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METHOD OF PRODUCING FRICTION ELEMENTS

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The present improvements relate more particularly to a novel method of incorporating a specific type of saturant into a fibrous base and hardening the saturant into a binder within the fibrous base.

In a specific embodiment of the invention, it relates to improvements in a method of making rigid formed unwoven brake segments having an incombustible fibrous base, comprising asbestos. In the United States in recent years, rigid unwoven brake segments have enjoyed increasing favor, particularly for use in the internal expanded type of brake where small clearances are provided and wear is an important factor. As manufactured, this type of lining generally comprises a curved segment comprising asbestos fibres, usually felted, bonded with a binder having the characteristics of drying and curing to a hard durable state. The necessity for using a type of saturant which will cure to a hard durable state, substantially unaffected by frictional heat developed in service, has limited materials which can be employed as saturants and binders for this type of brake lining. Phenolic condensation products mixed with suitable friction augmenting or modifying agents have been found to possess properties making the phenolic condensation type of saturant particularly adaptable for this type of brake lining.

Previous methods of utilization of phenolic condensation products as saturants and binders for friction element stock either with or without the addition of a modifying agent, have required careful control and regulation of the chemical reaction taking place to insure uniform hardening; a separation of liquids involving the waste of a considerable quantity of constituents in the discarded aqueous layer; and another operation of heating, mixing and cooling to incorporate the modifying agent and complete the preparation. Briefly, these previous methods have comprised causing a reaction to take place between phenol or its polymers, formaldehyde solution and an accelerating base or catalyst, the reaction being controlled to produce a liquid reaction product having the property of being transformable by heat into a substantially insoluble, infusible body. Slow reaction would continue to take place in this liquid reaction product, and if not used within a reasonable time after manufacture, the continued slow reaction within the liquid itself would cause it to thicken, gel and finally harden into a solid. Where this liquid reaction product was used within a short time after it was made, it was mixed with a suitable modifying agent such as China wood oil or the like, the latter functioning to impart qualities of limited flexibility and heat deformability to the final hardened product.

The present invention proposed to secure the very desirable effects of using a phenolic condensation product in a very simple and efficient manner while obviating most of the serious objections to methods formerly employed. Briefly, the process comprises mixing at room temperature, hexamethylenetetramine, cresylic acid and China wood oil to produce a potentially reactive, non-reacted thinly fluid mixture, saturating the fibrous base with this mixture, initiating reaction by subjecting the saturated base to heat, and then curing the binder within the base to a substantially insoluble, infusible state.

As a specific feature of the invention, the initial reaction is carried out while the saturated base is maintained in a closed receptacle.

In the specific embodiment of the invention, a potentially reactive, non-reacted thinly fluid mixture is made up using about the following proportions: 45 parts cresylic acid, 10 parts hexamethylenetetramine, and 55 parts China wood oil. The hexa is easily soluble in cresylic acid up to at least 50% by weight of the latter. This mixture is prepared by simply mixing the ingredients in the cold, i. e. at room temperature. In the above proportions, when the hexa is added, there is a constant temperature rise of about 8° F., whether the initial mixture be at 40° F. or 90° F. This indicates that the rise in temperature is heat of solution and not that of exothermic reaction. The hexa solution also is completely stable, showing no tend-

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ency to thicken or react at temperatures below 100° F. It is thinly fluid and clear, its properties being practically those of the simple mixture of cresylic acid and China wood oil. This potentially reactive, but unreacted mixture is utilized in the present invention as a saturant having the asbestos fibrous base.

Large blanks of asbestos mill board comprising asbestos fibres felted on a wet machine into the desired thickness are then completely saturated in this unreacted mixture to about 45% increase, which may take from two to five hours, more or less. The saturated blanks are then removed from this saturant and allowed to drain, after which they are placed in containers into which they are intentionally caused to fit substantially snugly. As many blanks are placed together in a container as will fill it substantially completely. The container, which may be made of metal, may be then closed and made air tight and placed in a heated oven at about 225° F. for a period of from ten to fifteen hours, more or less. At the end of this time, the containers are allowed to cool, are opened and emptied. The blanks are now substantially dry and show marked plasticity. They do not adhere to each other. At this point some reaction has taken place between the constituents of the saturant, which reaction was initiated by the heat applied during the time the saturated blanks were held in the closed container. I have found that the drying or evaporation of the saturant concomitant with this initial reaction during a long low temperature heating operation in the open is not advantageous, both from the standpoint of waste of cresylic acid and the nuisance produced by the evaporated acid. The utility, therefore, of carrying out the low temperature heating period in a closed container filled as completely as possible with a saturated board will be obvious. I use a temperature of approximately 225° F., believing that in the presence of a saturated crysylic acid atmosphere and of a large proportion of cresylic acid, reaction might proceed slowly at a lower temperature, and in order to counteract this a temperature of approximately 225° F. was advisable. To determine the most desirable length of time at which the saturated blanks should be maintained during the initial hardening reaction, a test should be made to ascertain whether the saturated blanks have sufficient dryness and hardness for rolling to thickness.

On cutting the large blanks into strips and curing in shaping forms for approximately five hours at approximately 350° F., followed by approximately a two hour open cure at approximately 350° F., it was found that the segments produced had maximum toughness and strength and that the total loss of saturant, including that due to slight leakage of the containers, was between 4% and 7%. The final cure at 350° F. causes the reaction product to become substantially insoluble and infusible. It may be desirable to permit some plasticity at 400° F. for satisfactory application to brake shoes or other supports.

The two main advantages of the proposed process outlined above are: (1) The preparation of a reactive but unreacted saturant by a simple room temperature mixing of the ingredients, all of which are commercial and standard materials. The saturant so produced is a thin fluid which is stable and does not thicken up over considerable periods at ordinary temperatures. Because of its fluidity it is not essential that the surface of the saturated blanks be washed to remove excess saturant. (2) The elimination of loss of saturant by the closed container cure, allowing exact control of the final binder; the elimination of noxious vapors in the plant and neighborhood of the plant by preventing loss of saturant above mentioned. The increase in uniformity of the preliminary cure, because of the fact that the oven will be a heating oven with little or no circulation and uniform temperature, instead of a drying oven with large circulation and non-uniform temperature.

It is to be expressly understood that the present invention is not limited in any way to the particular proportions of materials referred to in the illustrated example, as these proportions may vary widely within the scope of the invention. Preferably the hexa is first dissolved in the cresylic acid, after which this solution is mixed with the China wood oil.

In addition to the advantages of securing complete saturation in a much shorter time than when employing former methods, the present invention eliminates the steps of preparing the initial condensation product from formaldehyde, ammonia and cresylic acid, then separating the water, then mixing with China wood oil and finally dehydrating and solubilizing.

Since the novelty of the present invention resides more particularly in a method of making the saturant and curing it in the presence of the fibrous base which it is desired to bond, it is not thought necessary to describe in detail the particular method of making the rigid brake lining for which the present invention is particularly adapted, since my co-pending applications, Serial No. 114,849, filed June 9, 1926, and Serial No. 247,753, filed January 18, 1928, describe in detail methods of making this type of brake lining utilizing saturants and binders by methods different than that which forms the basis of the present invention.

While I have particularly described the saturation of asbestos mill board, it is to be understood that the present invention is just

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as applicable to the saturation of woven asbestos fibrous material.

While I have described the use of China wood oil as one of the constituents of the saturant, it is to be understood that I do not wish to be limited specifically to China wood oil, as any vegetable oil or gums will dissolve satisfactorily in the hexa cresylic acid mixture, as will also tars and pitches derived from coal or other oils derived from coal. Furthermore, fatty acid pitches and fatty acids, caseins, etc., dissolve satisfactorily.

I claim as my invention:

1. A process which comprises mixing hexamethylenetetramine, cresylic acid and a modifier to produce a potentially reactive, unreacted thinly fluid mixture, saturating a fibrous base therewith, subjecting the saturated base to heat in a closed container while preventing substantial loss of vapors to initiate reaction and partial hardening, continuing said heating in said closed container until the saturated base shows marked plasticity, and thereafter curing said saturant to a substantially insoluble infusible state by subjecting the saturated base to a higher temperature.

2. A process which comprises mixing at substantially atmospheric temperature hexamethylenetetramine, cresylic acid and China wood oil in proportions correlated to produce a potentially reactive, unreacted thinly fluid mixture, saturating a fibrous base therewith, subjecting the saturated base to heat in a closed container while preventing substantial loss of vapors to initiate reaction and partial hardening, continuing said heating in said closed container until the saturated base shows marked plasticity, and thereafter curing said saturant to a substantially insoluble infusible state by subjecting the saturated base to a higher temperature.

In testimony whereof I affix my signature.

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