ABSTRACT

**Polyfunctional finish** is the term used for any single chemical finishing treatment which can impart more than one functional property in the textile material. The advantages are savings in energy, time and labor, reduction in lock-in period and increase in production. 100% cotton fabric requires several functional properties like crease recovery, dimensional stability, reduced flexural rigidity and soil release to make it ideally suitable for meeting the apparel requirements of the customer. Antimicrobial, UV repellent and flame resistance characteristics also expected to be present in the material meant for specific end uses. By choosing suitable new range of finishing chemicals, more number of functional properties can be imparted in cotton textiles using *one single application* process.

In this research work, polycarboxylic acids which were scarcely used in earlier researches viz., itaconic acid (IA), tartaric acid (TA), maleic acid (MA) and citric acid (CA) and chitosan were chosen as finishing chemicals and applied on cotton solely and in different combinations to study their effect on imparting multiple functional properties such as crease recovery with greater strength retention, soil release, reduced flexural rigidity, greater whiteness retention percentage antimicrobial and thermal resistance. Pad-Dry-Cure process sequence has been followed for all finishing processes.

In single PCAs application, peak density at 1730 cm$^{-1}$ in FT-IR spectroscopic study represents ester groups which confirm the formation of ester crosslinks between cellulosic chains. Crease recovery angle (CRA) increases as the concentration of PCAs increases in all the four PCAs treated
samples. A maximum CRA of 278° has been observed for 6% MA and 5% IA samples against 265° for the DMDHEU resin treated control sample. In case of PCAs treated samples, the strength loss is lower in the range of only 20 to 25%. Stiffness is lower with very low flexural rigidity values in the range of 7.34 – 17.40 mg.cm. All the PCAs treated samples exhibit the highest soil release grade 5. Whiteness retention is more than 95% in all samples. In single PCAs application, maleic acid and itaconic acid are found to be efficient in imparting the above functional properties at concentrations of 4% and above.

Since the functionality in terms of carboxyl groups increases in cases of combination of PCAs, their crosslinking ability also increases. The CRA value for MA and IA combination at 6% concentration shows a maximum of 281°. MA and IA can copolymerize in the presence of a catalyst to form a tetracarboxylic acid group which is the reason for better crease resistance. Synergy is observed when CA is combined with other PCAs. Soil release grade of 5 is obtained for all the combination samples. Whiteness retention percentage values are above 93% for all the samples. Among the different combinations used in the study, MA and IA combination samples at 5% and 6% are more efficient in achieving the functional properties.

Effect of concentration and curing conditions of chitosan has been studied using 3 concentrations of chitosan cured under 3 different curing conditions. Zone of inhibition values, for the bacterial strains *Escherichia coli* (*E.coli*) and *staphylococcus aureus* (*S.aureus*), increase as the concentration is increased from 0.5% to 1%. From 1% to 1.5%, the difference is not so pronounced. Zone of inhibition values for 1% chitosan samples range from
23mm-27mm for \textit{E.coli} and 25mm-31mm for \textit{S.aureus}. Amine groups present in chitosan inhibits the growth of bacteria. The nitrogen present in the amine groups of chitosan causes increase in flame retardant characteristics. All the chitosan treated samples show \textit{class I} flammability. Soil release grade of 4 is observed for all the samples. 1\% chitosan treatment cured at 170\textdegree C for 3min is the optimum concentration.

Combination of chitosan and single PCAs treated samples impart good antimicrobial property with zone of inhibition ranging from 22mm to 25mm for \textit{E.coli} and 24mm to 27mm for \textit{S. aureus}. As chitosan is crosslinked with cellulose using PCAs, durability of antimicrobial activity is better than that of samples treated with chitosan solely. \textit{Class I} flammability is obtained for all samples. Good CRA values in the range of 248\textdegree - 261\textdegree is obtained for all the samples. Strength loss is observed to be low in the range of 11\%-18\%. Soil release grade of 5 is recorded for all the samples. 1\% chitosan + 5\% maleic acid in single PCAs combination and 1\% chitosan + 5\% of maleic acid & itaconic acid (total concentration is 5\%) in mixed PCAs combinations are found the optimum combinations for achieving the multifunctional properties in an efficient manner on cotton textiles.