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COATING MINERAL AGGREGATES

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18 Claims. (Cl. 106—273)

The present invention relates to improvements in coating mineral aggregates with oil or bituminous material and particularly to the use of addition agents to improve the adherence of cracked bituminous materials or cracked oils to mineral aggregates in the presence of water.

Oils and/or bituminous paving materials do not coat and adhere well to mineral aggregates unless the aggregate is substantially dry, and for this reason in conventional pavement or road construction practice it is customary to dry the mineral aggregate by suitable well-known methods such as by heating or air drying. Furthermore, water entering the road or pavement during service also may have a detrimental effect, in that it may displace the oil or bitumen from the surface of the aggregate and thus diminish the bonding effect of the bitumen on the mixture by disrupting the bitumen-aggregate bond. This materially shortens the life of the road or pavement, requiring frequent repairs and is therefore highly undesirable.

Mineral aggregates employed in road or pavement construction range in character from hydrophylic to hydrophobic. In general, siliceous and acidic mineral tend to be hydrophilic, and calcareous alkaline minerals tend to be hydrophobic. It has been observed that siliceous acidic minerals have a greater attraction for water than for oil or bitumens, and that it is difficult to obtain, by conventional methods, complete or satisfactory coating of such aggregates by oil or bitumen when water is present. Further, even though satisfactory coating is obtained by using dry aggregate, the film of oil or bitumen tends to be displaced if water enters the pavement. While alkaline, calcareous, hydrophobic aggregates in general exhibit less tendency to stripping of the bituminous film or coating by water than do hydrophilic aggregates, even when hydrophobic aggregates are used the oil or bitumen does not always resist displacement from the aggregate surface by water.

It is an object of the present invention to provide an agent which promotes adherence of oils and/or bituminous materials more especially cracked oils and/or cracked bituminous materials to mineral aggregates, particularly hydrophilic siliceous aggregates, without the necessity of drying the same. Another object of the invention is to provide a means of preventing or reducing the tendency toward stripping of these oil and bituminous materials from the mineral aggregate by water after the road or pavement or other structure is constructed. Other objects and advantages of the invention will become apparent as the description thereof proceeds.

We have discovered that the foregoing objects can be attained by adding inorganic halides, particularly metalloid halides to the oil or bituminous material. The halides which we employ are the halides of the metalloids of the fifth group of the periodic system and preferably the chloride and bromides of phosphorus, antimony, and arsenic, specifically PCl_3, PCl_5, PBr_3, PBr_5, $SbCl_3$, $SbCl_5$, $SbBr_5$, and $AsCl_3$, etc. While the specific activity of these materials varies to some extent, all of them are effective in promoting the adherence of oil and bituminous materials to mineral aggregates. The metalloid trihalides, particularly phosphorous trichloride and antimony trichloride, are most effective in promoting the adherence of bituminous materials particularly cracked road oils and/or cracked asphalts, to mineral aggregates.

The amount of metalloid halide, for example PCl_3, to be used depends upon several factors, among which are the type of oil or bituminous material to be applied, the surface characteristics of the aggregate, and the area of the aggregate-bitumen interface. For example, some road oils are benefited by amounts of PCl_3 up to 1.0%, while others will be benefited by amounts up to 0.1%, but will not be further benefited by amounts of PCl_3 greater than 0.1%. This appears to be a characteristic or property of the bituminous material which cannot be predicted by analysis or from other properties of the bituminous materials, and accordingly, as will be appreciated by those skilled in the art of compounding bituminous materials, must be determined by trial on the individual sample or type of bituminous material. The amount of metalloid halide to be used also depends upon the composition or characteristics of the aggregate surface. In general, siliceous aggregates are more responsive to the use of such addition agents than are calcareous, alkaline aggregates. Accordingly, with aggregates which are predominantly siliceous, larger amounts of the metalloid halide can advantageously be added than with aggregates which are predominantly calcareous. The area of the aggregate-bitumen interface also influences the amount to be used. It will be understood by those skilled in the art that as this area, which depends upon the particle size distribution, particle shape, and degree of surface roughness or smoothness of the aggregate, and upon the proportions of aggregate and bituminous material, varies, the amount of metalloid halide which it is

advantageous to use will vary. It will also be appreciated that these three factors are interdependent to some extent, and that therefore the amount of metalloid halide which can most advantageously be used must be determined for the individual combination of bituminous material and aggregate. In general we have found that the amount required to produce the optimum effects is from 0.025% to about 5% or more, and preferably from about 0.05 to 1%, based upon the oil or bitumen used.

The addition agents described herein can be added to the bituminous material at about room temperature and the mixture employed immediately. Optionally, the addition agents can be added to the hot bituminous material at an elevated temperature of about 150° F. to about 400° F., or added to the mixture of bituminous material and mineral aggregate during preparation of the mixture, or incorporated in the aggregate, preferably immediately prior to addition of the bitumen.

It is known that the coating of mineral aggregates by oil or bitumen in the presence of water can be effected, and the resistance of the coating to stripping or displacement by water improved, by treating the aggregate with an aqueous solution of a polyvalent metal salt, and subsequently applying thereto a small amount of a water-soluble soap of a fatty acid. The mechanism whereby the aggregate is made preferentially wetted by the bituminous material and the latter therefore made more adherent to the aggregate, is theoretically as follows: It is believed that one valence of the heavy metal ion is attached to the mineral and another valence reacts with the fatty acid, which thereby becomes attached to the mineral surface with its hydrocarbon chain oriented outwards. When enough of these oriented hydrocarbon chains become attached to the surface the latter becomes water-repellant and preferentially wetted by the oil or bitumen.

The above method has the disadvantage that the relative amounts of the polyvalent metal salt and the soap are critical, and must be correctly adjusted for optimum results. Furthermore, two solutions must be prepared and applied separately or mixed before application. Finally, we have found that with many aggregates the effects obtainable by the above method are less favorable than are obtained with the metalloid halides described herein, either in that the amounts or cost of agent required to obtain adequate coating are greater, or in that the degree of coating obtainable with a given amount of agent is less than with the agents described herein.

We have found that mineral aggregates, particularly of the hydrophilic, siliceous type, can be provided with an adherent coating of cracked oils or cracked bituminous materials by employing the metalloid halides, preferably the trichlorides of the metalloids of the fifth group of the periodic system. The use in combination therewith of a polyvalent salt of a heavy metal is unnecessary, and the careful and exact proportioning of two reagents which must be done when fatty acid soaps are employed is unnecessary. The coatings so obtained are highly resistant to displacement by water, both immediately or after the mixture has dried.

While the application to the aggregate of a polyvalent metal salt or the incorporation of such a salt in the mixture of aggregate, bituminous material and addition agent during the preparation of said mixture, is not necessary to obtain the benefits outlined herein, the adherence of the bituminous material to the mineral aggregate can in some cases be further improved by employing a polyvalent metal salt in addition to the addition agents described herein. In distinction to the above use of a polyvalent metal salt with a water-soluble soap of a fatty acid, in which use very little or no advantage is obtained unless the polyvalent metal salt is employed in sufficient quantities, the use of polyvalent metal salts with the addition agents described herein serves principally to supplement or enhance the effects of the addition agents and does not require exact or critical proportioning of the salt and addition agent. The amount of polyvalent salt which can advantageously be used varies from none to 2 moles per mole of addition agent and typically from 0.1 to 1.0 mole per mole of addition agent.

We have found that the use of the addition agents described herein in the amounts stated results in an appreciable increase in the viscosity or consistency of the bituminous material, particularly of cracked bituminous materials. This is advantageous in that bituminous materials of higher consistency have less tendency to be displaced from the aggregate surface by water and are in other respects more desirable, and in that the increase in consistency is obtained without the expense of processing the bituminous materials expressly to obtain higher viscosity products, as by reduction or oxidation.

While we have described our invention as applicable to the coating of mineral aggregates with bituminous materials with special reference to highway and/or pavement surfacing, the invention is applicable to the preparation of products in which a water-resistant bond between mineral substances and bituminous material is advantageous or necessary. For example the invention may be adapted for the preparation of bituminous grouts, mastics, caulking or sealing compounds, enamels, or pipe dips; for the preparation of filled asphalts comprising asphalt and very fine mineral fillers, such as are used in composition shingles or roofing; or for improving the adhesion of siliceous mineral granules to asphalt-surfaced roofing.

Having fully described our invention, it is to be understood that the same is not to be limited to the details herein set forth, except insofar as the same is defined by the appended claims.

We claim:

1. The method of forming a water-resistant bond between a siliceous material and a bituminous material comprising incorporating in the bituminous material a small amount of a halide of a metalloid of the fifth group of the periodic system.

2. The method of forming a water-resistant bond between a siliceous material and a cracked bituminous material comprising incorporating in the cracked bituminous material a small amount of a halide of the fifth group of the periodic system.

3. The method described in claim 2, in which the metalloid halide is incorporated in the cracked bituminous material prior to the application of the latter to the siliceous material.

4. The method of forming a water-resistant bond between the siilceous material and the cracked bituminous material comprising adding a small amount of a phosphorus halide to the said cracked bituminous material and then applying the same to the siliceous material.

5. The method described in claim 4 in which

the phosphorus halide is phosphorus trichloride.

6. The method of forming a water-resistant bond between the siliceous material and the cracked bituminous material comprising adding a small amount of an antimony halide to the said cracked bituminous material and then applying the same to the siliceous material.

7. The method described in claim 6 in which the antimony halide is an antimony chloride.

8. The method of forming a water-resistant bond between the siliceous material and the cracked bituminous material comprising adding a small amount of an arsenic halide to the said cracked bituminous material and then applying the same to the siliceous material.

9. The method described in claim 8 in which the arsenic halide is an arsenic chloride.

10. In the construction of a bituminous pavement in which a cracked bituminous coating material is applied to a mineral aggregate the improvement comprising incorporating in the mixture of the mineral aggregate and cracked bituminous material a small amount of a halide of a metalloid of the fifth group of the periodic system.

11. In the construction of a bituminous pavement in which a cracked bituminous coating material is applied to a mineral aggregate the improvement comprising incorporating in the mixture of the mineral aggregate and cracked bituminous material a small amount of a phosphorus halide.

12. In the construction of a bituminous pavement in which a cracked bituminous coating material is applied to a mineral aggregate the improvement comprising incorporating in the mixture of the mineral aggregate and cracked bituminous material a small amount of phosphorus trichloride.

13. A coating material for siliceous substances comprising a cracked bituminous material and a small amount of a halide of a metalloid of the fifth group of the periodic system.

14. A coating material as described in claim 13 in which the metalloid halide is an antimony halide.

15. A coating material as described in claim 13 in which the metalloid halide is an antimony chloride.

16. A coating material as described in claim 13 in which the metalloid halide is an arsenic halide.

17. A coating material for siliceous substances comprising a cracked bituminous material and a small amount of a phosphorus halide.

18. A coating material as described in claim 17 in which the phosphorus halide is phosphorus trichloride.

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CERTIFICATE OF CORRECTION.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 8-9, for "chloride" read --chlorides--; line 11, after "$SbCl_5$," insert --$SbBr_3$,--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of May, A. D. 1942.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.