CHAPTER VII

CONCLUSIONS AND SCOPE OF FUTURE WORK

7.1 Conclusions

The studies on the modification of petroleum pitch by chemical modification method and development of general-purpose carbon fibers from petroleum pitch and coal tar pitch were carried out. The modified petroleum pitch and mesophase pitch based carbon fibers were characterized for their chemical composition, mechanical properties and surface morphology.

Various conclusions drawn from these studies are,

Modification of low softening point petroleum pitch with nitric acid was carried out. Nitric acid being strong oxidizing agent, treatment with more than 30% conc. nitric acid and for longer time’s results in excessive dehydrogenation, cross-linking, increased softening point and incorporation of nitrate ions in the molecules. Though, their modification resulted in increased coke yield but the resulting coke was isotropic in character. Treatment of pitch with nitric acid of 20-30% conc. for shorter times (30-60 min) results in pitches of workable softening point, high coke yield and fine mosaic cokes. The modified pitches show noticeable changes in the softening point. The softening point rises from 110°C to 220°C. The modified pitch has enhanced the percentage amount of insoluble content. The chemical modification also affects formation of mesophase. It shows that after chemical treatment the development of mesophase structure get inhibited. The microstructure changes from anisotropic to isotropic as the concentration and time periods of chemical treatment is increased.

So the chemical modification of petroleum pitch effect on the softening point, carbon yield, microstructure and solubility of the pitches.
Modification of low softening point petroleum pitch by different concentration of sulphuric acid was carried out at room temperature for 1hrs time period. It is less reactive with petroleum pitch at room temperature as compared to the reaction with nitric acid. Softening point of petroleum pitch gets increased from 110°C to 150°C for higher concentration. The chemical treatment results on the formation of mesophase structure during the pyrolysis of pitches. The optical microscopy results show that as the concentration of sulphuric acid increases the formation of mesophase is inhibited and it shows change of flow structure to the coarse mosaic structure. So the chemical treatment with sulphuric acid inhibit the nucleation process of pitch molecules. The chemical modification also affects the solubility of pitches. The results show that the quinoline, toluene and benzene insoluble content increases as the concentration of sulphuric acid increase.

Low softening point pitch based fibers are difficult to stabilize in air. The nitric acid treatment of starting pitch fibers facilitates stabilization in less time periods at high heating rate. Both types of pitch fibers were brittle in nature after nitric acid treatment, but after stabilization, brittleness gets reduced. These fibers exhibit high carbon yield, but formation of some crack was observed along the fiber direction due to the strong oxidizing nature of nitric acid (70%wt). The fibers show isotropic structure after heat-treatment to 3000°C. it shows that the chemical treatment with nitric acid delay, the graphitization of pitch fibers.

The chemical treatment of as spun fibers with nitric acid affects the graphitization behavior of the carbon fibers.
Mesophase pitch based carbon fibers are the strategic materials for the high performance applications due to their light weight, high strength and high thermal conductivity. The studies were carried out on the effect of mixing different types of mesophase pitch and heat treatment temperature on the composition of the precursor pitch fibers mechanical properties, physical properties and microstructure. The results show that as the heat treatment temperature is raised the mechanical property of carbon fibers improves. The heat treatment temperature also enhances graphitization of carbon fiber. Addition of supercritical extracted pitch to mesophase pitch alters the spinnability and hence microstructure of the fibers. It results in mixed mode structure which in turn affects the mechanical properties of the fibers.

7.2 Scope of Future Work

The present studies were an attempt to study spinnability of the petroleum pitches and alternative methods to stabilize these fibers in relatively short time. The effect of these treatment on microstructure and properties of the fibers has been studied. However, there are some other oxidizing agent especially ozone, hydrogen peroxide which may also lead to rapid stabilization of pitch fibers. These studies can be undertaken in future. Further, the development of activated carbon fibers from these fibers and studies on their adsorption behavior can be studied in future.