained from process licensors. They do not have the latest technology but have offered to develop technology and engineer the units for Indian entrepreneurs. Some of the design engineering groups are Ing. A. Maurer S.A., Switzerland and Raphael Katzen Associates International Inc., USA.
13. The production of cyanuric chloride in India is now going on for over two decades. The sole Indian manufacturer, seems to have generally absorbed the operational technology, and have also set up a second manufacturing plant without recourse to imported know-how. However, they have not undertaken any basic development work, with the objective of modifying or improving the process technology. The quality of their product is still found deficient by users vis-a-vis imported cyanuric chloride. Neither have they undertaken the development of the process based on HCN, which would prove to be far more economical. Hence, absorption of technology by Indian Dyestuff Industries can be termed as partial.
14. IICT have developed NaCN based process know-how upto pilot plant stage, which is now being taken up for commercialisation. It would be worthwhile to undertake similar development and engineering efforts for technology based on HCN.
15. Process licensors are unwilling to give technology based on HCN route. Hence, indigenous research and development efforts should be encouraged for developing this technology. Development of technology in collaboration with reputed design engineering houses should also be encouraged to bridge the technology gap, by providing necessary assistance.
16. There is a need for an additional capacity of 1500 - 2000 TPA by 1994-95. If HDC plant, based on HCN route is established, then this need will be satisfied. Beyond 1994-95, the market is likely to grow and there will be a need for a similar or a larger capacity plant.
17. Chemistry of manufacturing cyanuric chloride from NaCN or HCN route is well known. However, raw materials, intermediate products and final product are all toxic, hazardous and highly corrosive. It is, therefore, necessary to pay special attention to equipment design with special reference to materials of construction, operating safety and pollution. Such

an expertise in the country needs to be developed. This would enhance Indian expertise in the area of toxic and corrosive chemicals. It will also help to build up R & D and operating personnel bank which can be a national asset.

18. It is, therefore, recommended that all possible help and encouragement be provided in developing, importing and absorbing process technology based on HCN route.
19. Since the production involves safe handling of chemicals, and the treatment of effluents, which are highly toxic, the manufacture of cyanuric chloride should be restricted to only such units who have the necessary expertise, infrastructure and experience to handle toxic chemicals. Alternatively, the project should be set up in the vicinity of large units, to take umbrage under the complete disaster planning scheme which the large units would be operating for themselves and for the neighbouring areas.