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BITUMINOUS COMPOSITIONS

Peter Alexander, Surbiton, and David Rupert Lamb, Warrington, England, assignors to Shell Development Company, Emeryville, Calif., a corporation of Delaware

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This invention relates to bituminous compositions suitable for use in the construction of surfaces such as roadways, footpaths, floors, airport and aerodrome runways and the like and for use in the protection of such surfaces.

The advent of jet-propelled aircraft has accentuated problems arising in connection with the asphalt surfaces employed on airfield runways, warm-up aprons and hangar floors. While the conventional asphalts comprising bitumen or tar in conjunction with solids such as rocks, stones, sand and cement generally provide satisfactory base materials for the construction of surfaces for propeller-driven aircraft, they may rapidly soften, disperse and disintegrate under the action of certain jet aircraft warming up and taking off from them. The primary factor affecting the destruction of conventional asphalt surfaces under the action of jet aircraft is the velocity and temperature of the exhaust gases which issue from the orifice of a jet engine, which are in the order of 1,200 M. P. H. and 700° C. respectively. When the operation of jet engines involves "after burning" for boost purposes, the temperature of the exhaust gases may be as high as 1,400° C. The temperature and velocity of the gases at the point at which they impinge on the asphalt depend on a number of factors, such as the height of the engine above the ground and the inclination of the jet, and in certain cases conventional asphalt surfaces are incapable of standing up to the disruptive force of such exhaust gases. Since during servicing the blast of exhaust gases may act on the surface for periods up to above five minutes, it has proved necessary either to use a surface other than an asphaltic surface or to provide a protective surface for the conventional asphalt capable of withstanding the aforementioned forces for such comparatively long periods.

Such a surface must not only be capable as aforesaid but must also be resistant to deterioration under the action of fuels or other liquids which may be spilled onto it. In starting jet aircraft a sufficient amount of fuel is often discharged on to the surface beneath the plane to cause the known types of asphaltic pavement to soften and deform under traffic.

Furthermore, the surface employed must not only be capable of itself withstanding the disintegrating effects of the exhaust gases and the softening effects of spillage, but, if employed as a protective layer over a conventional surface, it must sufficiently insulate the underlying material to prevent softening or deterioration thereof and subsequent deformation under the weight of following aircraft or other vehicles.

It has now been discovered that bituminous compositions capable of meeting the requirements set out above can be prepared by the addition of certain water-soluble salts to certain bitumen emulsion-Portland cement-mineral aggregate compositions, the function of the said salts being to give plasticity to the compositions and to prevent dilatancy thereof. It has been found that not only are the said salts essential for improving the workability

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and ease of application of the compositions, but also that the bitumen emulsion-Portland cement-mineral aggregate compositions employed must be of a particular type to produce a surface of the properties necessary to meet the requirements recited above.

In the following description and in the claims hereinafter appearing, the following terms and expressions have the meaning assigned to them below:

"Selected aggregate" means mineral aggregate of a type known to be suitable for road and footpath construction, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than 25% by weight of fines passing a 200 mesh U. S. standard sieve.

"Stable bitumen emulsion" means an aqueous bitumen emulsion which will not coagulate appreciably when 100 ml. of it is stirred for 3 minutes with 50 grams of Portland cement.

"Parts" means parts by weight.

In accordance with the present invention, a bituminous composition comprises a mixture of 100 parts of a selected aggregate, 5 to 20 parts of a bitumen in the form of a stable bitumen emulsion, 5 to 15 parts of Portland cement, and 0.2 to 2 parts of a water soluble polyvalent metal salt of a strong mineral acid.

Still in accordance with the present invention, the above composition containing water results in the formation of a novel paving surface highly resistant to the blast of jet engines and to the softening due to spillage of internal combustion engine fuels. This protective surface comprises about 100 parts of the "selected aggregate" such as that described above, from about 5 to about 20 parts of bitumen, preferably paving grade asphalt, from about 5 to about 15 parts of Portland cement and from about 0.2 to about 2 parts of at least one water-soluble polyvalent metal salt of a strong mineral acid.

The water-soluble polyvalent metal salts are those of a strong mineral acid preferably having a molecular weight from 36 to 98. These include especially sulfuric, hydrochloric and phosphoric acids and mixtures thereof. The most effective salts are those of alkaline earth metals and of amphoteric metals. Typical alkaline earth metal salts meeting the requirements of the present invention include calcium chloride, magnesium chloride, barium chloride, and the like. Salts of amphoteric metals useful in these compositions include especially aluminum sulfate, chromium chloride, and aluminum chloride. Preferably, these salts should be soluble to the extent of at least about 5 parts by weight per 100 parts of water and still more preferably should be soluble to the extent of at least 10% on the same basis. In addition to the above salts, other typical compounds which may be added include antimony chloride, cobalt chloride, ferric chloride, antimony sulfate, cadmium sulfate, and manganese chloride. These salts are preferably employed in the form of an aqueous solution and are conveniently utilized in solutions having between 5 and 20% by weight of the salt and still more preferably between 8 and 15% by weight of the salt.

In addition to the water present in the compositions of this invention by reason of the stable bitumen emulsion employed and the aqueous solutions of the salts, further water may be added if necessary to improve the workability of the mixture, i. e., to facilitate its mixing and laying.

Any type of mineral aggregate known to be suitable for road and footpath construction may be employed. Preferably, the size of its particles and chips should conform with the definition of a "selected aggregate" set out above. Thus, basic aggregates such as limestone, rhyolite, and siliceous aggregates, including quartzite, flint, slag, or granite may be employed. The high proportion

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of material retained on a 50 mesh sieve in the selected aggregate prevents shrinkage cracks which otherwise might develop during the setting of the bituminous compositions after they have been laid. It is preferred that the maximum size of the chips in the selected aggregate be about two thirds of the thickness of the layer of composition to be applied. Also, it is sometimes advantageous to incorporate china clay or diatomaceous earth in the selected aggregate, but where it is used it is to be considered as part of the selected aggregate and should not therefore be used in such quantities as would increase the amount of fines passing a 200 mesh sieve to over 25% or reduce the quantities of chips retained on a 50 mesh sieve to less than 50%.

The defined binder may be asphalt, coal tar or coal tar pitch or a mixture of any of these materials. ~~Also~~ It must have an ASTM penetration of from 40 to 500 at 25° C. Thus the binder may be what is generally termed a high viscosity coal tar or road tar or a soft coal tar pitch. Blends of road tars and hard coal tar pitches are particularly effective, since the resulting compositions give protective surfaces completely resistant to the effects of kerosene spillage. The penetration of the binder used has a considerable effect on the properties of the protective surface finally obtained. Thus, compositions made from aqueous emulsions of thin coal tars are unsatisfactory in that they tend to coagulate on mixing, thus preventing the development of a cement structure and lowering the resistance of the finished protective surface to the effects of hot blasts.

It has been found that the quantity of bitumen employed in the compositions is not critical within the range specified, but if less than about 5 parts of bitumen are employed for every 100 parts of selected aggregate, the compositions on setting are too brittle, whereas if more than 20 parts are used, the protective surface readily softens under a hot blast and under the action of spilled fuel. Similarly, it is highly desirable that the bitumen be employed in the form of a stable bitumen emulsion since the use of straight bitumen or a bitumen cutback results in compositions which readily soften under a hot blast.

The bituminous emulsions used in these compositions preferably contain bitumen in an amount between about 40 and about 60% based on the combined water and bitumen. It is essential that these emulsions be of the oil-in-water type and that the correct additives be employed to form a stable emulsion which will pass the demulsability test described hereinbefore in the definition of the term "stable bitumen emulsion." The type of emulsifying agents and stabilizing agents which may be used for the production of such stable emulsions are well known in the art. Usually these are employed in amounts varying between about 0.5 and 5% based on the weight of the bitumen. The most stable varieties include such materials as alkali metal surface active emulsifying agents such as sodium caseinate, or other alkali metal salts such as the sodium salt of lignin and the like, the alkali metal salts of sulfonated lignin and the alkali metal soaps of hydrocarbon insoluble pine tree resin acids, such as those marketed under the trade name "Vinsol." Alkyl aryl sulfonates also are suitable, such as the sodium sulfonate of toluene or benzene which has been alkylated with propylene tetramer.

The ingredients of the bituminous compositions of this invention may be mixed in any convenient manner, but it is considered expedient to mix the Portland cement, aqueous solution of polyvalent metal halide or sulphate and stable bitumen emulsion with the selected aggregate in that order. Finally, any additional water necessary to improve the workability of the compositions may be added.

Bituminous compositions of this invention have the consistency of a cement mortar or a fine asphalt before setting. They may be laid in any conventional manner, e. g., they may first be spread roughly with shovels fol-

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lowed by screeding, and finally finished, if necessary, by trowelling, or alternatively, they may be laid by means of a normal concrete laying machine. They attain a heat-resistant condition after a setting period of a few days.

The precise thickness of the layer to be applied will depend upon the particular conditions to which it is to be subjected, but when the compositions are used for protecting asphalt runways and warming-up aprons from the blast from jet aircraft, a thickness of 0.5 to 1 inch usually suffices.

While in the foregoing description particular reference has been made to the protection of asphalt surfaces which are subjected to the blast from jet aircraft, the bituminous compositions of the present invention can find application in any circumstances where asphalt or other paving surfaces are liable to be subjected to conditions under which they soften or disintegrate. Moreover, they can be used for the construction of roadways, footpaths, floors, airport and aerodrome runways and the like without employing any other road surfacing material beneath them.

The following examples illustrate the invention.

Example I

The following ingredients were mixed in the order stated with 100 parts of a selected aggregate which was a mixture of 93.5 parts of limestone and 6.5 parts of china clay and which had the following sieving characteristics: retained on a 50 mesh sieve—84%, passing a 50 mesh sieve—16%, passing a 200 mesh sieve—11%, and which had a maximum chip size of ¼".

14 parts Portland cement

9.5 parts 10% aqueous calcium chloride solution

30 parts stable asphalt emulsion containing 55% by weight of bitumen emulsified in water with sodium caseinate.

1 part additional water.

The product was a bituminous composition having the consistency of a cement mortar which when laid on an asphalt base to a depth of ½", set after a few days without appreciable shrinkage to a tough, non-brittle material, strongly adherent to the underlying surface. Under the action of intense heat and blast from the exhaust gases from a jet engine, for example, the hardened protective surface showed no disintegration or cracking, no tendency to flake and negligible softening. Under similar conditions of heat and blast a conventional asphalt surface in an unprotected state was completely disintegrated and softened sufficiently to be blown about.

Example II

The following ingredients were mixed in the order stated with 100 parts of quartzite which had the following sieving characteristics: retained on a 50 mesh sieve—80%, passing a 50 mesh sieve—20%, passing a 200 mesh sieve—2%, and which had a maximum chip size of ¼".

10 parts of Portland cement

6.5 parts 10% aqueous calcium chloride solution

20 parts stable bitumen emulsion containing 55% by weight of asphalt emulsified in water with sodium caseinate

7 parts additional water.

The product was a bituminous composition which when allowed to set gave an excellent paving surface capable of withstanding the disruptive effects of hot blasts and spillage.

Example III

The following ingredients were mixed in the order stated with 100 parts of stone which had the following sieving characteristics: retained on a 50 mesh sieve—74%, passing a 50 mesh sieve—26%, passing a 200 mesh sieve—13%, and which had a maximum chip size of ¼".

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10 parts Portland cement
6.5 parts 10% aqueous calcium chloride solution
20 parts stable bitumen emulsion containing 55% by weight of bitumen emulsified in water with sodium caseinate
6 parts additional water.

The product was a bituminous composition which when allowed to set gave an excellent paving surface capable of withstanding the disruptive effects of hot blasts and spillage.

Example IV

When compositions are prepared similar to those described in Example II utilizing aluminum sulfate in place of calcium chloride the results obtained are substantially those obtained in Example II.

Example V

When compositions are prepared similar to those described in Example III using magnesium chloride in place of calcium chloride, the results obtained are substantially identical with Example I.

Example VI

If compositions are compounded employing about 25 parts of asphalt in the form of an emulsion, the other proportions of ingredients being substantially the same as those in Example III, the resulting paving becomes unduly sensitive to disruption by either jet engine blast or spillage of aircraft fuel.

Example VII

The following ingredients were mixed in the order stated with 100 parts of limestone which had the following sieving characteristics: retained on a 50 mesh sieve—80%, passing a 50 mesh sieve—20%, passing a 200 mesh sieve—12%, and which had a maximum chip size of $\frac{1}{4}$ ".

10 parts Portland cement
5 parts 15% aqueous calcium chloride solution
25 parts stable emulsion comprising 55% by weight of the binder which was a blend of equal parts of coal tar and hard coal tar pitch and which had an ASTM penetration at 25° C. of 50. The binder had been emulsified by means of sodium caseinate, the potassium soap of solid rosin and bentonite.

The product had the consistency of a cement mortar which, when laid on an asphalt base to a depth of $\frac{1}{2}$ ", set after a few days without appreciable shrinkage to a tough, non-brittle material, strongly adherent to the underlying surface. Kerosene spilled onto the hardened protective surface had no detrimental effect and under the action of intense heat and blast from the exhaust gases from a jet engine, the hardened protective surface showed no disintegration or cracking, no tendency to flake and negligible softening. Under similar conditions of heat and blast a conventional asphalt surface in an unprotected state was completely disintegrated and softened sufficiently to be blown about.

Example VIII

The following ingredients were mixed in the order stated with 100 parts of slag which had the following sieving characteristics: retained on a 50 mesh sieve—90%, passing a 50 mesh sieve—10%, passing a 200 mesh sieve—2.5%, and which had a maximum chip size of $\frac{1}{4}$ ".

10 parts of Portland cement
4 parts 15% aqueous calcium chloride solution
20 parts stable emulsion containing 55% by weight of the binder which was a blend of 65% coal tar and 35% hard coal tar pitch and which had an ASTM penetration at 25° C. of 215. The binder had been emulsified by means of sodium caseinate, the potassium soap of solid rosin and bentonite.

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The product had the consistency of a conventional fine asphalt, which could be compacted by tamping or rolling. When allowed to set, it gave an excellent paving surface capable of withstanding the disruptive effects of hot blasts and kerosene spillage.

Example IX

The following ingredients were mixed in the order stated with 100 parts of limestone which had the following sieving characteristics: retained on a 50 mesh sieve—78%, passing a 50 mesh sieve—22%, passing a 200 mesh sieve—15%, and which had a maximum chip size of $\frac{1}{4}$ ".

10 parts of Portland cement
5 parts 15% aqueous calcium chloride solution
25 parts stable emulsion containing 55% by weight of the binder which was a blend of 75% coal tar and 25% hard coal tar pitch and which had an ASTM penetration at 25° C. of 450. The binder had been emulsified by means of sodium caseinate, the potassium soap of solid rosin and bentonite.

The product had the consistency of a conventional fine asphalt which could be compacted by tamping or rolling. When allowed to set it gave an excellent paving surface capable of withstanding the disruptive effects of hot blasts and kerosene spillage.

Example X

The following ingredients were mixed in the order stated with 100 parts of the limestone described in Example IX.

10 parts of Portland cement
5 parts 15% aqueous calcium chloride solution
25 parts stable emulsion containing 55% by weight of the binder which was bitumen having an ASTM penetration at 25° C. of 190 to 210.

The product had the consistency of conventional fine asphalt and could be compacted by tamping or rolling. When laid on an asphalt base the product set after a few days to a tough condition capable of resisting jet blast and fuel spillage.

The bitumen used in the above example was replaced in further mixes by bitumen having an ASTM penetration at 25° C. of 40 to 50, 60 to 70, 90 to 110, 280 to 320 and 400 to 500 respectively. The protective surfaces obtained from such mixes were also capable of resisting jet blast and fuel spillage.

Example XI

In order to illustrate the effect of water content on the consistency of the compositions of this invention, the composition described in the first paragraph of Example X was made, using 6.5 parts of the 15% aqueous calcium chloride solution and adding a further 4 parts of water after all the ingredients had been mixed. The product then had a consistency, not of conventional fine asphalt as in Example X, but of a cement mortar.

This application is a continuation-in-part of parent application Serial No. 233,494, filed June 25, 1951, now abandoned.

We claim as our invention:

1. A bituminous composition comprising as the sole aggregate a siliceous mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains no more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5–15 percent by weight based on the aggregate of Portland cement, 5–20 percent by weight based on the aggregate of an asphalt emulsified in water with sodium caseinate to form an emulsion containing 40–60% asphalt having an ASTM penetration between about 40 and about 500 at 25° C. and 0.2–2 percent by weight based on the aggregate of calcium chloride.
2. A bituminous composition comprising as the sole

aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight based on the aggregate of Portland cement, 5-20 percent by weight based on the aggregate of a paving grade asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion said emulsion containing 40-60% by weight of asphalt and 0.2-2 percent by weight based on the aggregate of a water soluble polyvalent metal salt of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides, water-soluble polyvalent metal and sulfates.

3. A bituminous composition comprising as the sole aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight based on the aggregate of Portland cement, 5-20 percent by weight based on the aggregate of asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion said emulsion containing 40-60% by weight of asphalt and 0.2-2 percent by weight based on the aggregate of aluminum sulfate.

4. A bituminous composition comprising as the sole aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight based on the aggregate of Portland cement, 5-20 percent by weight based on the aggregate of an asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt emulsion said emulsion containing 40-60% by weight of asphalt and 0.2-2 percent by weight based on the aggregate of a water soluble polyvalent metal sulfate.

5. A bituminous composition comprising as the sole aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight based on the aggregate of Portland cement, 5-20 percent by weight based on the aggregate of asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion, said emulsion containing 40-60% by weight based on the aggregate of asphalt and 0.2-2 percent by weight of an alkaline earth metal halide.

6. A bituminous composition comprising as the sole aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight based on the aggregate of Portland cement, 5-20 percent by weight based on the aggregate of asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion, said emulsion containing 40-60% by weight of asphalt and 0.2-2 percent by weight based on the aggregate of a water soluble amphoteric metal sulfate.

7. A bituminous composition comprising as the sole aggregate a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 percent by weight of Portland cement, 5-20 percent by weight of asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion, said emulsion con-

taining 40-60% by weight of asphalt and 0.2-2 percent by weight of a water soluble polyvalent metal salt of a hydrohalogen acid.

8. A bituminous composition consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of Portland cement, 5-20 parts by weight of an asphalt having an ASTM penetration between about 40 and about 500 at 25° C. in the form of a stable asphalt-in-water emulsion said emulsion containing 40-60% by weight of asphalt and 0.2-2 parts by weight of a water soluble polyvalent metal salt of hydrochloric acid.

9. A bituminous composition consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of a Portland cement, 5-20 parts by weight of a coal tar having an ASTM penetration at 25° C. between about 40 and 500, said tar being in the form of a stable tar in water emulsion, and 0.2-2% by weight of water soluble polyvalent metal of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides and water-soluble polyvalent metal sulfates.

10. A bituminous composition consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of a Portland cement, 5-20 parts by weight of a coal tar pitch having an ASTM penetration at 25° C. between about 40 and 500, said tar pitch being in the form of a stable tar pitch in water emulsion, and 0.2-2% by weight of a water soluble polyvalent metal of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides and water-soluble polyvalent metal sulfates.

11. A bituminous composition consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of a Portland cement, 5-20 parts by weight of a mixture of coal tar and coal tar pitch having an ASTM penetration at 25° C. between about 40 and 500, said tar being in the form of a stable tar in water emulsion, and 0.2-2% by weight of a water soluble polyvalent metal of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides and water-soluble polyvalent metal sulfates.

12. A bituminous composition consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% by weight of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of a Portland cement, 5-20 parts by weight of a mixture of coal tar and asphalt having an ASTM penetration at 25° C. between about 40 and 500, said tar being in the form of a stable tar in water emulsion, and 0.2-2% by weight of a water soluble polyvalent metal of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides and water-soluble polyvalent metal sulfates.

13. A bituminous mixture consisting essentially of about 100 parts by weight of a mineral aggregate, at least 50% of which is retained on a 50 mesh U. S. standard sieve and which contains not more than about 25% by weight of fractions passing a 200 mesh U. S. standard sieve, 5-15 parts by weight of a Portland cement,

5-20 parts by weight of a bitumen of the group consisting of asphalt, coal tar, coal tar pitch, and mixtures thereof, said bitumen having an ASTM penetration at 25° C. between 40 and about 500, said bitumen being in the form of a stable oil-in-water emulsion, and 0.2-2% by weight of a water soluble polyvalent metal salt of a strong mineral acid of the group consisting of water-soluble polyvalent metal chlorides and water-soluble polyvalent metal sulfates.

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