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GRINDING COMPOSITIONS AND MAKING OF SAME

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This invention concerns certain new grinding compositions and a method of making the same.

The compositions provided by the invention are of the type comprising a suspension or dispersion of abrasive particles in a liquid to gelatinous, or grease-like, medium. They are of liquid to gelatinous consistency and are adapted for use in grinding or polishing surfaces of hard, solid materials such as metals, glass, or ceramic materials, etc. For instance, they may be used in grinding valves, glass joints, or bearings to obtain a tight fit between the complementary parts thereof. They may be applied between surfaces, e. g. of a valve and its seat, which are to be fitted together and the grinding be accomplished by rubbing the composition between such surfaces. The grinding may be done slowly by hand or rapidly in a power driven manner. The compositions of the invention differ from conventional grinding compositions as regards the kind of medium in which the abrasive particles are suspended.

It is well known to admix finely divided abrasives with liquids such as water, mineral lubricating oil, or petroleum jell, etc., and to employ the resultant mixtures, or suspensions, as grinding compositions. The effectiveness of such composition for grinding purposes is dependent to a large extent upon the kind of medium employed and, in part, on the conditions under which the composition is used. During use of most such known compositions in grinding operations there is a tendency toward formation of agglomerates of solid particles in the composition which frequently cause scratching or scoring of the surface being ground. Such agglomerates are composed either of abrasive particles coagulated from the composition, or of particles ground from the surface of the material under treatment, and in most instances of both such materials. Formation of such agglomerates is usually not of serious consequences when the grinding is performed by hand, since any tendency toward seizure or scoring of the parts being ground may then readily be detected and the grinding composition be removed and replaced with fresh material. However, heat generated in a rapid power-driven grinding operation appears to induce formation of agglomerates and the tendency toward seizure during such operation cannot readily be detected until the parts being ground have been severely scratched or scored. For these reasons, the known grinding compositions, comprising suspensions of abrasive particles in liquids, are usually employed in grinding or polishing operations that are to be performed slowly, e. g. by hand; especially when the material to be ground is fairly soft, e. g. of copper, brass, bronze, nickel, or nickel alloy steel, etc.

It is an object of this invention to provide certain new grinding compositions which are adapted for use either in hand grinding or polishing operations, or where the parts to be ground are power driven. Other and related objects will be evident from the following description of the invention.

I have found that water and polyhydric alcohols, thickened by addition of salts of sulphonated polymers of alkenyl aromatic compounds, constitute excellent media for use in grinding compositions such as those discussed above. These thickened media have desirable properties of wetting and forming continuous lubricating films over surfaces of solid parts to be ground, of maintaining in dispersed condition both the abrasive particles and particles formed by grinding of the material under treatment, and of rapidly absorbing and dissipating heat generated by the grinding operation. The sulphonated alkenyl aromatic resin ingredient appears to perform a number of useful functions, i. e. it thickens and contributes to the lubricating action of the liquid; it reduces the rate of vaporization of the liquid at a given temperature and thus prevents rapid drying of the grinding composition during use; and it serves as a dispersing agent, or a protective colloid, so as to maintain the abrasive particles in suspension and cause dispersion of particles formed from a material, e. g. a valve, subjected to grinding by the composition.

The sulphonated alkenyl aromatic resins which may be employed as ingredients of the compositions are obtained by the nuclear sulphonation of solid polymers and copolymers of monalkenyl aromatic hydrocarbons having the general formula:

$$Ar-\overset{R}{\overset{|}{C}}=CH_2$$

wherein Ar represents an aryl radical and R represents hydrogen or a methyl radical. Examples of such alkenyl aromatic resins are polystyrene, solid polymers of vinyltoluene, vinylxylene, ar-ethylstyrene, alpha-methylstyrene, or ar-methyl-alpha-methylstyrene, etc., and solid copolymers of such alkenyl aromatic compounds with one another, e. g. copolymers of styrene and alpha-methylstyrene, or of styrene and vinyltoluene, etc. Although any such solid, resinous polymer or copolymer may be sulphonated for use in the compositions of the invention, the polymers and copolymers which, when dissolved in nine times their weight of toluene, form solutions having viscosities of from 4 to 800 centipoises at 25° C. are most satisfactory. Polystyrene is preferably employed.

The alkenyl aromatic resin is sulphonated in known manner, e. g. using a sulphonating agent such as concentrated or fuming sulphuric acid, chlorosulphonic acid, or sulphur triozide, etc., to a point at which it contains an average of from 0.55 to 0.95 sulphonic acid radical per aromatic nucleus. The mixture is then neutralized by treatment with an alkali such as sodium hydroxide, potassium hydroxide, sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, or ammonia, etc. The resultant alkenyl aromatic resin sulphonate is separated, preferably in dry form. Procedures for carrying out these operations are known in the art.

The alkenyl aromatic resin sulphonates thus prepared have a property, when added to water or liquid aliphatic polyhydric alcohols, of dissolving, or swelling to a substantially uniform gel, with resultant increase in viscosity of the liquid. Peculiarly, addition of the resin sulphonates to a monohydric alcohol such as methyl or ethyl alcohol causes relatively little, if any, increase in viscosity of the alcohol. The extent to which the viscosity of water or a polyhydric alcohol is increased by addition of such resin sulphonate thereto is dependent upon a number of factors such as the kind of liquid employed, the kind and molecular weight of the alkenyl aromatic resin from which the sulphonate was prepared, the extent of sulphonation of such resin, and the proportion of sulphonated resin added to the liquid. Thickening becomes greater as the proportion of an added resin sulphonate is increased. For the purpose of this invention, an alkenyl aromatic resin sulphonate is added to the water, or aliphatic polyhydric alcohol, in a proportion such that the thickened liquid has a viscosity of

from 1,000 to 50,000, preferably from 5,000 to 40,000, centistokes at 25° C.

Examples of aliphatic polyhydric alcohols which may be thickened with alkenyl aromatic resin sulphonates and be employed in the compositions of the invention are ethylene glycol, propylene glycol, butylene glycol, glycerine, diethylene glycol, and dipropylene glycol, etc. Apparently, any liquid saturated aliphatic polyhydric alcohol may be used in the compositions, but those containing not more than six carbon atoms and having an average of three or less carbon atoms per hydroxyl group in the molecule are preferred.

An abrasive material, in the form of fine grains or particles, is added to the liquid thus thickened with the alkenyl aromatic resin sulphonate and the mixture is stirred to form a suspension of the abrasive particles in the liquid. Any of the usual abrasives, such as silicon carbide, aluminum oxide, silicon dioxide, ferric oxide, or powdered glass, etc., may be used in the composition. The abrasive is usually in the form of particles or granules of between 100 and 360 mesh size on the Tyler standard screen scale, but smaller or larger particles can be used. The choices as to kind and grain size of abrasive to be employed are dependent in part on the kind of material to be ground and the fineness of grinding desired. Where considerable cutting away of material is desired during grinding, the abrasive should be a material harder than that to be ground, but where polishing is the principal objective, the abrasive may be as soft, or softer, than the material to be polished. In general, the coarseness of grinding increases with increase in size of the abrasive particles in the composition.

The proportion of abrasive material added in forming the composition may be varied widely, e. g. from that forming a mobile, or flowable, composition to that forming a fairly stiff, non-flowable paste. The composition should contain sufficient liquid to serve as a medium in which the abrasive particles are suspended. In most instances, the abrasive is added in amount corresponding to from 0.5 to 50, preferably from 15 to 30, percent of the weight of the composition, but it may be employed in smaller or larger proportions.

The compositions prepared as just described are suitable for direct employment as grinding or polishing compositions. However, other usual ingredients such as dyes, pigments, waxes, perfumes, or essential oils, etc., may be added, if desired, to give such composition a pleasing appearance, or fragrance, or to otherwise modify its properties.

All of the compositions prepared in accordance with the invention are suitable for the grinding or polishing of corrosion-resistant materials such as glass, or stainless steel, etc. However, the compositions comprising water as the liquid vehicle cause rusting of iron or steel if retained thereon, whereas those containing a polyhydric alcohol as the liquid vehicle do not have appreciable effect in accelerating the rusting of iron or steel. The polyhydric alcohols in the latter compositions need not be entirely anhydrous, e. g. the alcohol ingredient may contain up to about 10 percent by weight of water without greatly accelerating rusting of iron or steel contacted with the compositions. In instances in which corrosive-resistant materials are to be ground, mixtures of water with one or more of the polyhydric alcohols in any desired proportions may be used as vehicles for the compositions. The polyhydric alcohols of 90 percent concentration or higher, preferably anhydrous, possess a further advantage of being far less volatile, i. e. of higher boiling point, than water so that the compositions containing them as vehicles have less tendency to undergo drying during use, and may be employed at higher temperatures, than the compositions containing water as the vehicle. For these reasons, the compositions comprising polyhydric alcohols of 90 percent concentration or higher constitute a preferred embodiment of the invention.

The compositions may be employed in ways customary with other grinding and polishing compositions, e. g. where polishing is desired they may be applied and rubbed over a surface with a cloth, or a buffing wheel, etc. For purpose of grinding valves, or joints of glass or a metal, they are usually applied between surfaces of the parts which are to be fitted by grinding and the parts are rotated or oscillated while being pressed together. It is an advantage of the compositions of the invention that they permit grinding at high speeds in a motor driven manner without excessive danger of irregularly scratching or scoring the surfaces being ground. Apparently, the alkenyl aromatic resin sulphonate ingredient of the composition causes rapid dispersement, throughout the liquid vehicle, of particles formed by the grinding and thus prevents formation of solid agglomerates of the particles such as would cause scratching. The thickened liquid vehicle also serves as a lubricant to prevent binding of the parts being ground.

The following examples describe a number of ways in which the invention has been applied and illustrate certain of its advantages, but are not to be construed as limiting the invention.

Example 1

Approximately 2 parts by weight of a sodium salt of sulphonated polystyrene was admixed with 98 parts of water to form a substantially uniform, viscous liquid medium. The sulphonated polystyrene salt contained an average of about 0.7 of a sulphonate radical per benzene nucleus thereof. It was prepared from ordinary polystyrene of a molding quality, i. e. from solid polystyrene having a molecular weight of between 75,000 and 150,000 as determined by the well known Staudinger viscosity method. The sodium polystyrene sulphonate appeared to dissolve when admixed with the water, presumably with formation of a colloidal solution of the sulphonate. The solution had a viscosity of 378 centistokes at 25° C. Approximately 30 parts by weight of finely divided silicon carbide, in the form of particles of from 150 to 200 mesh size, was added to the solution and the mixture was stirred to form a suspension of the particles in the thickened liquid. The resultant composition was applied to the contacting surfaces of a roughly formed glass joint and was used in grinding the joint to obtain a tight fit. It was found to be highly satisfactory for the purpose and did not cause scratching or scoring of the parts being ground. The experiment was repeated in grinding other glass joints. Certain of the grinding operations were carried out by hand and others were carried out at high speed using a motor to turn the parts being ground. In all instances, the grinding was accomplished satisfactorily without seizure, scoring, or other damage to the parts being ground. It was observed that the grinding composition adheres well to the parts being ground and that the grinding could be accomplished while holding the surfaces under treatment in either vertical, or horizontal, positions, i. e. the composition did not flow away from the surfaces under treatment. The composition was also applied satisfactorily in grinding glass to form spherical balls of from ¼ inch to ⅝ inch diameter.

Example 2

To 98 parts by weight of an aqueous glycerine solution, containing 10 percent by weight of glycerine, there was added 2 parts of a sodium salt of sulphonated polystyrene. The sulphonated polystyrene salt was obtained by sulphonating polystyrene to a stage at which it contained an average of approximately 0.7 sulphonic acid radical per aromatic nucleus, neutralizing the sulphonated polystyrene to form a sodium salt thereof, and separating the salt as a substantially dry powder. On adding

and dissolving the sodium polystyrene sulphonate in the aqueous glycerine, the viscosity of the liquid increased greatly. To 73 parts by weight of the thickened aqueous glycerine solution there was added 27 parts of silicon carbide in the form of particles of from 250 to 329 mesh size. The mixture was stirred to form a suspension of the particles in the liquid and the resultant composition was applied to the plug of a steel plug cock and used in grinding the plug and its seat to obtain a close fit. The grinding was accomplished by rapid twisting, with a motor, of the plug in its seat. The grinding occurred satisfactorily without uneven scratching or scoring of the parts. However, it was noted that the grinding composition thickened materially, during the grinding operation, due to vaporization of a portion of the liquid medium therefrom. The residual composition adhered tightly to the ground plug cock parts, i. e. it was difficult to wipe all traces of the composition from the parts with a cloth. It was noted that the ground plug cock parts became rusted after standing in the room for a day. Apparently, traces of the grinding composition which were retained on the parts promoted rusting of the latter.

Example 3

A grinding composition was prepared and tested, as in Example 2, except that the liquid medium in the composition was an aqueous glycerine solution containing 50 percent by weight of glycerine. During grinding of a steel plug cock with this composition, the latter did not thicken greatly, i. e. the grinding did not cause a pronounced loss of the liquid medium by vaporization. The composition proved satisfactory from a viewpoint of effecting a uniform grinding without scoring of the parts being ground. Also, the composition was readily wiped from the ground parts to leave the latter apparently clean. However, the ground plug cock parts were permitted to stand while coated with the grinding composition for purpose of determining whether the latter would cause rusting. After one day of standing, the parts were noticeably rusted, but the rusting was not as extensive as that reported in Example 2.

Example 4

Approximately 98 parts by weight of propylene glycol was thickened with 2 parts of a sodium salt of sulphonated polystyrene. The latter contained an average of about 0.7 sulphonate radical per aromatic nucleus. The polystyrene from which the salt was derived was of a molecular weight such that a 10 percent by weight solution thereof in toluene had a viscosity of 15 centistokes at 25° C. To 70 parts by weight of the solution of the sodium salt of sulphonated polystyrene in the propylene glycol there was added 30 parts of silicon carbide in the form of particles of from 250 to 320 mesh size. The mixture was stirred to form a suspension of the particles in the thickened propylene glycol and the resultant composition was employed to grind steel plug cocks at a rapid rate with power driving of the parts being ground. The grinding operations were carried out without seizure or scoring of the parts being ground and without noticeable thickening of, or loss of liquid from, the grinding composition used. The ground parts fitted well. After completing the grinding operations, the composition was readily wiped from the ground parts to leave the latter apparently clean. However, the ground parts of a steel plug cock were permitted to stand, under ordinary room conditions, while coated with the grinding composition to determine whether rusting would occur. The plug cock parts were not rusted after 48 hours of standing under the conditions just stated. Accordingly, the grinding composition of this example is suitable for the grinding of iron or steel parts.

Other modes of applying the principle of the invention may be employed instead of those explained, change being made as regards the method or compositions herein disclosed, provided the steps or ingredients stated by any of the following claims or the equivalent of such stated steps or ingredients be employed.

I claim:

1. A composition, adapted for use in grinding and polishing operations, consisting essentially of a suspension of solid abrasive particles in a flowable medium consisting essentially of a liquid, of the group consisting of water, aliphatic polyhydric alcohols, and mixtures thereof, thickened with a small amount of an alkali salt of a sulphonated alkenyl aromatic resin.

2. A composition, as claimed in claim 1, wherein the salt of the sulphonated alkenyl aromatic resin is one containing an average of from 0.55 to 0.95 sulphonate radical per aromatic nucleus thereof.

3. A composition, as claimed in claim 2, wherein the salt of the sulphonated alkenyl aromatic resin is an alkali metal salt of sulphonated polystyrene.

4. A method of making grinding and polishing compositions which comprises, as the essential steps thereof, thickening a liquid of the group consisting of water, aliphatic polyhydric alcohols, and mixtures thereof, by adding to the same a minor amount of an alkali salt of a sulphonated alkenyl aromatic resin, thereafter adding to the thickened liquid a finely divided abrasive material, and agitating the mixture to form a suspension of the abrasive material in the thickened liquid.

5. A method, as claimed in claim 4, wherein the salt of the sulphonated alkenyl aromatic resin is one containing an average of from 0.55 to 0.95 sulphonate radical per aromatic nucleus thereof.

6. A method, as claimed in claim 5, wherein the salt of the sulphonated alkenyl aromatic resin is an alkali metal salt of sulphonated polystyrene.

7. A composition, adapted for use in grinding and polishing operations, consisting essentially of a suspension of solid abrasive particles in a flowable medium consisting essentially of at least one aliphatic polyhydric alcohol, containing not more than six carbon atoms and having an average of not more than three carbon atoms per hydroxyl group in the molecule, thickened with a small amount of an alkali metal salt of a sulfonated alkenyl aromatic resin.

8. A composition, adapted for use in grinding and polishing operations, consisting essentially of a suspension of solid abrasive particles in a flowable medium consisting essentially of propylene glycol thickened with a small amount of a sodium salt of sulfonated polystryrene.

9. A method of making grinding and polishing compositions which comprises, as the essential steps thereof, thickening a liquid consisting essentially of at least one aliphatic polyhydric alcohol, containing not more than six carbon atoms and having an average of not more than three carbon atoms per hydroxyl group in the molecule, by adding to the liquid a minor amount of an alkali salt of a sulfonated alkenyl aromatic resin, thereafter adding to the thickened liquid a finely divided abrasive material, and agitating the mixture to form a suspension of the abrasive material in the thickened liquid.

10. A method of making grinding and polishing compositions which comprises, as the essential steps thereof, thickening propylene glycol by adding thereto a minor amount of a sodium salt of sulfonated polystyrene, thereafter adding to the thickened liquid a finely divided abrasive material, and agitating the mixture to form a suspension of the abrasive material in the thickened liquid.

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