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ASPHALT EMULSION

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This invention relates to asphalt emulsions and has for its objects the provision of certain improvements in the manufacture of asphalt emulsions and the provision as a new article of manufacture of an improved asphalt emulsion.

This application is a division of our Patent No. 1,714,982.

The asphalt emulsions of commerce are for the most part mixtures of asphalt and water with various agents designed to effect and maintain an emulsification of the asphalt and water. Colloidal clays have been largely used commercially as so-called emulsifying agents, while numerous other substances have been suggested in the patent and other literature, such for example as colloidal vegetable and animal substances, soaps, alkalies, etc., which are true emulsifying agents. Relatively large amounts of these agents have been prescribed as necessary in order to produce a reasonably stable asphalt and water emulsion, and/or suspensions in the case of clays and the like.

We have discovered that tri-sodium phosphate crystalline ($Na_3PO_4+12H_2O$), or dehydrated tri-sodium phosphate (Na_3PO_4) in relatively small amounts effects very satisfactory and true emulsification of asphalt and water. We have moreover found that this emulsifying action is only effective when limited quantities of tri-sodium phosphate are used. In other words, there appears to be a critical relationship between the amount of tri-sodium phosphate used and the effectiveness of the emulsification, whereby satisfactory emulsification can only be obtained when the amount of tri-sodium phosphate employed is between critical predetermined limits, which vary with different kinds of asphalts. Thus, when the amount of tri-sodium phosphate employed as the emulsifying agent is increased beyond about 0.4% Na_3PO_4 calculated by weight with respect to the emulsion in the case of a certain grade of Bermudez asphalt, the resulting mixture of asphalt and water while possessing certain aspects of an emulsion is a markedly inferior product to that obtained when less than 0.4% or about 0.24% of Na_3PO_4 is employed as the emulsifying agent. While with a California steam distilled asphaltic base oil residual asphalt the best emulsion is obtained when using more than 0.4% but less than 0.6% Na_3PO_4.

Our present invention, based on the foregoing discoveries, involves the emulsification of asphalt and water by the emulsifying action of relatively small amounts of tri-sodium phosphate, preferably not exceeding 0.24% Na_3PO_4, by weight on the weight of the finished emulsion, in some cases. In the practice of the invention we have secured excellent results with from 0.1 to 0.3% of Na_3PO_4, calculated by weight with respect to the weight of the emulsion. In no case should the tri-sodium phosphate exceed about 0.75% Na_3PO_4 by weight on the emulsion, and the optimum results will usually be obtained when the amount of tri-sodium phosphate is considerably less than 0.6%

The following examples illustrate the practical application of the principles of the invention:

100 kilograms of water are heated approximately to boiling, as for example by the injection of live steam. One kilogram of crystalline tri-sodium phosphate equal to about 0.4 kg. Na_3PO_4 is added to this hot water. 100 kilograms of freely flowing molten asphalt are then gradually run into the hot water containing the dissolved tri-sodium phosphate. The mixture is vigorously stirred while the molten asphalt is being added to the water. The stirrer used for this purpose should be of a fairly active type, such for example as a propeller stirrer, and should be arranged to disseminate the asphalt promptly after it contacts with the water. When the asphalt has been thoroughly and uniformly dispersed throughout the water, the mixture is run through an emulsifying machine, such, for example, as a colloid mill. The resulting emulsion discharged from the emulsifying machine is relatively hot and while cooling to room temperature should be gently stirred, with or without artificial cooling.

As another example of the application of the invention, we will describe the manufac-

ture of an emulsion containing three parts of asphalt and one part of water. The water (250 kilograms) containing four (4) kilograms of crystalline tri-sodium phosphate (1.6 kg. Na_3PO_4) is heated to a temperature of about 80° C. The molten asphalt (750 kilograms) at about 135° C. is introduced into the water in a regulated stream and with continuous agitation from a fast moving propeller agitator. If the asphalt is added too rapidly, the emulsion may boil over, also the asphalt may "float" because it is not taken up by the water as fast as it is fed. These conditions should be guarded against since it is preferable to get the asphalt completely emulsified at the time it enters the water. The preliminary coarse emulsion formed in this way is now fed, continuously and with appropriate stirring, into a mechanical emulsifier, such as a colloid mill, from which the finished fine emulsion is continuously discharged. The emulsion discharged from the emulsifier is cooled, artificially if desired, with gentle stirring and canned, or otherwise prepared for storage or use. The operations of cooling and canning are preferably conducted in a continuous manner to prevent asphalt skin formation caused by undue exposure of the warm and rich emulsion to air.

The cold emulsion resulting from the foregoing operation is of a dark brown color and of a heavy consistency but will yet flow which is remarkable considering the high asphalt content (3 asphalt to 1 water) and the small amount of emulsifying agent (1.6 parts Na_3PO_4 to 750 parts asphalt or 1000 parts emulsion). The emulsion, while very stable in the cans, reforms true asphalt in a very few minutes when coated on a concrete wall, cardboard, metal, etc.; the coating being just as water-proof, black and shining as when formed from non-emulsified asphalt. The concentrated emulsion may, if desired, be thinned with water to form a more dilute emulsion. For example, two parts of the emulsion may be mixed with one part of water to make a thin brown emulsion of milk-like consistency containing about 50% pure asphalt.

As a third example of the application of the invention, we will describe the manufacture of an emulsion containing 60% asphalt and made from a California steam distilled asphaltic base oil residual asphalt. The water (67 kilograms) containing 1 kilogram Na_3PO_4 is heated to a temperature of about 90° C. The molten asphalt (100 kilograms) at about 150° C. is introduced into the water in a regulated stream and with continuous agitation from a fast moving propeller agitator. The emulsion discharged from the emulsifier is cooled very quickly by artificial means and canned or otherwise prepared for storgae or use.

As a further example of the application of the invention we will describe the manufacture of an emulsion containing 60% asphalt and made from a straight Mexican steam distilled asphaltic base oil residual asphalt. The water (67 kilograms) containing 0.75 kilograms crystalline tri-sodium phosphate (0.3 kilograms Na_3PO_4) is heated to a temperature of about 90° C. The molten asphalt (100 kilograms) at about 150° C. is introduced into the water in a regulated stream and with continuous agitation from a fast moving propeller agitator. The emulsion discharged from the emulsifier is cooled very quickly by artificial means and canned or otherwise prepared for storage or use. It has also been found that even smaller amounts of tri-sodium phosphate may be advantageously employed.

While the invention is of general application and can be advantageously practiced with substantially all asphaltic materials, it is particularly applicable in preparing emulsions of asphalts containing relatively small percentages of mineral matter. Thus, for example, natural or residual Bermudez asphalts, California or similar asphaltic base oil residue asphalts, or cut-back asphalt cements thereof, containing around 1 to 7% of mineral matter are admirably suited for the practice of the invention. Similarly, the residual asphalts from the distillation of other asphaltic base oil, or cut-back asphalt cements thereof, are well suited for the practice of the invention. Emulsions made of such asphalts contain relatively small amounts of mineral or similar inert matter, and consequently contain maximum percentages of the desirable hydrocarbon compounds of asphaltic materials. Moreover, in consequence of the small amount of tri-sodium phosphate used, the emulsions are not contaminated with any substantial quantity of emulsifying agents.

The melting point of the asphalt used in practicing the invention should not be substantially higher than the boiling temperature of water, since otherwise objectionable steaming of the water will take place upon mixing the water and molten asphalt. Since the melting point of asphalt is to some extent dependent upon its hardness, as determined by its penetration factor, it follows that in general it is desirable to use asphalts of relatively high penetration factors. Where the penetration factor is too low, the asphalt may be cut-back with hydrocarbon oils, thereby producing what is known as asphalt cement, to appropriately increase its penetration factor. We have secured excellent results in the practice of the invention using Bermudez asphalt products having a penetration factor of 30 and upwards at 25° C., as determined by the Dow penetrometer and with the aforementioned California

asphaltic base oil residue asphalts having a penetration factor of 70.

The asphalt emulsions of the invention are characterized by their relatively low viscosity, considering their high asphaltic contents. Thus, the emulsions of the invention are freely flowing liquids, as contrasted with the paste-like products of equivalent asphalt content that have heretofore appeared on the market. Moreover, the products of the invention are true emulsions in which the asphalt is uniformly dispersed in a very fine state of subdivision. Under a high powered microscope, the emulsions of the invention are seen to consist of minute globules of asphalt very uniformly distributed throughout the water, which constitutes the continuous or external phase of the emulsion.

The emulsions of the invention are moreover characterized by their brown color, thereby further evidencing the very fine state of subdivision of the black dispersed phase (asphalt). The color of an asphalt-water emulsion becomes lighter (i. e.. varying from black to brown) as the asphalt becomes more finely subdivided and dispersed in the water. This is believed to be due to the increased reflection and scattering of light in consequence of the increased subdivision and dispersion of the asphalt particles. This color phenomenon is utilized in the preparation of the emulsions, and the operator judges the completeness of the dissemination of the asphalt throughout the water and hence the desired end-point in the mixing and/or emulsifying operations by the brown color of the resulting product.

The emulsions of the invention are furthermore characterized by their relatively rapid drying qualities, that is, their ability, upon application in the form of a thin coating, to "set" or reform within a few minutes into an impermeable coalescent coating of true pure asphalt, typified by its shining black appearance. When applied to a surface with a spray gun, the asphalt dries and sets almost immediately, and when applied by a brush or the like, dries and sets in a very few minutes. The drying and setting of the asphalt is more rapid, the more porous the material to which the emulsion is applied. This rapid drying quality of the emulsion of the invention is due, we believe, to the high degree of subdivision and dissemination of the asphalt whereby greatly increased surface areas are exposed for evaporation of the water.

The emulsions of the invention, when applied and dried, produce an asphalt coating of characteristic black and glossy appearance. This is largely due to the fact that the coating consists of pure asphalt uncontaminated with any substantial amounts of emulsifying agents or other inert substances. This is in striking contrast with the so-called asphalt emulsions containing clay and the like, which when dry have a dull, flat appearance. This absence of any substantial amount of emulsifying agents or other inert substances in the asphalt coating produced by the emulsions of the invention, results in securing the maximum effectiveness of the asphalt as a waterproofing or protective medium. It is to be understood, however, that non-emulsion breaking fillers may be added where very thick coatings are desired and suitable fillers giving an initially water permeable characteristic may be used so that the water phase may evaporate or flow off, for if a heavy coating of the pure emulsion be attempted, the outer surface or skin thereof under certain conditions as applied to certain materials would not allow the water to evaporate after such a skin had been formed.

The emulsions of the invention are very stable and have no tendency to break down on standing. When stored in cans or other receptacles, some slight settling may take place, but the relatively thin layer of supernatant liquor is readily mixed in and the uniformity of the emulsion re-established by simply stirring. The emulsions, more particularly those of relatively high asphalt content, can be readily diluted or thinned with water accompanied by appropriate stirring to produce more fluid or less concentrated emulsions, as desired.

We do not desire to be restricted to any theory of the effectiveness of small amounts of tri-sodium phosphate in emulsifying water and asphalts, and the fact remains that small amounts of tri-sodium phosphate produce remarkably effective emulsification of asphalt and water. We believe that the effective emulsifying action of small amounts of tri-sodium phosphate, characteristic of the present invention, is due in part to the chemical, and perhaps physical, composition and behavior of tri-sodium phosphate, as well as to its presence in amounts preferably not exceeding around 0.6% (Na_3PO_4) by weight on the emulsion, and in no case exceeding about 0.75%.

It should be noted that in accordance with our invention, the complete emulsification may be effected with a fraction of one per cent (1%) of tri-sodium phosphate. Other agents or substances may, however, be added to the emulsion for imparting thereto qualities or properties quite apart from that of emulsification. In this connection, however, care must be taken not to add substances that exercise a deleterious effect upon or break down the emulsion. In all cases, however, the additive emulsifying agent will not substantially exceed 1.5% and the emulsion will consist principally of water and asphalt. In their preferred form, employing asphalts of low mineral content, the emulsions of the invention contain by weight over 90%, and preferably not less than 95%, of combined

water and asphaltic constituents soluble in carbon bisulfide.

While we have particularly mentioned tri-sodium phosphate, other water-soluble alkaline phosphates of monovalent metals, such as potassium phosphate and/or ammonium phosphate or mixtures of the same may be employed as the emulsifying agent, and are to be understood as included in the scope of the appended claims. The relative cheapness and commercial availability of tri-sodium phosphate, however, make it a convenient agent in practice. Also the separate addition of the necessary component metal salts and a phosphoric reagent may under certain conditions be employed.

We claim:

1. An asphalt-water emulsion containing tri-sodium phosphate as an emulsifying agent in amount not exceeding 0.75% Na_3PO_4 by weight on the emulsion.

2. An asphalt-water emulsion containing tri-sodium phosphate as an emulsifying agent in amount not exceeding 0.3% Na_3PO_4 by weight on the emulsion.

3. An asphalt-water emulsion containing about 0.1 to 0.3% by weight of Na_3PO_4 as an emulsifying agent.

4. An asphalt-water emulsion containing tri-sodium phosphate as an emulsifying agent in amount not exceeding 0.3% Na_3PO_4 by weight on the emulsion and characterized by substantially uniform dispersion of the asphalt in the form of minute globules and further containing not less than 90% by weight of combined water and asphalt constituents soluble in carbon bisulfide and not less than one part by weight of asphalt for each part by weight of water.

5. An asphalt-water emulsion containing tri-sodium phosphate as an emulsifying agent in amount not exceeding 0.3% Na_3PO_4 by weight on the emulsion and characterized by substantially uniform dispersion of the asphalt in the form of minute globules and further containing not less than 90% by weight of combined water and asphalt constituents soluble in carbon bisulfide and at least two parts by weight of asphalt for each part by weight of water.

6. An asphalt-water emulsion containing as an emulsifying agent a tri-basic phosphate of an alkali metal in amount not exceeding the equivalent of 0.75% Na_3PO_4 by weight on the emulsion.

7. An asphalt-water emulsion in the production of which a tri-basic phosphate of an alkali metal has been added in amount not exceeding the equivalent of 0.75% Na_3PO_4 by weight on the emulsion.

8. An asphalt-water emulsion in the production of which tri-sodium phosphate has been added as an emulsifying agent in amount not exceeding 0.75% Na_3PO_4 by weight on the emulsion.

9. An asphalt-water emulsion in the production of which tri-sodium phosphate has been added as an emulsifying agent in amount not exceeding 0.75% Na_3PO_4 by weight on the emulsion and characterized by substantially uniform dispersion of the asphalt in the form of minute globules.

In testimony whereof we affix our signatures.

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