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MINERAL OIL COMPOSITION

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This invention pertains to the composition of mineral oils used for electrical purposes, and has for particular purpose to improve the quality of cable and condenser oils with regard to their tendency to evolve gas when subjected to electric stress.

In modern methods of manufacturing high tension cables having a fibrous insulation impregnated with oil, great care is taken to remove all traces of air in the fibrous layers. The cable to be impregnated is usually first subjected to a very high degree of vacuum, so that a thorough impregnation may be effected with substantially no residual air left in the dielectric.

It has been found, however, that such methods are insufficient to preclude all possibility of gas pockets forming in the dielectric, since gas bubbles may be generated there as a result of the decomposition of the oil itself under the very high electric stresses to which it is subjected. The high field intensities usually prevailing in a high tension cable or condenser may then give rise to glow discharges in the gas pockets, leading to an increase in their number and size and to an ultimate deterioration of the cable or condenser.

It is therefore of the greatest importance to develop a type of oil whose gas-forming tendency under operating conditions would be at a minimum.

It is known that the degree of gas formation depends to a great extent on the nature of the mineral oils. Thus, with two oils having approximately the same flash point but consisting respectively of a substantially paraffinic and of a substantially aromatic mixture of hydrocarbons, the evolution of gas in the aromatic mixture is very considerably lower than that in the paraffinic mixture.

It is not, however, possible to use aromatic oils in the manufacture of cable wrappings and electric condensers, since the desirable characteristics of these oils with regard to gas formation, are entirely offset by their negative properties, such as their strong tendency to form sludge and their failure to respond to the action of anti-oxidants to prevent aging. It has therefore been customary until now to use for these purposes mineral oils which had been subjected to a refining treatment for the removal of aromatic

components in order to obtain an oil with the highest possible resistance to oxidation.

I have now discovered that it is possible to obtain an oil composition which although consisting substantially of paraffins and/or naphthenes and possessing therefore the non-oxidizing and non-sludge forming qualities, may be made, through the addition of a very small amount of certain aromatic compounds, to evolve only negligible amounts of gas.

I have found that when a mixture of liquid paraffins is exposed to a high electric stress, a considerable evolution of gas takes place. When 1% of aromatics of the same volatility, such, for example, as an Edeleanu extract of a mineral oil, is added to the mixture, the evolution of the gas remains practically the same. When, however, 1% of more volatile aromatics is added, the gas evolution is considerably reduced.

On the other hand, an aromatic mixture, such as the Edeleanu extract from a spindle oil, gives off only a very small amount of gas when subjected to high electric stresses. The addition of 1% of paraffins at approximately the same volatility causes practically no change, while the addition of 1% of more volatile paraffins brings about a considerable evolution of gas.

These facts prove conclusively that the evolution of gas under the influence of high electric stresses is largely determined by the nature of the most volatile constituents of the oil, which predominate, owing to their relatively high vapor pressure, in the gas bubbles forming in the oil, and probably decompose as a result of the glow discharges.

Moreover, I have found that the rate of gas formation in hydrocarbon mixtures made according to my invention is lower than the rate of gas formation of either aromatic or paraffinic component used for preparing the mixture.

My invention consists, therefore, in adding to a suitably refined cable or condenser oil, a relatively more volatile cyclic compound with a compact molecule, in amounts sufficient to give an aromatic nature to the gas phase present or a gas phase which may arise.

As examples of such suitable aromatic compounds with a compact molecule may be mentioned those consisting only of carbon and hydrogen, such as benzene, toluene, xylene, anthra-

cene, etc., and also such heterocyclic or nitrogen cyclic compounds as pyridine, picolines, lutidines, collidines, or quinoline and its methyl substituted derivatives.

- 5 As stated above, it is necessary to add only very small amounts of these compounds to cable and condenser oils in order to reduce the evolution of gas to a sufficiently low value. In general, I have found that these amounts should lie between the
10 limits of

$$\frac{10}{225-A} \% \text{ and } \frac{1}{15}(A-40) \%$$

- while particularly satisfactory results are obtained if the quantities of the substances added
15 lie between

$$\frac{1}{150}(A-60) \% \text{ and } \frac{1}{15}(A-40) \%$$

- 20 where A is the molecular weight of the substance added.

- The following list gives the percentage by weight, computed according to these formulae, in which some of the above substances may be
25 added to cable and condenser oils:

	Percent
Benzene ----- between --	0.2 and 2
Toluene ----- do ----	0.3 and 3
Xylene ----- do ----	0.3 and 3
30 Anthracene ----- do ----	1.0 and 5

Below the lower limit indicated the substance to be added is usually either inactive, or insufficiently active, or else loses its activity with time.

- 35 On the other hand, an addition of amounts greater than those shown above not only fails to achieve a further reduction of gas formation but decidedly impairs the quality of the mixture by raising its flash point and causing higher sludge formation and evaporation losses.

- 40 By the compact molecules of substances used according to this invention are designated the

molecules of carbocyclic or heterocyclic compounds having no side chains, like benzene, naphthalene, pyridine and the like, or their substituted derivatives containing one or more methyl groups attached to the cyclic nuclei.

I claim as my invention:

1. A method of insulating electric conductors, as electric cables, carrying high voltages which comprises maintaining around said conductors a mineral oil composition comprising a refined 10 substantially aromatic-free oil suitable for insulating purposes, and a small amount of a relatively more volatile aromatic hydrocarbon having a compact molecule of a molecular weight less than 225, said small amount being effective 15 in inhibiting the formation of gases in said oil composition, and being within the range of from

$$\frac{1}{15}(A-40) \% \text{ to } \frac{A-60}{150} \%$$

20 by weight of the refined oil, wherein A is the molecular weight of the aromatic hydrocarbon.

2. A method of insulating electric conductors, as electric cables, carrying high voltages which comprises maintaining around said conductors 25 a mineral oil composition comprising a refined substantially aromatic-free oil suitable for insulating purposes, and a small amount of a relatively more volatile liquid sulfur dioxide soluble portion of mineral oil, said portion containing cyclic 30 hydrocarbons having a compact molecule of a molecular weight less than 225, said small amount being effective in inhibiting the formation of gases in said oil composition, and being within the range of from

$$\frac{1}{15}(A-40) \% \text{ to } \frac{A-60}{150} \%$$

35 by weight of the refined oil, wherein A is the average molecular weight of the cyclic compounds.

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