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SELF-EMULSIFIABLE PENETRANT COMPOSITION

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ABSTRACT OF THE DISCLOSURE

Self-emulsifiable penetrant composition particularly designed for use in the penetrant method for detecting surface discontinuities, the composition containing (1) at least one straight chain alcohol containing from 8 to 15 carbon atoms per molecule ethoxylated with from 3 to 12 mols of ethylene oxide per mol of alcohol, (2) a water immiscible fatty alcohol, (3) a vegetable oil, particularly castor oil, (4) an aliphatic hydrocarbon solvent, and (5) a dye.

CROSS REFERENCE TO RELATED APPLICATION

This application has subject matter in common with the application of Ilmars Z. Dukats, Ser. No. 759,219, now abandoned, entitled "Emulsifier Composition and Method" filed Sept. 11, 1968 and assigned to the same assignee as the present application. The compositions of the present invention differ from those of the Dukats application by not requiring the use of an aromatic solvent and by including both a vegetable oil such as castor oil for its adhesion and improved stability toward fluorescence and a water immiscible alcohol to achieve a controlled removability by water.

BACKGROUND OF THE INVENTION

Field of the invention

This invention is in the field of self-emulsifiable penetrant compositions employed in the usual dye penetrant inspection process wherein a penetrant is applied to the surface of the piece being tested, excess penetrant is removed leaving penetrant trapped in any surface discontinuities, a wet or dry developer is applied to extract the trapped penetrant, and then the piece is examined under either visibile light or ultraviolet light, depending upon the nature of the dye in the penetrant.

Description of the prior art

Self-emulsifiable penetrants have been extensively used in the dyed penetrant inspection field since the 1940's, as exemplified by U.S. Pat. No. 2,405,078. The use of the self-emulsifiable pentrant has various advantages including ease of application, low cost, simplicity, rapidity and wide applicability to various types of parts. However, as pointed out by Carl E. Betz in his book entitled "Principles of Penetrants" (1963), page 130, this process of the past has met with several disadvantages, among them being the danger of "over-washing," that is, the possibility of removing penetrant from defects by prolonged or over-vigorous washing. Another disadvantage is that the penetrant may be susceptible to deterioration by contaminants, especially water. In addition, the self-emulsifiable penetrant compositions previously used were limited in the matter of temperature range over which they could be applied.

In addition, in order for the penetrant composition to be easily washed from the surface of parts and leave a minimum of fluorescent background, a high emulsifier content is desirable. However, as the emulsifiability of the penetrant composition is increased, the removability of the penetrant from the entrapments is likewise increased. If the emulsifier content is decreased to minimize this difficulty, clean washing is hindered and fluorescent blotches may be left on the surface, resulting in a loss of sensitivity for fine defects.

Summary of the invention

The present invention provides a self-emulsifiable composition suitable for use as a penetrant which provides a controlled balance between removability by water and ability to stay retained in the surface defects. The sensitivity of this new composition is substantially independent of the time and intensity of water washing. It has been found that on porous surfaces, the new compositions leave fluorescent residues which are considerably weaker in intensity than those of previously employed penetrants, thereby improving the sensitivity. In addition, the new composition does not require the use of a coupler which was used in many prior art compositions.

The major ingredient of the new composition is an ethoxylated straight chain alcohol having from 8 to 15 carbon atoms in the alcohol molecule, with from 3 to 12 mols of ethylene oxide being grafted into the alcohol. This type of compound contributes to a great extent to the improved sensitivity of the penetrant.

The new compositions also include vegetable oil, particularly castor oil. This material improves the retention of the penetrant in shallow discontinuities and provides an improved adhesion with the fluffy, dry developer particles.

The new compositions also include an aliphatic hydrocarbon solvent which is less expensive than the aromatic hydrocarbon solvents which have heretofore been employed in such compositions. Also included within the new compositions is a water immiscible fatty alcohol which functions to reduce the washability of the ethoxylated alcohol but not to the point where the sensitivity is substantially decreased.

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

Description of the preferred embodiments

The improved self-emulsifiable penetrant compositions of the present invention have compositions within the following ranges:

	Percent by weight
Straight chain alcohol (C_8 to C_{15}) ethoxylated with 3 to 12 mols of ethylene oxide	10–50
Water immiscible fatty alcohol C_{12} to C_{15})	5–20
Vegetable oil	5–20
Aliphatic hydrocarbon solvent	20–50
Dye	Up to 1

The straight chain ethoxylated alcohol can consist of a single material or a mixture of ethoxylated alcohols having varying chain lengths and varying amounts of ethoxylation. For example, one of the better compositions within the present invention uses a mixture of "Alfonic 1412–40" which is an 11 carbon atom alcohol ethoxylated with three mols of ethylene oxide, and "Alfonic 1012–60" which is an 8 carbon atom alcohol ethoxylated with five mols of ethylene oxide. The first named material is sparingly soluble in water, but the second-named material is fully water-miscible. The alcohol forming the backbone for the ethoxylated alcohol may be a primary or secondary alcohol.

The ethoxylated straight chain alcohols of the type described above are solids, pastes or cloudy liquids at room temperature. When the degree of ethoxylation is in excess of that specified, the solution which results in a penetrant vehicle is relatively cloudy and therefore is not particularly suited for use in a penetrant formulation.

The amount of ethoxylated alcohol should exceed individually the amounts of the water immiscible alcohol and the vegetable oil. In most cases, the amount of ethoxylated alcohol will exceed the amount of fatty alcohol and vegetable oil combined.

The water-immiscible alcohol, as previously mentioned, is used to provide a controlled amount of water removability in the ethoxylated alcohol. At relatively high concentration of fatty alcohol, the removability of the penetrant becomes more difficult, but the formulation exhibits an excellent sensitivity, particularly on smooth surfaces. In this respect, it is possible to control the amount of fatty alcohol to provide a penetrant which would be most suitable for a given surface condition or roughness. The preferred fatty alcohol content for general usage is about 7 to 12 weight percent.

The vegetable oil may consist of materials such as soy bean oil, corn oil, coconut oil, or olive oil, but substantially improved results are obtained when castor oil is used. One of the reasons castor oil is preferred is that it does not affect the fluorescent properties of the penetrant when a fluorescent dye is employed. Other vegetable oils tend to dim the fluorescent brightness and diminish the stability of the penetrant solution toward ultraviolet light. While I am not aware of the explanation for this, it may be that because of its unique chemical structure, castor oil behaves differently than similar vegetable oils. Castor oil is a glyceride of ricinoleic acid. This acid is optically active due to the presence of an asymmetric carbon atom in the number 12 position of the chain.

Castor oil also provides improved adhesion toward dry developers. Without the presence of castor oil, there is little difference between the brightness of indications before and after the application of a fluffy dry developer powder. Since castor oil is an extremely viscous liquid, it is impractical to employ large quantities within the formulation. It is therefore preferably present in an amount of about 7 to 12 weight percent.

The aliphatic hydrocarbon solvent employed in the compositions of the present invention is preferably one having a high flash point, one of at least 160° F. A particularly preferred material for use in the new compositions is "Apco 467" which is a kerosene having an initial boiling point of 410° F., with 95% of the material being distilled over at 465 to 470° F. The flash point (TCC) of this material is about 175° F. It is a relatively low volatility material so that it does not exhibit substantial loss by volatilization upon standing.

The dye which may be employed in the compositions of the present invention may be any of the dyes, visible or fluorescent, which have heretofore been used in penetrant compositions. Since the activities of the dyes vary so substantially, it is not meaningful to provide a preferred compositional range for the dyes. Amounts ranging from a small fraction of 1% up to about 10% by weight can be used in typical formulations.

Particularly good results have been achieved by compositions having the following ingredients:

	Parts by weight
"Alfonic 1012-60"	50
"Neodol 25" (C_{12}–C_{15} linear primary alcohol)	10
Castor oil	10
"Apco 467"	35
"7 GA" naphthalamide dye	0.2
MDAC (methyl diaminocoumarin dye)	0,3

The sensitivity of the new self-emulsifiable penetrants is independent of the time and intensity of water washing. This means that regardless of the mode of water washing, whether by spraying, dipping with or without agitation, or pouring, the liquid penetrant is retained in surface discontinuities to exhibit an improved sensitivity in comparison with previously used self-emulsifiable materials. On porous surfaces, the compositions leave fluorescent residues which are considerably weaker in intensity than those of previously employed penetrants, thereby providing a better background against which inspection can take place.

The penetrant compositions of the present invention can be used both with the wet type developer in which a developing powder such as talc is suspended in a relatively volatile liquid, or with the dry, fluffy type powder developers which have been heretofore used for this purpose. The penetrant composition works particularly well with the dry developer because of the affinity of the castor oil for the dry powder.

I claim as my invention:

1. A self-emulsifiable penetrant composition adapted for use in the penetrant method for detecting surface discontinuities, said composition consisting essentially of:

(1) from 10 to 50% by weight of at least one straight chain alcohol containing from 8 to 15 carbon atoms per molecule ethoxylated with from 3 to 12 mols of ethylene oxide per mol of alcohol.

(2) 5 to 20% by weight of a water immiscible fatty alcohol,

(3) from 5 to 20% by weight of a vegetable oil,

(4) from 20 to 50% by weight of an aliphatic hydrocarbon solvent, and

(5) a dye.

2. The composition of claim **1** in which said aliphatic hydrocarbon solvent is a kerosene having a flash point of at least 160° F.

3. The composition of claim **1** in which said dye is a fluorescent dye.

4. The composition of claim **1** in which said fatty alcohol contains from 12 to 15 carbon atoms per molecule.

5. The composition of claim **1** in which said vegetable oil is castor oil.

6. A self-emulsifiable penetrant composition adapted for use in the penetrant method for detecting surface discontinuities, said composition consisting essentially of:

about 50 parts by weight of a C_8 alcohol ethoxylated with about 5 moles of ethylene oxide,

about 10 parts of a fatty alcohol containing from 12 to 15 carbon atoms per molecule,

about 10 parts of castor oil,

about 35 parts of kerosene having a flash point of at least 160° F., and

up to 1% by weight of a dye.

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