Application of Superconductivity & Related Cryogenics in India: Present & Future Prospect

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***Abstract*— Low temperature (4.2 K) physics research in India started at National Physical Laboratory (NPL), New Delhi in the year 1952 under the leadership of Prof. K S Krishan, founder Director NPL and Prof. David Shoenberg of Cavendish Laboratory, Cambridge. An ADL - 50 Collin's helium liquefier of capacity 4 litres/hr was commissioned at NPL that year. Perhaps in the same year the first commercial helium liquefier was also installed in Japan at Tohoku University. Low temperature physics studies along with basic research on superconductivity spread to a number of institutes in India during 1960- 1970. During 1980–90, multi-filamentary Nb-Ti wires in long lengths were produced at BARC, Mumbai and now pursuing Nb-Ti CIC conductor for tokamak programme. Around the same time A-15 superconductors (Nb_3Sn & V_3Ga) were produced by NPL on a laboratory scale. Several Nb-Ti and Nb_3Sn magnets for a variety of applications were built at NPL. The activity in the field of applied superconductivity got a quantum jump during 1990-2000 in terms of man power, facilities and enhanced funding. Challenging projects like Superconducting Cyclotron (K-500) at VECC. Kolkata, Superconducting Linear Accelerators at IUAC Delhi & TIFR Mumbai (using SRF cavities) and Steady State Superconducting Tokamak (SST-1) at IPR, Ahmedabad were undertaken. During the same period RRCAT, Indore contributed to LHC programme at CERN by supplying more than 2000 superconducting corrector magnets. In parallel, NPL and BHEL collaborated to develop successfully a 5 T high gradient magnetic separator and a 200 KVA superconducting generator. All these programmes enhanced the capacity of a single helium refrigerator from 100 W to 1 kW. Their number too grew manifold. Large scale consumption of liquid helium prompted the indigenous development of helium refrigerators based on reciprocating engine and the turbine technology at RRCAT and BARC respectively. A SQUID based magneto-encephalogy facility was developed at IGCAR, Kalpakkam. Unfortunately, we do not have participation of industry in India and it is for this reason that scientists' capabilities have never been exploited for commercial production. Some public-sector companies are working on the development of electric devices like FCL, transformers and motors using HTS, 1 G as well as 2G wires. India is now participating in some international projects like ITER at France, FAIR at Germany and ILC with KEK. All these programmes will be focusing on high field RF superconducting cavity and large size focusing magnets for high energy physics. Indian Cryogenics Council is playing an important role to promote the activity of applied superconductivity and cryogenics in India. It is presumed that in near future, superconductivity for power application, development of MRI magnet along with the RF superconductivity will be the thrust area in India.**

***Keywords (Index Terms)*— Helium liquefier, cryogenics, magnet, accelerator, fusion, SQUID, power application.**

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