SUMMARY

This dissertation concerns with designing and synthesizing novolac type phenolic resin-based materials for uses as adsorbing materials to remove azo dyes from aqueous medium and antimicrobial system relating to health care applications.

Synthetic dyes, in particular, azo dyes are extensively used in various industries and have drawn a lot of attention because the discharge of dye containing industrial effluents is related with water pollution resulting into acute effect on environment and human health. Removal of such pollutants has become an essential task to save the environment/eco-system. Among several techniques, removal by polymer-based adsorbents has received increasing interest due to their unique physicochemical properties. On the other hand, antibacterial materials play an increasingly important role for environmental applications including disinfection in water treatment and in medical devices. With the advent of nanotechnology, a new generation of materials is being developed. Among them, polymer–nanoparticle hybrid materials have attracted interest for biocidal applications.

Taking into account these issues, this dissertation highlighted the new family of novolac-based materials with uniqueness and utilities in solving these issues, which have not yet been addressed.

The thesis is comprised of six chapters to communicate the findings of this investigation and is presented as follows:

Chapter-1: This introductory chapter gathered an overview of the author's motivation for undertaking this research, the general aspects of phenolic resin, its versatile properties and the basis of its selection in designing new materials toward azo dye decolourization and antimicrobial applications. Further, it covered the general aspects of antimicrobial polymer–metal nanoparticles hybrids in the context of author's achievement on novolac-based materials. Finally, this section presented objectives, outcomes and author's achievements and the organization of this thesis.

Chapter-2 described a full account of the syntheses, characterization and azo dye adsorption properties of novolac-based network structured materials bearing low molecular weight amine units, such as ethylenediamine and diethylenetriamine units. Synthesised materials were characterization by FTIR, ^{13}C NMR, SEM, BET, TGA and elemental analyses. In this section, the adsorption performance of synthesized materials in removing the selected azo dyes such as methyl orange (MO), orange-II (OII) and orange-G (OG) from aqueous solution was studied. Effects of the experimental conditions on the adsorption behavior were investigated by varying pH, contact time, adsorbent dose and initial concentration.

Chapter-3 focused on the extension of obtained novolac-based materials in the preparation of iron (III) loaded novolac-based networks as hybrid adsorbent materials showing high performance on azo dye removal from aqueous solution.

Chapter-4 explored the successful synthesis of novolac-based network structured sorbent bearing 3-aminopyridine units. Obtained network was characterized by FTIR, solid state ^{13}C NMR, FESEM, BET, TGA, elemental and particle size analyses. This network was found to be very efficient adsorbent for removal of representative azo dyes, i.e., MO, OII and OG over a wide pH range (acidic-neutral-basic conditions). Reusability studies on the prepared materials presented in Chapters 2- 4. Further, adsorption mechanisms of designated removal systems were outlined.

Chapter-5 offered discussion on the preparation of an antibacterial hybrid of functionalized novolac resin with Silver nanoparticles (AgNPs). The designed functionalized novolac was characterized by FTIR, ^{1}H NMR and TGA. The AgNPs in the hybrid were characterized by UV-vis and TEM. The antibacterial effectiveness of the resulting hybrid against (*Staphylococcus aureus* MTCC 3160, *Staphylococcus epidermidis* NCIM2493, *Bacillus subtilis)* and Gram-negative (*Pseudomonas aeruginosa* ATCC27853, *Escherichia coli*) bacteria was estimated from minimal inhibitory concentration (MIC) method. The results provide evidence of hybrid to achieve designated goal in its antibacterial application.

Finally, in *Chapter-6* concluding remarks on the development and applicability of novolac-based materials were given.