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NEW ENTERPRISES

ASBESTOS REINFORCED RESINS

CHEMICAL REACTIONS OF ASBESTOS

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SUMMARY The chemical modification of chrysotile asbestos (processed by the Nuclear Company) is being studied. The most likely point of attack for this type of asbestos is at pendant hydroxyl groups which can be represented by the fragmental formula: $\geq$Si-OMgOH. The reactions studied thus far have been with organic compounds containing groups known to be active with hydroxyls: anhydrides, acids (organic and inorganic), alkylene oxides and isocyanates. The work has followed an exploratory and fundamental pattern with each reaction being studied as quantitatively as possible by analyses, weight increases or losses of reaction product, etc. The results and information gathered for each reacting compound are summarized below. In no case should the information be considered as complete and further work is planned in all areas.

DISCUSSION Chrysotile asbestos is written empirically by various authorities as (1) $Mg_6(OH)_6Si_4O_{10}\cdot H_2O$ or (2) $Mg(OH)_8$-Si_4O_9. (Formula weight - 554.2)

These formulas represent the constitution of the recurring unit in the chrysotile polymer. The exact configuration of the silicon-oxygen bonding in the polymer spine is not clearly defined, to the authors at least, but the important consideration is that, in each recurring unit (that is 554.2 formula weight), there are six (-O-MgOH) groups.

Aqueous Hydrochloric Reaction

This reaction, of course, has been known and studied elsewhere and is not novel. The purpose of the study here was to determine the speed of the reaction and the ultimate amount of acid required for our particular form of asbestos. The reaction can be

represented as: $\equiv Si\text{-}OMgOH + 2\ HCl \longrightarrow MgCl_2 + H_2O + \equiv SiOH$. Reactions were carried out at boiling temperatures with 1.3-1.5 N starting acid. Data obtained showed that 11.6-11.7 mols of HCl were used for each formula weight of asbestos. Magnesium analyses at the same time indicated 5.6-5.85 atoms of magnesium were removed. The figures give good confirmation for the assumption of six (-MgOH) groups per formula weight. Sterling Forest has shown that the skeletal structure of the original asbestos polymer remains intact after acid treatment. Because of this fact, the residue should prove interesting for chemical modification and a relatively large amount is being prepared for this purpose.

Maleic Anhydride Reaction

The most desirable result of this reaction would be a product represented as:

$$\equiv SiOMgOOCCH=CHCOOH$$

This would give an asbestos product which might be visualized as giving chemically bonded filler for an epoxy/maleic/styrene resin system. Unfortunately, our work to date (all in organic solvent), indicates considerable cross-linking of the asbestos even with excess of anhydride. However, there is work underway with molten maleic anhydride in large excess reacting under pressure which may alter this picture.

Maleic Acid Reaction

The objective here, of course, is identical with maleic anhydride treatment. Reactions in molten maleic acid (mp 137-138°C) at 140-150°C and in boiling water solutions have given such large amounts of magnesium cleavage that this method of attack does not appear to have much merit. However, future work at lower temperatures might conceivably alter this picture.

Alkylene Oxide Reaction

Reactions at 150°C under pressure with propylene oxide at mol ratios of 167/1 have apparently produced, as might be expected, considerable amount of propylene glycols. However, in one experiment, where practically all of the oxide was reacted, there is considerable evidence that oxide was attached to the asbestos. Full evaluation of this product has not been completed, however.

Diisocyanate Reaction

The reaction with toluene diisocyanate in boiling methyl ethyl ketone solution (TDI/OH ratio 1:1) is quite rapid until it is terminated, apparently by cross-linking of the asbestos. This point occurs at approximately 1.4 mols diisocyanate/1.0 formula weight of asbestos. In another approach, a prepolymer of polypropylene glycol 425 and TDI (1.0/2.0 mol ratio) was prepared and then reacted at 135°C with asbestos (prepolymer/OH ratio 1:1). Weight increase of the product indicated 0.9 mols of the prepolymer had reacted with each formula weight of asbestos. The very interesting feature of this product was the fact that it was swollen considerably by organic solvents.

It is obvious that reactions using higher ratios of NCO/OH are in order and further work in this direction is planned.

ANALYTICAL In following acid/asbestos reactions, it is advantageous to follow analytically the stripping of magnesium from the asbestos molecule. Conventional analytical methods for the determination of Mg^{++} are tedious and time consuming. A rapid and sufficiently accurate method has been developed for our work, which involves the precipitation of the Mg^{++} ion from neutral solution with an excess of standard alkali solution. The precipitated magnesium hydroxide is allowed to settle and an aliquot of the supernatant liquid is back-titrated with standard acid and the Mg^{++} calculated from the alkali used for precipitation.

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