EXECUTIVE SUMMARY

0.1 INTRODUCTION

Formaldehyde is one of the most versatile chemicals and is a basic building block to many important industries. Formaldehyde is used to manufacture resins; as an intermediate for synthesizing other chemicals and is also directly used without further processing. The various applications of formaldehyde as resins, as an intermediate and as itself are described below :

As Resins : The largest amount of formaldehyde finds application in the manufacture of Resins, viz., Phenol Formaldehyde (PF), Urea Formaldehyde (UF) and Melamine Formaldehyde (MF) - which finds applications in laminates, plywood, MDF, particle board and hard boards. These resins are also used for the following :

- To produce curable moulding materials.
- As raw materials for surface coatings.
- As binders for foundry sand.

As an Intermediate : Formaldehyde is also used for synthesizing chemicals like :

- Pentaerythritol.
- Hexamine.
- Paraformaldehyde.
- 1,4 - Butanediol.
- Polyacetal Resins.

- Methylene Diplineylene Di-isocynates (MDI).

- Trimethylolpropane.

- Neopentylglycol.

Direct Use : Formaldehyde is also used directly for the following :

- Mirror finishing and electroplating.

- Preservation and disinfection.

- Film development in photography industry.

Though, there are several routes to manufacture formaldehyde, only routes based on catalytic oxidation of methanol are being employed today. Today, all of the world's commercial formaldehyde is manufactured from methanol and air using either a silver catalyst or a metal oxide catalyst. Silver catalyst process combines dehydrogenation and oxidation to obtain formaldehyde, while metal oxide process employs an oxide catalyst for a direct oxidation route to formaldehyde.

In comparison to conventional silver process which is based on incomplete conversion and distillative recovery of methanol, metal oxide process has higher yield, lower energy consumption through excess steam generation and produces highly concentrated formaldehyde solutions without distillation, allowing for low operating cost.

The improved version of silver process, which employs complete conversion of methanol avioding distillation step, has made it possible to produce formaldehyde of higher concentration with substantial reduction in energy consumption levels.

0.2 FORMALDEHYDE INDUSTRY : INDIAN SCENARIO

The formaldehyde industry started in India in early 1960s. Presently, there are about 25 formaldehyde plants having total installed capacity of about 3,59,700 tonne per annum.

At present silver process is predominant in the Indian formaldehyde industry. About 72% of the total capacity is based on silver process. Metal oxide process has been introduced in the country by mid-1980s and is found to be gaining acceptance.

Growth rate of the formaldehyde industry was found to be about 6% per year during 1979-80 to 1986-87. During the last five years, the average compounded annual growth rate observed is about 11%. The high growth rate in the last few years is mainly due to the growth in almost all the end-use sectors.

The consumption of formaldehyde during the year 1993-94 is estimated to be about 1,90,000 tonne.

In view of the growth in formaldehyde demand in past few years, it has been envisaged that market for formaldehyde will grow consistently in the coming years. Based on growth in various end-use segments of formaldehyde, demand for formaldehyde has been enstimated to be about 2,22,390 MT in 1994-95 and 3,70,450 MT in 1999-2000.

0.3 FORMALDEHYDE INDUSTRY : GLOBAL SCENARIO

The total installed capacity of formaldehyde in world is estimated at about 15 million tonne and the capacity utilisation is about 85-90% worldwide.

Of the present total capacity, about 30% is based in USA and Canada; about 32% in Western Europe and about 8% in Japan.

Of the total installed capacity, silver process has a major share of

about 60%. The recent trend is to adopt metal oxide process for new plants and it accounts for about 70% of the newly installed capacity.

The major producers of formaldehyde in the world are the following :

- Borden, USA
- DuPont, USA
- Perstorp, Sweden
- Hoechst Celanese, USA
- Georgia Pacific, USA
- Degussa, Germany

During 1982-1991, the average rate of growth in the world market was about 3.3% and 2-3% per annum in USA and Western Europe respectively.

Major formaldehyde consumption is in resins which are used as binders.

An average growth rate of about 4% is envisaged for the formaldehyde industry.

0.4 TECHNOLOGY STATUS IN INDIA

In India, both, silver catalyst process and metal oxide process are being employed for formaldehyde manufacture. Out of 25 formaldehyde plants, only 4 plants are based on metal oxide process; while the rest of the plants are based on silver catalyst process.

Almost all plants were set up based on know-how obtained from foreign technology suppliers. However, complete detailed engineering were done by domestic engineering consultants.

Most domestic formaldehyde manufacturing units are found to be operating at approximately same level of performance, with minor variations. These variations can be attributed to following factors :

- Type of Process Adopted.
- Source of Technology.
- Source of Catalyst.
- Age of the Plant.

Several important observations made on the current technology status in India have been summarised below :

(i)	Efficiency of Technology	Yield of plants based on silver catalyst process is found in the range of 86-90%, while for plants based on metal oxide process is 91-93%.
(ii)	Raw Materials	Methanol consumption per ton of formaldehyde is observed in the range of 450-500 kgs. in the units based on silver catalyst process, and 430-440 kgs. in the units based on metal oxide process.
(iii)	Electricity Consumption	Electricity consumption per ton of formaldehyde is found to be about 25-40 KWH in the units based on silver catalyst process, while it is 70-80 KWH in the units based on Metal Oxide process.
(iv)	Steam Consumption	Steam consumption of about 600-610 kg. per ton of formaldehyde is found in the units based on silver catalyst process.

(v)	Export Steam	About 260 kg of steam is generated in silver catalyst process based plants, while 620-630 kg. of steam is available for export in the plants based on metal oxide process.
(vi)	Instrumentation/ Automation	Plants based on silver catalyst process operates at nominal level of instrumentation as the process is simple. Plants based on metal oxide process have employed either Digital Control or Pneumatic Control System.
(vii)	Product Concentration	Formaldehyde units usually manufacture 37% concentration formaldehyde as compared to 55% concentration prevalent in advanced countries. Limitations have been found at the end-users level to use higher concentration of formaldehyde. Stabilizers required for higher concentration of formaldehyde are not available indigenously. Facilities for storage and transportation are not available at the producer's and end-user's level for higher concentration formaldehyde.
(viii)	Environmental Aspects	Solid and liquid waste are not generated in the formaldehyde plants. The off-gas is the only possible source of pollution. Most of the domestic units are recycling 2/3rd part of the tail

		gases and remaining is incinerated (in silver catalyst process) or oxidised to water and carbon dioxide by Emission Control System (In Metal Oxide Process).
(ix)	Safety Aspects	Most of the units are found to have taken effective steps for safety by providing rupture disc valves in the reactor, interlocks for tripping of the plant and flame-trap arrangement in air-methanol-water vapour line to prevent back flash.

With the growth of domestic formaldehyde industry, it is felt necessary to develop indigenous capability in the following areas :

- Basic Engineering.
- Catalyst Manufacturing.
- Equipment Fabrication.

In the above mentioned areas, many commendable efforts have been made and significant break-throughs have been achieved.

Formaldehyde industry is self-reliant as fas as the silver catalyst process is concerned. Few domestic units have claimed to have developed basic engineering capabilities for silver catalyst process.

Basic engineering package for metal oxide process is still sourced from overseas suppliers. However, National Chemical Laboratory, Pune has claimed to have developed this process at Laboratory Scale and are working further to develop basic engineering package.

Few domestic companies have developed silver catalyst indigenously.

Metal Oxide catalyst is still being imported. However, recently, National Chemical Laboratory, Pune has developed Ferric-Molybdenum catalyst and successfully transferred technology to manufacture this catalyst to M/s. International Catalysts Limited for commercial production.

Platinum catalyst, required for catalytic incineration of off-gases in Metal Oxide process is yet to be developed indigenously.

All the plant and machinery required for the silver catalyst process can be fabricated indigenously.

In the metal oxide process, all plants and equipments except catalytic converter pre-heater can be fabricated indigenously. Air blowers are also required to be imported as quality blowers are not available indigenously.

Few units have developed techniques to recover metal from the spent catalyst.

0.5 AREAS OF TECHNOLOGY GAPS

Inspite of above mentioned developments that took place through significant efforts of the industry and research institutions, gaps in several areas still exist, where the need for upgradation/improvement has been felt. Following gaps have been identified.

a) Product Concentration Front

- Inadequate facilities for storage and transportation of higher concentration of formaldehyde at consumers' and producers' end.

- Non-availability of stabilizers for the higher concentration of formaldehyde.

b) Application Front

- The requirement of formaldehyde for certain applications like Polyacetal, MDI, 1,4-Butanediol and Neopentylglycol does not exist in India.

c) Technology Front

- Non-availability of basic engineering package for metal oxide process, indigenously.

- Non-availability of technology to manufacture higher concentration and solid formaldehyde, indigenously.

d) Process Operation Front

- Higher methanol consumption levels in some units.

- High electricity consumption levels in some units.

RECOMMENDATIONS

i) Suggestions to Promote the use of Higher Concentration of Formaldehyde

The formaldehyde manufacturers may create awareness about the advantages of using higher concentration of formaldehyde among the user industry by organizing seminars, group meetings and others. The user industry should be provided with proper manuals for the usage and safe handling of higher concentration of formaldehyde.

The task of indigenous development of necessary stabilisers can be taken up by Auxiliary manufacturers alongwith national research laboratories, like NCL, Pune and IICT, Hyderabad.

ii) Suggestions to Improve Overall Performance of the Formaldehyde Industry

The formaldehyde manufacturers should initiate necessary steps to enhance exports of various derivatives of formaldehyde. There is a need to explore and identify the promising down-stream products which have export potential and countries where they can be exported to. This additional export market will help domestic units to attain better capacity utilisation levels.

New capacities may be added only by means of either expansion or by setting up large capacity plants, in order to attain better economies of scale.

The industry can give greater thrust for the development of new markets for formaldehyde i.e., Polyacetal, MDI , Neo Pentyl Glycol, etc.

iii) Suggestions to Strengthen Indigenous Capabilities and Achieve Self-Reliance

Large formaldehyde plants based on conventional silver catalyst process could be revamped with the features available in the advanced silver catalyst process. The entire revamping process can be carried out in a phased manner as described below :

Phase - 1 : Reduction of Refrigeration Load.
Phase - 2 : Change in the feed ratio.
Phase - 3 : Change in the reactor design.
Phase - 4 : Change in the absorber design.
Phase - 5 : Utilisation of Tail gases in the existing boiler.

The domestic engineering consultants offering advance silver catalyst process may organise a seminar to explain the benefits of revamping to the existing formaldehyde manufacturing units using traditional silver catalyst process.

The industry may promote the use of indigenous catalyst and carry out necessary research in collaboration with domestic catalyst manufacturers to improve indigenous catalyst. Domestic catalyst manufacturers may also make efforts for the export of catalyst.

Domestic capital goods industry may make necessary efforts to manufacture desired quality of high capacity blowers, which are required to be imported at present by the units based on metal oxide process. In fact, domestic engineering consultants engaged in the detailed engineering of formaldehyde plants can make attempts and extend their expertise in developing reliable and suitable vendors for the supply of critical equipments indigenously.

A time targeted programme may be undertaken at National Laboratories in collaboration with engineering companies to develop basic engineering pacakage for the metal oxide process. In the initial stage, efforts should be to develop pilot plant facility and then in collaboration with engineering company, efforts can be made for scaling up the developed process to commercial scale.

4) Suggestions to Improve Occupational Safety Levels

Formaldehyde manufacturers and end users must take necessary steps for safety and limiting formaldehyde exposure levels by taking preventive measures to avoid leaks, explosion hazards and check emission levels. Various safety measures that can be incorporated are the following :

Provision of rupture disc in a vaporizer.

- Immediate replacement of a cracked tube in a vaporizer.

- Use of Hermetic canned motor pumps to avoid formaldehyde leakage etc.

The domestic formaldehyde industry in collaboration with National Institute of Occupational Health (NIOH) should organise seminars and publish manuals to bring about awareness which is required for safe handling of formaldehyde and reduce health hazards to workers handling this product.