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METAL FLAW DETECTION LIQUID

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This invention relates to an improved composition for visually detecting sub-surface surface-connected defects and flaws in metals.

One object of the invention is to provide a new penetrant composition for use in visually detecting flaws adjacent metal surfaces. Another object is to provide a penetrant composition which permits visual detection of the most minute sub-surface cracks and defects in metals. A further object is to provide a new penetrant flaw detection composition of which the excess is easily flushed off the metal surfaces by means of water. A still further object is to provide an improved penetrant liquid for detecting sub-surface flaws in metals which discloses defects without the use of developers or mechanical processing other than washing off the surplus liquid. Another object is to provide a non-toxic penetrant testing liquid.

These and other objects are attained by my invention, which will be understood from the following description.

I have discovered that the use of a saturated monohydric alcohol ester, particularly propyl, butyl, and amyl, of the higher fatty acids, both saturated and unsaturated, in a penetrant solution for testing for sub-surface, surface-connected defects in metals, gives greatly improved sensitivity and ease of detection over the penetrant compositions which have heretofore been used and are known in the art. By the term "higher fatty acids" is meant saturated and unsaturated fatty acids having from 8 to 20 carbon atoms in empirical formulae, for example as set forth on pages 382 and 383 of Fieser, Organic Chemistry (1944 D. C. Heath & Co., Boston).

The particular esters that I have found to have these superior properties are those formed from the higher fatty acids occurring in commercial turkey red oil, and those derived from commercial animal and vegetable oils containing higher fatty acid compounds. I have found that the esters from the mixture of acids found in turkey red oil, coconut oil fatty acids and the like, including specifically palmitates, myristates, laurates, oleates, caprates and caprylates, either as individual esters, or as mixtures of esters, derived from the commercial sources, give superior penetrant flaw detecting liquids. The alcohol or base constituent of any of these esters may be any of the propyl, butyl, or amyl radicals, either separately or in mixtures. In some testing procedures the single or mixed esters alone may be used but I have found that the testing for sub-surface flaws is greatly facilitated by dissolving in the ester or mixed esters a visible or a fluorescent dye which, of course, makes the defects visually more apparent. I have also found that because of the high viscosity at testing temperatures of some of these dyed esters and ester mixtures, which prevents quick spreading action over the surface of the metal, an inert diluent liquid may be used to advantage, the diluent having substantially no other effect than to lower the viscosity and permit spreading of the penetrant material in a non-viscous thinner layer on

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the metal surface to be tested. The diluents which I find most satisfactory either separately or in mixtures are Stoddard's solvent; chlorinated hydrocarbon solvents such as carbon tetrachloride or trichlorethylene; and one or more of the butyl alcohols.

I have found that the penetrant solutions above described are readily removed by flushing with water, both during the processes of the testing procedure to remove the excess from the surface, as well as at the end of the test for removing any residual testing re-agents.

Illustrative of my invention are the following compositions:

I. Normal butyl fatty acid esters (mixed), as derived from commercial coconut oil fatty acids, 98 parts by weight; and 2 parts by weight of Mefford Red, a red dye, soluble in said mixed esters.

II. Normal butyl fatty acid esters (mixed), derived from coconut oil fatty acids, 99½ parts by weight; and, ½ part by weight of Fluorol 7GA, a fluorescent dye soluble in said mixed esters.

III. Amyl oleate, 20 parts by weight; Stoddard's solvent, 78 parts by weight; and Mefford Red, ester-soluble red dye, 2 parts by weight.

IV. Isopropyl fatty acid esters (mixed), derived from commercial coconut oil fatty acid, 25 parts by weight; Stoddard's solvent, 61 parts by weight; N-Butyl alcohol, 10 parts by weight; "Petronate L," a sodium petroleum sulfonate, 2 parts by weight; and Mefford Red, ester-soluble dye, 2 parts by weight.

Any dyestuff which is soluble or emulsifiable in oil, preferably red, or any oil soluble or emulsifiable fluorescent dye, may be used in my compositions. I have used Mefford's Red, an oil soluble dyestuff whose formula is said to be O-toluene-azo-xylylene-azo-b-naphthol. I have also used General Dyestuff Corporation's "Fluorol 7GA" for producing a fluorescent penetrant composition. Obviously, other dyes and fluorescent materials which are soluble or thoroughly dispersed or emulsifiable in the penetrant esters may be used.

As a fatty acid ester emulsifier to facilitate the removal of the penetrant liquid, I have used, for example, Atlas G-1256, manufactured by the Atlas Powder Company, which is a polyoxethylene sorbitol ester of mixed fatty and resin acids; and "Petronate L," manufactured by L. Sonneborn Sons, a sodium petroleum sulfonate having an empirical formula, $C_{24}H_{38}SO_3Na$.

In general, any of the emulsifiers known to be suitable for emulsifying oil and water may be used, although I prefer to use one or the other of those mentioned. While in some of my compositions a small amount, not more than about two parts per 100 parts of solution, by weight, of a suitable emulsifier facilitates the removal of the excess penetrant liquid by flushing with water, or the clean-up of the tested pieces, it is pointed out that an emulsifier is not necessary, and water alone will satisfactorily remove the excess penetrant liquid, including the specified diluents of the fatty acid ester or esters, so that the penetrant in the cracks and defects which are sub-surface but connected with the surface, will become visible by seeping or creeping out upon the cleaned surface.

The ester materials used in my penetrant liquids may be made by well known esterification processes. Mixed esters of the higher fatty acids which are present in coconut oil may be prepared by cross esterification with an alkaline catalyst, whereby the glycerine is displaced by the lower molecular weight propyl, butyl or amyl alcohols, and the esters then separated from the glycerine product.

The method of using my penetrant liquid will be apparent from the above description. The metal specimen which is to be tested is cleaned by any suitable means, and then the surface is covered with the penetrant liquid.

After standing for a sufficient time to allow the penetrant liquid to spread into the surface connected flaws, cracks and defects, the excess penetrant liquid is flushed off the surface by means of water, following which the colored or fluorescent penetrant liquid in the flaws, cracks, and defects creeps out of the cracks and spreads to show up the defect.

The application is a continuation in part of my copending application, Ser. No. 229,517, filed June 1, 1951, now abandoned.

I claim:

1. A penetrant liquid for detecting surface-connected defects in metal comprising an ester whose acid constituent is a higher fatty acid radical selected from the group consisting of palmitic, myristic, lauric, oleic, capric, and caprylic acids, and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; and from 0.5 to 2 percent by weight based upon said ester of a dyestuff dispersible in said ester.

2. A penetrant liquid for detecting surface-connected defects in metal comprising an ester whose acid constituent is a higher fatty acid radical selected from the group consisting of palmitic, myristic, lauric, oleic, capric, and caprylic acids, and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; from 0.5 to 2 percent based upon said esters of a dyestuff dispersible in said ester; and an inert non-aqueous diluent for said ester.

3. A penetrant liquid for detecting surface-connected defects in metal consisting of from 20 to 99.5 parts by weight of an ester whose acid constituent is a higher fatty acid radical selected from the group consisting of palmitic, myristic, lauric, oleic, capric and caprylic acids, and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; 0.5 to 2 parts by weight of a dyestuff dispersible in said ester; and 0 to 78 parts by weight of an inert non-aqueous diluent for said ester.

4. A penetrant liquid for detecting surface-connected defects in metal consisting of a mixture of esters whose acid constituents are higher fatty acid radicals selected from the group consisting of palmitic, myristic, lauric, oleic, capric, and caprylic, and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; from 0.5 to 2 percent by weight based upon said esters of a dyestuff dispersible in said mixed esters; and a proportion of an inert diluent for said esters sufficient to lower the viscosity of said mixture of esters and dye to facilitate spreading thereof.

5. A penetrant liquid for detecting surface-connected defects in metal consisting of a mixture of 20 parts by weight of amyl oleate; about 2 parts by weight of oil-soluble red dye and about 78 parts by weight of Stoddard's solvent.

6. A penetrant liquid for detecting surface-connected defects in metal consisting of 98 parts by weight of a mixture of esters whose acid constituents are higher fatty acid radicals derived from commercial cocoanut fatty acids and whose base constituent is normal butyl alcohol radical; and 2 parts by weight of a dyestuff dispersible in said mixed esters.

7. A penetrant liquid for detecting surface-connected defects in metal consisting of 99½ parts by weight of a mixture of esters whose acid constituents are higher fatty acid radicals derived from commercial cocoanut fatty acids and whose base constituent is normal butyl alcohol radical; and ½ part by weight of a fluorescent dye dispersible in said mixed esters.

8. A penetrant liquid for detecting surface-connected defects in metal consisting of 98 parts by weight of a mixture of esters whose acid constituents are higher fatty acid radicals derived from commercial cocoanut fatty acids and whose base constituent is isopropyl alcohol radical; and about 2 parts by weight of a dyestuff dispersible in said mixed esters.

9. A penetrant liquid for detecting surface-connected defects in metal consisting of 98 parts by weight of a mixture of esters whose acid constituents are higher fatty acid radicals derived from commercial cocoanut fatty acids and whose base constituent is amyl alcohol radical; and about 2 parts by weight of a dyestuff dispersible in said mixed esters.

10. In the process of detecting surface-connected flaws in metal, the steps of coating the surface of the metal with a penetrant liquid containing a dyed non-volatile ester whose acid constituent is a higher fatty acid radical and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; allowing the liquid to stand on the metal surface for a sufficient time to spread into surface connected defects, water flushing the surface to remove excess liquid; and allowing the liquid in the flaws to spread over the flushed off surface, whereby to make said flaws visible.

11. In the process of detecting surface-connected flaws in metal, the steps of coating the surface of the metal with a penetrant liquid containing a dyed non-volatile ester whose acid constituent is a coconut oil fatty acid radical and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; allowing the liquid to stand on the metal surface for a sufficient time to spread into surface connected defects, water-flushing the surface to remove excess liquid; and allowing the liquid in the flaws to spread over the flushed off surface, whereby to make said flaws visible.

12. A penetrant liquid for detecting surface-connected defects in metal consisting of from 20 to 99.5 parts by weight of an ester whose acid constituent is a higher fatty acid radical selected from the group consisting of palmitic, myristic, lauric, oleic, capric, and caprylic acids, and whose base constituent is a saturated monohydric alcohol radical having from 3 to 5 carbon atoms; 0.5 to 2 parts by weight of a dyestuff dispersible in said ester; 0 to 2 parts by weight of an emulsifier soluble in said mixture; and 0 to 78 parts by weight of non-aqueous diluent for said ester.

13. A penetrant liquid for detecting surface-connected defects in metal consisting of from 96 to 99.5 parts by weight of an ester whose acid constituent is a higher fatty acid selected from the group consisting of palmitic, myristic, lauric, oleic, capric, and caprylic acids, and whose base constituent is butyl alcohol; 0.5 to 2 parts by weight of a dyestuff dispersible in said ester; and 0 to 2 parts by weight of an emulsifier soluble in said mixture.

References Cited in the file of this patent

UNITED STATES PATENTS

2,298,432	Thompson	Oct. 13, 1942
2,478,951	Stokely	Aug. 16, 1949
2,667,070	Sockman	Jan. 26, 1954
2,764,556	Sockman et al.	Sept. 25, 1956

OTHER REFERENCES

Atlas—Surface Active Agents—Pub. 1948 by Atlas Powder Company of Wilmington, Del., Table I.
Modern Polishes and Specialties (Johns), Chem. Pub. Co. Inc., Brooklyn, N. Y., page 299 (1947).