EXECUTIVE SUMMARY

0.1 Acetone also known as dimethyl ketone CH_3 $COCH_3$ is colourless, mobile, flammable liquid with mildly pungent and somewhat aromatic odour. Its flammability in air varies between 2.13 and 13.0 percent.

0.2 It is widely used as a solvent for vast majority of resins, nitrocellulose, cellulose acetate, and pharmaceuticals. Its derivatives are ketenes, methyl methacrylate, bisphenol A, diacetone alcohol, mesityl oxide, methyl isobutyl ketone, hexylene glycol and isophorone.

0.3 Its chemical stability diminishes in presence of water. Acetone may react violently and sometimes explosively, especially in a confined vessel. It is particularly sensitive to oxidising agents like notoriously chloride, hydrogen peroxide and others.

0.4 There is Indian Standard (IS: 170 - 1986 third revision) for acetone adopted by the Bureau of Indian Standards.

0.5 The various technologies that have evolved over the years are :

- Prior to World War : Dry distillation of calcium acetate
- Early 1920s onwards : Dehydrogenation of isopropyl alcohol
- During World War II : Fermentation process & few ethanol processes
- Late 1950s & early 1960s : Cumene-hydroperoxide, phenol as main product
- Mid 1960 : Direct oxidation of propylene.

The current commercially important technologies are :

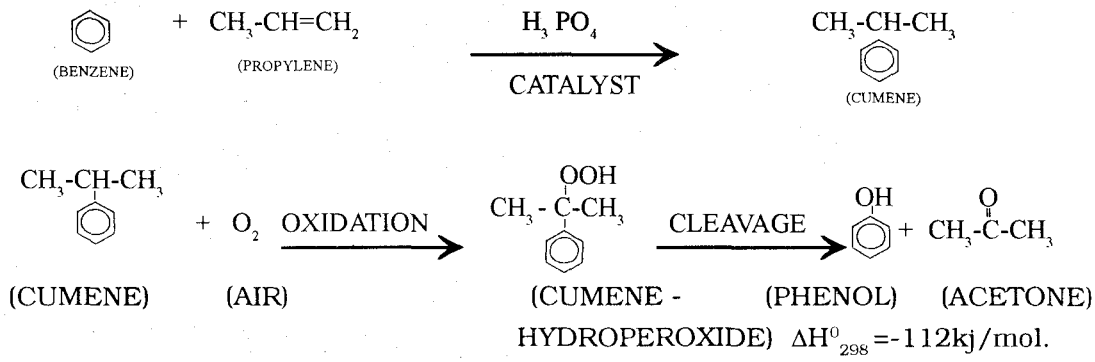
(i) Cumene - hydroperoxide process as by product of phenol :

(ii) Dehydrogenation of isopropyl alcohol :

0.6 It is estimated that, at present nearly 85 percent of world capacity is based on cumene oxidation route for co-production of acetone and phenol. In 1974 and 1986, the World capacity based on cumene for co-production of acetone phenol was 65% and 75% respectively.

0.7 Cumene is synthesised from propylene and benzene, followed by oxidation for the formation of hydroperoxide and splitting the same into acetone and phenol. The crude products are then fractionated to get pure acetone and phenol.

The chemical reaction sequence is as follows :



ΔH^{0}_{298} =-112kj/mol.

0.8 Dehydrogenation of isopropanol is the next process for the manufacture of acetone accounting for nearly 10 percent of total acetone capacity. The catalyst used is 7-8 percent zinc oxide, promoted by zirconium oxide (0.5 percent weight) at a temperature of 350-400^{0}C and about 2 at a pressure in tubular reactors. The crude product is fractionated and pure product is obtained.

0.9 In the alcohol based process, ethyl alcohol is vaporised and mixed with steam in right proportions, preheated and passed over the catalyst bed maintained at about 45^{0}C and slightly above atmospheric pressure. The catalysts used are Zinc chromite, ZnO or Fe_2O_3-ZnO-CaO. The conversion per pass varies between 80-65 percent. This process is not practised anywhere in the world except India.

0.10 There are eight units in India, one each in Kerala and Gujarat and rest in Maharashtra with total installed capacity of 68700 TPA. The production in 1993-94 was about 51000 MT. The prominent manufacturers are Herdillia Chemicals Ltd., Hindustan Organic Chemicals and National Organic Chemical Industries Ltd. accounting for nearly 36000 TPA.

0.11 The feed stock for HOC and Herdillia is cumene made in the same premises from propylene and benzene; for NOCIL it is isopropanol also made in the same premises and for the rest it is ethanol.

0.12 The technology for all these units are from different sources. HOC imported UOP, USA, technology while Herdillia and NOCIL got the technologies from B.P. Chemicals, UK, and Shell, Netherlands respectively. The technology for one ethanol based unit was imported from British Solvents, U.K and for the others, the technology was provided by Savalle Chemie India Pvt. Ltd. which had association

with Savalle Ltd. Paris, France.

0.13 The units with ethanol as feed stock normally do not run throughout the year. Moreover some of these units are also constrained by irregular supply of feed stock.

0.14 Present demand of acetone will grow to about 67000 MT by the year 1999-2000 as per Perspective Plan for Chemical Industry projections. Other data indicate much higher demand estimated at 90000 MT, Keeping in line with Phenol demand by the year 1999-2000.

0.15 Cumene and Isopropanol based technologies are considered contemporary ones, but the former is preferred for economic and as well as technological point of view.

0.16 Except for the ethanol based units, the performance of the industry is satisfactory.

0.17 The estimated world acetone capacity is 4.0 million MT. About 85 percent of these plants are based on cumene feed stock producing simultaneously phenol also.

0. 18 The trend of change of technology is evident since early sixties when nearly 81 percent acetone production was based on dehydrogenation of isopropyl alcohol compared to only 14 percent cumene based.

0. 19 The current world consumption of acetone is around 3.7 million MT. The world demand is growing, on an average at the rate of 3 percent/year. In the world market the demand of acetone goes up when phenol demand goes up.

0.20 Internationally the thrust in technology is towards energy efficient, cost effective and environment friendly ones. Intense world competition has led to the formation of joint licensing system i.e merging of two licensors into one, combining the best of both the technologies e.g Allied-UOP, B.P-Hercules etc. The prominent process licensors for acetone are Allied-UOP, B.P Hercules, Chevron, Power Gas Ltd. Rhone-Poulene, S/R (Societa Italiana Resine, Euteco, Italy), Ciech Imports & Exports of Chemicals Ltd. Bland, Mitsui Petrochemical and Inst. Francis du Petrol.

Zeolite based catalyst instead of conceptional solid phosphoric acid or aluminium Chloride is emerging as one of the ecofriendly production process for cumene in the USA. The organisations like Mobil/Badger, DOW, EOP and Kellog have developed zeolite based catalyst. Gradually the organisations are shifting towards the said catalytic process instead of conventional ones for cumene production for productivity coupled with less environmental pollution.

0.21 Although the part played by catalyst in all these processes is not very significant, yet there is a constant search for better catalyst for each process.

0.22 Ethanol based technology is also available from developed countries e.g A.W Freud & Associates, U.K, Chematur AB, Sweden, and Petrobras International S. A. Brazil. In India, ethanol based technology is available from Savalle Chemie India (P) Ltd. Bombay and Ordnance Factory, Aruvankadu, Tamil Nadu.

0.23 Indian acetone industry is in existence for more than two decades. Organisational approach of each unit towards technological improvements, process innovation and other cost effective measures through in-house R&D or sponsored research by reputed national laboratories has been different.

0.24 Sirsilk, one of the pioneers in the acetone (ethanol based) industry, through their in-house R&D work improved the converstion catalyst. The overall R&D activities of the ethanol based units are limited. The ethanol based technology is in use for more than a decade and is fully absorbed.

0.25 HOC, NOCIL and Herdillia, each one have their own R&D centre recognised by the Department of Scientific Industrial Research. Each of these organisations are multi product units. These units through their in-house R&D contributed towards improvement of imported technology. All these technologies are in use for a considerable length of time and fully absorbed.

0.26 The acetone/phenol units of Herdillia and HOC have more or less achieved specific consumption figures comparable to international ones.

0.27 The pollution control methods adopted by these units are, to a large extent, based on in-house R&D effort and integrated.

0.28 CONCLUSIONS

0.28.1 In India as well as abroad, bulk of the acetone is made as a co-product of phenol. Consequently, phenol demand determines to a large extent the availability of acetone.

0.28.2 Currently there are eight units in existence for the production of acetone with a combined capacity of 68,700 TPA.

0.28.3 All but three manufacturing units are based on imported technologies.

0.28.4 Cumene oxidation process along with phenol as a co-product accounts for nearly 60 percent of the total capacity.

0.28.5 The current capacity of 68700 TPA is just about adequate to meet the domestic demand of acetone.

0.28.6 The import and export of acetone has not been significant in the past.

0.28.7 The growth rate of acetone is in line with other chemicals and is close to 7-8 percent.

0.28.8 Ethyl alcohol based units are not doing well because of increasing feed stock cost, lower capacity utilisation and higher manufacturing cost.

0.28.9 The product manufactured in India meets IS as well as international specification.

0.28.10 Acetone industry is beyond the scope of small or even medium scale entrepreneurs from investment point of view.

0.28.11 Benzene and propylene are in short supply while ethanol production is steadily increasing but not available to consuming units regularly.

0.29 RECOMMENDATIONS

0.29.1 Projected demand for acetone being higher than current existing capacity, one or two more units may be required to meet the demand.

0.29.2 Because of identical growth of demand for acetone as well as phenol, cumene oxidation route should be given preference for production of two useful products simultaneously.

0.29.3 The problem faced by ethyl alcohol based units needs examination in order to make them competitive.

0.29.4 Sponsored R&D work is desirable for the improvement of the existing ethanol based acetone (including other alcohol-based chemicals) units as a long term strategy.