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METHOD FOR OXIDIZING CARBONACEOUS DEPOSITS

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This invention relates to a method of cleaning objects bearing carbonaceous deposits.

Carbonaceous deposits which contain resinous or gummy materials and result from the coking of hydrocarbons are often difficult to remove by ordinary means, being too tenaceous to be effectively dislodged by detergents and situated on inaccessible or irregularly shaped surfaces so as to defy scraping. Thus, difficulties occur in removing deposits from the inner surfaces of heat exchanger tubes used in the petroleum industry and in molds used, for example, for rubber goods. Oxygen-liberating compounds such as hydrogen peroxide have been used heretofore to clean internal combustion engines, molds, and the like, but under conditions which caused no substantial oxidation thereof at ordinary temperatures.

Now in accordance with this invention, it was found that hydrogen peroxide in aqueous solution is activated and readily oxidizes the carbonaceous deposits when ammonia is admixed thereto. In most instances the aqueous solutions used contain from 6 to 30 weight percent hydrogen peroxide and ammonia yielding from 1 to 40 weight percent of ammonia hydroxide. The rate of oxidation is best controlled and the operation is safer, as described below, when the hydrogen peroxide content is between 12 and 27 weight percent and the ammonium hydroxide content between 3 and 32 weight percent.

In the practice of the invention, the activated oxidizing solution is applied to the carbonaceous deposits and maintained in the liquid phase in contact therewith until the deposits are, for the most part, oxidized to form fluid substances. The reaction is highly exothermic and the deposits are usually completely converted into gaseous or colorless, water-soluble products. The method may be applied at room or ambient temperatures.

As applied to the cleaning of tubes, such as aluminum heat exchange tubes, the activated oxodizing solution is admitted slowly to fill the tubes, preferably from the bottom, leaving the higher ends of the tubes open to permit generated gas to escape freely. A shield or apron to prevent spillage and a fume hood are useful at the higher ends.

The composition of the activated oxidizing solution is advantageously adjusted to complete the treatment in about four to twenty minutes. Higher temperatures, higher concentrations of hydrogen peroxide and, within limits, higher concentrations of ammonia result in more rapid oxidations; conversely the oxidation is retarded by the contrary changes. When oxidation is too rapid excessive foaming results; this can lead to spattering and, when applied to confined places such as tubes, to undesirable blow-off of fluid and/or build-up of pressure. Also, to avoid the hazard of forming explosive peroxides, solutions containing over 30 weight percent of hydrogen peroxide are advantageously avoided, and concentrations under 27 weight percent are preferred. Excessively low concentrations lead to disproportionately slow oxidation rates.

The method can be applied to any surface which is not excessively corroded by hydrogen peroxide; excellent

results were obtained on glass and aluminum objects bearing carbon deposits. Because of the high corrosion resulting from the treatment, it is usually not suitable for removing carbon deposits from heavy metals, such as lead, copper and brass, save in the unusual case where corrosion is not detrimental.

Example I

A solution consisting of two volumes of 30 weight percent H_2O_2 and one volume of concentrated ammonium hydroxide (having a final composition 20 weight percent H_2O_2 and 19.3 weight percent NH_4OH) was applied at room temperature to the surface of a sheet of aluminum having a carbonaceous deposit thereon resulting from the coking of jet engine lubricating oils. The solution covered the deposit for ten minutes, during which time carbon dioxide was liberated, accompanied with mild foaming and a temperature rise. At the end of the period the solution was clear and was removed, leaving a clean aluminum surface.

Example II

Tests on other aqueous hydrogen peroxide solutions following the deposits and procedure of Example I, indicate the effects of varying the concentrations. Their effects are shown in tabular form below:

Run No.	Wt. Percent H_2O_2	Wt. Percent NH_4OH	Other Additives	Relative Order of Oxidation Rate	Remarks
1	30	----------	----------	0	Essentially no reaction.
2	20	----------	17% Acetic Acid.	0	Do.
3	10	38	----------	2	Very slow reaction.
4	15	1	----------	1	Do.
5	15	3	----------	3	Moderate reaction rate.
6	15	7	----------	4	Fairly fast reaction.
7	15	14	----------	4	Do.
8	15	29	----------	4	Do.
9	20	7	----------	5	Fast reaction.
10	20	14	----------	6	Do.
11	20	19	----------	5	Do.
12	26	7	----------	6	Very fast reaction.

From the foregoing it is evident that aqueous hydrogen peroxide, neither alone nor when acidified with acetic acid, reacts appreciably with the carbonaceous deposits, but does so when activated with ammonia.

I claim as my invention:

1. The method of removing carbonaceous resinous or gummy deposits resulting from the coking of hydrocarbons from the inner surfaces of tubes which comprises flowing through said tubes a solution consisting essentially of water, hydrogen peroxide in amount between 12 and 27 weight percent and ammonium hydroxide in amount between 3 and 32 weight percent.

2. The method of removing carbonaceous resinous or gummy deposits resulting from the coking of hydrocarbons from objects which comprises oxidizing said deposits by covering the part of the object bearing said deposit with an aqueous solution of between 6 and 30 weight percent hydrogen peroxide and between 1 and 40 weight percent of ammonium hydroxide.

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