Use of Phenolic Resins for Conversion of Paper to Oil Filters.

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Literature studies have revealed that phenolic resins are widely employed for the conversion of paper to oil filters. The use of these products has taken a new turn since radiant curing has overcome some of the problems caused by low rate of strength development. The suitability of these phenolic products depends on the various functions related to viscosity, polarity, interfacial tension, molecular weight, solvent type, temperature and pressure. Water-soluble phenol formaldehyde resoles are being widely used for the preparation of oil filters. The characteristics of the resin should be such that stiffness is imparted to the paper in order to prevent collapse of the paper where the paper may be in contact with oil, fuel or water, and also to act as a binder for the surface through which the medium is being filtered. The present paper deals mainly on the studies carrid out for the conversion of filter paper to oil filters.

Phenolic resins are of considerable interest to the paper chemist for the conversion of paper and to impart to it various functional characteristics. Phenol-formaldehyde products may be added during beating or used for impregnating the paper web, on or off the machine. The application of these products has become more wide spread since radiant curing has overcome some of the problems in low rate of strength development.[1-3]

Impregnation technique is preferred as it produces high quality products. A comparison of various studies supports this view and it has been revealed that products of high chemical resistance and high quality electrical grades of paper are not made properly by wet web or beater addition[4].

Rate and extent to which resin systems penetrate into the fibre structure of paper are the functions of viscosity, polarity, interfacial tension, molecular weight, solvent type, temperature and pressure; while variables related to paper include hydration, fibre length, void concentration and density. The major factor is the use of solvent. Water is one of the best, and methanol close to it in swelling action on cellulose[5]. Retention studies of phenolics on fibres has been studied by Long et. al[6], while a detailed investigation on distribution of phenolic resins in laminating power has been carried out by Marton and co-workers[7]. Same authors have also discussed the interaction between fibres and phenolic resins[8].

Water soluble phenol-formaldehyde resins are widely employed for the conversion of paper to oiled filters. A German Patent[9] taken in 1966, discloses the use of phenol-formaldehyde products in iso-propyl alcohol along with a water dispersible methylhydrogen siloxane resin. Another patent[10] describes the manufacture of oil filters by impregnating the base paper with a formulation of water-soluble phenol-formaldehyde resin, vinsole, 20-28 (thermoplastic lignin type resin), resorcinol and water with a viscosity range 20-300 cp at 79°F. Two other patents[11,12] also describe the use of water soluble phenolic products to impregnate base filters for their conversion to oil filters. Moraru[13], in his paper has also discussed the use of these resins for the manufacture of crepe paper for gas oil filters.

The use of paper impregnated

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with thermosetting synthetic resin as a filtering medium particularly for applications such as oil filtration in the automotive field is now well established. The resin, in this application, is employed to impart stiffness to the paper so as to prevent collapse or disintegration under operating conditions, where the paper may be in contact with oil, fuel or water. The impregnant must therefore, act, both to increase the mechanical stiffness of the paper so that it will resist the pressures acting on it during construction and in operation and also as a binder from the surface into the medium which is being filtered. It is also necessary that these objectives should be met with the minimum resin addition since heavy impregnation would reduce the porosity of the paper and impair the flow of the medium. Since the filter should also withstand at elevated temperatures when used in internal combustion engines, the resin employed must therefore have adequate heat resistance.

In the present work laboratory experiments have been carried out to prepare water-soluble phenolic resole with all the mentioned characteristics using phenol and formaldehyde as the main raw materials, and alkali as a catalyst. Methanol was used as a solvent and samples were prepared after impregnation with the prepared phenolic resins. The studies have given promising results and helped in the preparation and formulation of a coating composition which will convert the filter paper to be used as to oil filters.

Experimental :

Samples of phenolic resoles, meeting the requirements mentioned above were prepared in the laboratory. The materials employed were phenol, m-chlorophenol, formaldehyde, sodium hydroxide and barium hydroxide. The reagents used were laboratory grade reagents.

Samples of phenolic resoles which gave promising results were prepared by varying P/F ratio from 1 : 1.2 to 1 : 1.7. In a typical reaction, phenol and formaldehyde were condensed, using sodium hydroxide as catalyst. The temperature during the reaction was carefully controlled and condensation carried out under reflux conditions, until a viscosity of 4-5 poises at 25°C was obtained; the reaction times varying from 1 to 3 hours. The condensation was stopped at this stage and the product was diluted with methanol. The prepared resole was used as such for paper impregnation. The contact period of sheet with resin was varied from 30 secs. to 3 mins. The sheets were finally dried and tested. The physical testing has shown a marked increase in their strength properties.

Discussion :

Phenolic resoles were produced by reacting phenol with formaldehyde sufficient to allow thermosetting, the product being obtained which is still soluble and fusible. The simple phenol used as the starting material can be replaced wholly or partly by other phenols, which are substituted on the ring positions ineta and para to the hydroxyl group. The use of m-chlorophenol is advantageous since they provide fire resistance. The other important factor is the use of suitable molar proportions of phenol to formaldehyde, (P/F). The P/F ratio below phenol formaldehyde 1 : 1 would yield product no thermosetting character, while amount of formaldehyde in excess of 2 moles per mole of phenol will not be desirable since it produces products with considerable odour.

Any commonly employed catalyst can be used such as alkali metal hydroxides; carbonate or ammonium hydroxides. For use, as an impregnant, the resole in the form of solution is preferred in a solvent which can easily be evaporated. Methanol is therefore, used as solvent to get favourable results. Acetone or methyl ethyl ketone are other replacements for methanol. Water can also be used as solvent but its use is avoided, since it reduces wet strength and is also slow to evaporate during the drying stage. The only difficulty encountered with phenolic resole is the storage of the prepared product. Further studies are in progress to increase the shelf life of the resole.

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