Development of SAF and Carbon Fibres

Carbon fibre technology transfer to M/s Kemrock Industries and Exports Ltd.

philosophy and safety interlock requirements have been worked for the commercial plant. Further, NAL provided hands on training to engineers and scientists of Kemrock spanning a period of about 60 days.

Since a carbon fibre plant of this capacity was being established for the first time in the country, equipments like fibre spinning machine and carbonization furnaces were not available in the country. Kemrock and NAL decided to walk the extra mile and develop Indian vendors for these equipment. To their credit M/s Genest Engineers, Ahmedabad and M/s Therelek Engineers, Bengaluru, the two industries identified for the purpose have done a very good job.

Space applications require special grades of carbon fibres with very high modulus together with high strengths. NAL has been trying to develop these special grade fibres with funding from Vikram Sarabhai Space Center, Tiruvananthapuram, one of R and D organizations of Department of Space. The activity initiated about three years back has made significant progress. Around 75% to 80% of the targeted properties have already been achieved.

The development of carbon fibres was possible because a number of organizations namely CSIR, NAL, ADA, DRDO, VSSC, DOS and Kemrock joined hands to pursue an important national goal.

Carbon Fibre Technology

Achieving production level scale-up in a key material sector

Keeping in view the strategic need in the country for carbon fibre based materials, a pilot plant for development of carbon fibres and prepgres has been set up at NAL with funding and support from ADA, DRDO, ISRO and CSIR.

The Integrated Facility for Carbon Fibres and Prepregs (IFCAP) was established with the objective of developing technology for producing precursor fibers, various grades of carbon fibres and unidirectional prepregs. This facility became fully operational in 2004.

The technology has been transferred to M/s Kemrock Industries and Exports Ltd., Vadodara for commercial production.

Facility for the synthesis of polyacrylonitrile (PAN) copolymer

Spinning of special acrylic fibres (SAF)

Carbon fibre precision winding unit

Helping towards national security in a strategic technology
Taking India into the Carbon Composite Age

Carbon fibre is an important and strategic raw material for the fabrication of advanced composite materials. Carbon fibre polymer matrix composites are being extensively used as light weight structural materials in a large number of applications. Aerospace structures, wind turbine blades, sports equipment, off shore platforms and transportation are some of the important areas where carbon fibre composites are widely used. The use of these materials results in products with very high strength, high stiffness and very low weight. Ability to fabricate complicated shapes and large sized components with relative ease is another major advantage of using composites.

In India the use of carbon fibre composites has a history of nearly two decades. Several national programs, namely, the advanced light helicopter, the integrated missile development program, light combat aircraft, space satellites and satellite launch vehicles have been using carbon fibre composites on a large scale. The composites technology has reached a mature level and is comparable to the best in the world. Though the technology has been developed mainly in defense and aerospace organizations, its foray into other industrial sectors is only a matter of time. Easy availability of the critical raw material, carbon fibres, will catalyze these developments while simultaneously removing the dependence on overseas suppliers of carbon fibres for strategic applications.

CSIR-NAL and DRDO-ADA initiated research and development activities aimed at developing production technology for carbon fibres with NAL as the project executing agency. Dr. A.P.J. Abdul Kalam, the then Scientific Adviser to Raksha Mantri took a keen interest in the project. NAL established a state of the art pilot plant for the purpose after initial lab level trials to establish the basic processes. The pilot plant, designed by NAL, is equipped with processing equipment, dedicated utilities, effluent treatment and computerized process control and process automation facilities.

The production of carbon fibres starts with the synthesis of polyacrylonitrile – a synthetic polymer. This is done by polymerizing acrylonitrile in the presence of catalysts. The NAL pilot plant adopts a continuous process at a rate of 35 kg of polymer per hour. The polymer is then purified by washing with water, filtered and dried.

The second stage in the carbon fibre production is the conversion of the polyacrylonitrile powder into fibres. The polymer powder is dissolved in a solvent to get a viscous solution. This solution is then forced through fine holes to form liquid filaments. These are solidified in a water to get solid fibres. The fibres are washed free of solvent and stretched to reduce the fibre diameter to the desired level. 3000 to 12000 filaments are extruded simultaneously to produce an acrylic fibre yarn.

Midway through the technology development, in what later on turned out to be a master stroke, NAL took a proactive step to organize an industry meet to inform the concerned industries about the work going on at NAL. M/s Kemrock Industries and Exports Limited, one of the participants in the industries meet showed a keen interest in NAL’s approach and after a series of fruitful discussions decided to commercialize the technology being developed at NAL. This decision of Kemrock was very crucial and its importance can not be over stated. It meant that the time from initiation of R & D activities to commercialization of the technology was less than six years. Considering the complexity of the process this is no mean achievement.

As a part of the technology transfer, NAL provided conceptual design for the entire plant including equipment sizing. NAL has also carried out chemical engineering design of all the major processing equipment including mass, momentum and energy balances for the processing steps. Process control facilities for the plant were also designed.