Chapter 6

Conclusions

Research work presented in this dissertation has lead to following conclusions:

- The novolac-based network polymers **2.3** and **2.4** derived from low cost crosslinkable novolac-based epoxy resin precursor **2.2** were designed and introduced in *Chapter-2*. The resulting networks were characterized by FTIR, NMR, SEM, BET, thermal (TGA) and elemental analyses with successful application as adsorbents for the removal of representative azo dyes viz. MO, OII and OG from aqueous solutions. Adsorption was evaluated as a function of various parameters such as pH of the solution, contact time, initial dye concentration and the dosage of adsorbents. The maximal removal efficiency and adsorption capacity were observed at pHs 2.30 and 7.20 i.e., under neutral to acidic conditions. The highest uptake of OG by sorbent networks might be ascribed to the largest content of attractive functional groups. Isotherm study suggested that Freundlich model well described equilibrium adsorption data. pH-driven adsorption-desorption cycle suggested that reused sorbent networks can be efficiently used for removal of azo dye pollutants.
- *Chapter-3* described strategic utilization of networks (**2.3**, **2.4**), reported in *Chapter-2*, in the design of polymer-inorganic hybrid materials **3.1** and **3.2** incorporating iron(III). The hybrids were characterized by FTIR, XRD and thermal (TGA) analyses. Batch experiments were performed for

the adsorptive removal of azo dyes (MO, OG) from aqueous solutions. According to observations, hybrids have better sorption capacity than only novolac-based networks. Freundlich model was applied to the equilibrium adsorption data.

- *Chapter-4* presented the synthesis of network polymer **4.1** using easily accessible novolac-based epoxy resin precursor **2.2**. 3-aminopyridine served as cross-linking agent in this network. The characterization of **4.1** was performed with FTIR, solid state ^{13}C NMR, FESEM, BET, thermal (TGA), elemental and particle size analyses. The adsorption potential of **4.1** in the removal of representative azo dyes viz., MO, OII and OG from aqueous solution was highlighted. It also presented the effect of different parameters such as solution pH, contact time and initial dye concentration on the adsorption capacity of **4.1**. Compared to the reported adsorbents in *Chapters-2* and *3*, pyridine-rich network exhibited improved adsorption ability over a wide pH range. The equilibrium adsorption isotherm data obtained were in good agreement with the Freundlich model. Good recyclability for azo dye removal as also observed without any considerable loss in adsorption capacity.
- *Chapter-5* reported a new strategy that uses aminoalcohol functionalized novolac resin **5.1** to prepare the hybrid **5.3** with AgNPs. The antibacterial activity of the resulting hybrid was tested against Gram-positive bacteria, Staphylococcus aureus MTCC 3160, Staphylococcus epidermidis

NCIM2493, Bacillus subtilis and Gram-negative bacteria, Pseudomonas aeruginosa ATCC27853, Escherichia coli. Hybrid was found to offer bactericidal effect as observed from MIC values. The killing activity of **5.3** against S. aureus and P. Aeruginosa was noted. Further, hybrid **5.3** demonstrated to show membrane damaging action leading to the leakage of cytoplasmic contents of bacterial strains.

Altogether, the results suggested that the synthesized novolac-based polymers are promising materials for their eventual use in water treatment and biomedical applications. To the best of author's knowledge this is the first effort in constructing novolac-based materials to apply in these directions. Hence the outcomes of this research provided clear evidence of successful usability of novolac type phenolic resin, adding to the body of knowledge, as confirmed by the author's publication list in *Appendix*.