EXECUTIVE SUMMARY

0.1 INTRODUCTION

Synthetic diamonds find application, in the production of diamond tools such as, resin bonded grinding wheels, stone cutting saw, stone polishing wheels, mining tools like drill bits cutting tools for ceramic glass, etc. Synthetic diamond are, also, for making compacts, metal bonded tools, etc. which also find application in, cutting, rock drilling, etc. Synthetic diamonds are, available and used, in various sizes, starting from micron powder, used in polishing gems and stone, to 35-40 mesh-size, used in stone cutting saws.

Synthetic diamond is a synthesized super hard material, in fact, the hardest material known, and is generlly produced, by re-crystallization of graphite, under high temperature and pressure, in presence of, a catalyst.

Synthetic diamonds, used by the diamond tool industry, are, presently, totally imported from, M/s General Electric (USA), M/s De Beers (U.K) and Tomai (Japan). The item falls under the Open General Licence category.

0.2. MANUFACTURING PROCESS:

The manufacture, of synthetic dimonds, is, essentially, a conversion, from hexagonal graphite, to cubic diamond, in the presence of a catalyst-solvent. The efficiency of conversion, which determines the economics of the process, depends upon, (i) the right condition of pressure, temperature and the time, for which, the temp. is held. (ii) the cell composition and, (iii) the catalyst solvent used.

M/s General Electric Co. USA; De Beers (U.K), South Africa, Ireland and Sweden; and Tomai, Japan; are the major manufacturers of synthetic industrial diamonds. Industrial Diamond Engineers in Finland, one plant in Czechoslovakia and one plant in China, also manufacture, synthetic diamond in small quantities. All plants utlise the same process. The Russians have developed, their own, process and the manufacturing units are located at Kiev.

The annual production of synthetic diamonds, globally, is estimated at 150-200 million carats.

0.3 STRUCTURE OF THE INDIAN INDUSTRY

The synthetic diamond manufacturing activity has recently started in India and the industry is in its infancy. There are, at present, the following two manufacturers:

(i) **Industrial Diamonds India Ltd.** Their unit has a licensed capacity of 1.6 million carats and an installed capacity of 2.0 million carats. It has a technical collaboration with, Industrial Diamond Engineers AB Limited, Finland. The unit is located near Madurai, in Tamil Nadu. The plant was commissioned in October 1988. The synthetic diamonds produced in trial runs are, understood, to have been given for user trials.

(ii) **Napro Synthetic Pvt. Limited., Bombay.** The unit has a licensed capacity of 1.5 million carats and an installed capacity of 1.5 million carats. It has a, technical and financial, collaboration, with U.S. Synthetic Corporation, U.S.A. The plant is located at Bharuch. The plant was probably commissioned in October-November 1988. However, no details of production, quantities sold and the quality of the product are available.

0.3.1 Product Range

The units are contemplating the manufacture of synthetic diamonds, in the varieties required by the diamond tool industry. However, it is not known to what extent they have been successful.

0.3.2 Selection of Collaborator

The world leaders in the synthetic diamond industry, i.e., General Electric, De Beers, and Tomai, have been refraining from offering any technical collaboration to the Indian industry and hence, only relatively less known sources of technology were availed of.

0.3.4 Process of Manufacture

The process adopted by the Indian manufacturers, is the same as is used by the world leaders in synthetic diamonds. A 'belt' die and punch assembly mounted on a vertical hydraulic press, is used.

Details of the size of the press and size of the die openning, are not available. However, it is understood, that these are much lower, than those, which are used by the two major manufacturers, GEC and De Beers. Presses of size of 20,000-70,000 tons carats and die opening, upto 150 mm, are used by these international manufacturers.

0.3.5 Technology Absorption,Technology Gaps and Thrust Areas

As the Indian units have just commissioned their plants and the products are still under trials, it is too early to make any assessment, about, the level of absorption, extent of technology gaps and the future plans.

However, it is learnt, that the end users will, always, insist on product quality, comparable, to that of imported synthetic diamonds, from the world leaders. As such, the existing, units will have to make, all-out efforts, to attain the desired quality standards; to satisfy the customers and to establish reputation.

0.3.6 Development Work-done in India

Considerable R&D activity has been carried out at NPL in the synthesis of industrial diamond under an UNDP project and the process developed and demonstrated at a laboratory scale. Efforts to upscale the process were not successful as the 1000 tonne press imported for the purpose could not be operated satisfactorily. Hence the process could not be commercially exploited.

The infrastructure available, at NPL, can, however, be utilised for providing R&D support to synthetic diamond manufacturers.

0.4 IMPORT OF SYNTHETIC DIAMONDS

The total import, of synthetic diamonds, from January to December 1989, was about, 8 million carats, valued at about Rs. 6.20 crores. The break up in terms of end uses, is as follows :

Tools & grinding wheels	1.5 m carats
Saws	1.0. m carats
Polishing Powder	6-6.5 m carats

0.5 INTERNATIONAL PRICE

The price of synthetic diamonds, as indicated by one diamond tool manufacture, in the year 1987, varied between 0.90 U.S. dollars, per carat, for micron powder, to, 4.10 U.S. dollars, per carat, for diamonds for segmental saws, used for cutting granite. However, similar grade diamonds are reported to have been imported, by another manufacturer, at lower prices, in 1989.

0.6 CUSTOMS DUTY

The customs duty, on synthetic diamonds, is 70% and, on raw materials and consumables, required for the synthesis, about 180%, because of which, as also, the high cost of capital equipments, it may not be possible to produce synthetic diamond indigenously at the international price.

0.7 CONCLUSIONS & RECOMMENDATIONS

Conclusions

0.7.1 Synthesis of diamond production is a high technology process, with heavy capital investment.

0.7.2 Authentic data, on consumption of synthetic diamonds, during the past five years, is not available. However, information obtained from the Assistant Collector of Customs, Bombay, has indicated, that during 1989, about 8.5 m carats of synthetic diamonds, valued at about Rs. 6.2 crores were imported. Out of these, about 6 m. carats was micronic polishing powder, which is a low cost item. The import of shaped diamond was, only 2.5 m. carats. In view of this, low value of imports, setting up of two manufacturing units, with an investment of, about, Rs. 6 crores each, does not seem to be viable.

0.7.3 Due to non-availability of the required authentic data, the demand, during the next decade, can not be predicted.

0.7.4 The major international producers, of synthetic diamonds, are M/s Des Beers U.K. and M/s General Electric U.S.A.

0.7.5 The present demand, in India, is met totally through imports, under open general licence, mainly, from the two major producers.

0.7.6 The price, of synthetic diamonds, is manipulated, by the major producers, to ward off competition, from the other manufacturers.

0.7.7 Two units have recently, commenced production of synthetic diamond, in India, with foreign collaboration. Their products are, under trial, by the user industry.

0.7.8 The range of products, being manufactured/proposed to be manufactured by these units, may not meet the requirements of the user industry, who has serious reservations, about the capability of indigenous units, to produce shaped diamonds, as well as, their economy of production.

0.7.9 The present installed capacity is 3.6 m. carats. The break up of this capacity into the size of diamonds to be produced is not known.

0.7.10. Considerable R&D work at a laboratory scale, was carried out, by the National Physical Laboratory, New Delhi, in the synthesis of diamonds. The technology, however, could not be commercialised, nor, it, could be demonstrated at a pilot plant scale. A 1000 tonne press and other facilities, are available at N.P.L. which can be utilised for R&D work.

0.7.11. At present, the customs duty, on import of synthetic diamonds,. is 70%, while, on the raw material and consumables, used in synthesis of dia-

monds is 180%. It may not be possible for the Indian manufacturers to produce the diamonds at international prices.

0.7.12 Compacts of cubic boron nitride, as also, of synthetic diamonds, are being used, internationally. These are not being produced, in the country, at present.

Recommendations

0.7.13 A high power committee may be appointed to carry out a techno-economic study, of the two manufacturing units. The committee may consider, inter-alia, the following aspects:

(a) Technology imported and the range of products that can be produced, form it.

(b) Training of manpower.

(c) Availability of, raw-materials and consumables, required for production.

(d) Costs of production.

(e) Support required to make the units economically viable.

0.7.14 New manufacturing units may not be allowed, till such time, as, ability of indigenous units, in terms of quality and cost, is fully ascertained.

0.7.15 Efforts should be made to utilise the equipment and facilities, available at the National Physical Laboratory, by the existing manufacturers, by a suitable arrangement between them and CSIR. Association of major diamond tool manufacturers with R&D would also be advisable. Some of the areas, where assistance could be provided, are :

(a) Optimisation of the design of the punch and die assembly.

(b) Determining suitability of indigenous raw-materials and consumables for diamond production

(c) Optimisation of process parameters to obtain desired shapes and sizes of synthetic diamonds

(d) R&D work on other super-hard materials, such as cubic boron nitride and compacts of CBN and diamonds.

(e) Development work in making compacts of cubic boron nitride and synthetic diamonds.