tests, becomes negligible. The residual oil in partially extracted flakes, after being subjected to extraction for a given time, was greater with some of the alcohol-hexane mixtures than with *n*-hexane. This of course is due to the ability of the alcohol to remove more total material. The methanol-hexane solvent consistently left lower oil residues in either soybean or cottonseed flakes than did *n*-hexane at similar residence times.

Although these preliminary studies indicate a usefulness for this type of solvent extraction, the true merit of an alcohol-hexane mixture could only be established by continued research including plant-scale operations.

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The Relationship Between the Greying of Textiles and the Frictional Electricity Generated in Organic Solvent Systems

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THE importance of frictional electric phenomena for dry cleaning operations is well known (1), and many attempts have been made to lessen the fire hazard which they constitute (2), as well as to counteract so-called lint transfer and insufficient soil removal or whiteness retention (3).

Approximate figures only are given in the literature for the observed voltages and amperages of frictional electricity, which may be due to the fact that such data are a function of the relative size of the equipment and agitation, which could be standardized and controlled though. It may also be due to the fact that the experimentally found voltages and amperages show little reproducibility when repeated under seemingly identical conditions. In our experience this is due to the large effect which vibrations and minute eccentricities of moving parts have on the agitation of fluids, especially when combined with the influence of mechanical handling, temperature, and humidity on the "matting" or stress of the textiles which are part of the equipment. In our experimentations a given set of voltage readings duplicated with a precision of better than ± 30%. Certain other facts duplicated with such precision that we are encouraged to make the following report.

Equipment and Method

Electrical Measurements (See Figure 1). A solvent "B" is placed into a metal cell "C" which acts as electrode and shield. Mechanical agitation is produced by the shaft "D," mounted in styrene and acting as the "hot" electrode. The shaft ends at "E" in a paddle, roller or frame, made of, or covered by any desired material. The electric current produced in this cell is observed in the amplifier "A" as an equilibrium between the internal circuit of the cell and the external circuit of the amplifier (Range: 7.5 milliamp to 1×10^{-14} amp.) (4).

We have experimented with a variety of sizes and shapes of the cell "C" and the rotor "E." However the experiments were carried out in a cylindrical cell, 3 in. high and 2 in. diameter, with a cylindrical rotor (2 in. high and ⅞ in. diameter) made of stainless steel. The middle 1¾ in. of the rollers height of electric furnace colloidal graphite in mineral oil. were covered by a sleeve of medium weight wool flannel. The cell was filled with 100 ml. fluid and the roller rotated with 300 r.p.m.

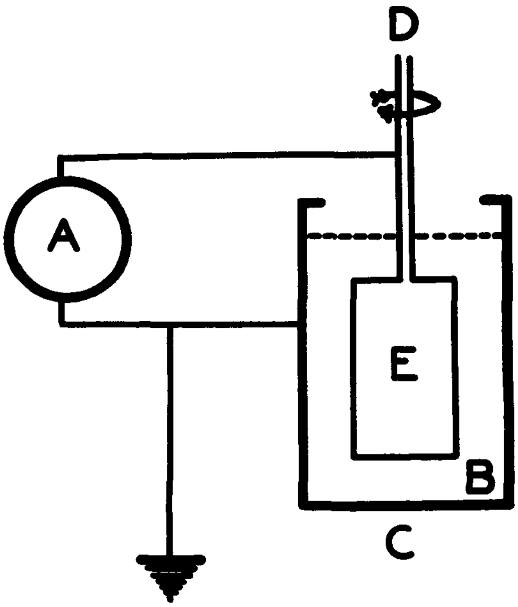

FIG. 1

Greying Tests. 250-ml. glass bottles with aluminum lined screw caps were clamped upright just above a horizontal shaft which rotated at 42 r.p.m. 100 ml. fluid, 30 stainless steel balls ($\frac{5}{32}$ inch O.D.), 0.0100 ml. oil-dag (an about 10 weight percentage suspension of electric furnace colloidal graphite in mineral oil. The average particle size of carbon is approximately 1 micron), 0.30 g. stearic acid, and one 3½ by 3½ in. sample of white wool-rayon gabardine were tumbled for 10 minutes.

The amount of greying can be determined either by comparing the light reflectivity of the textile sample before and after the test, or by measuring the transmittancy of the fluid (5). Before the test the

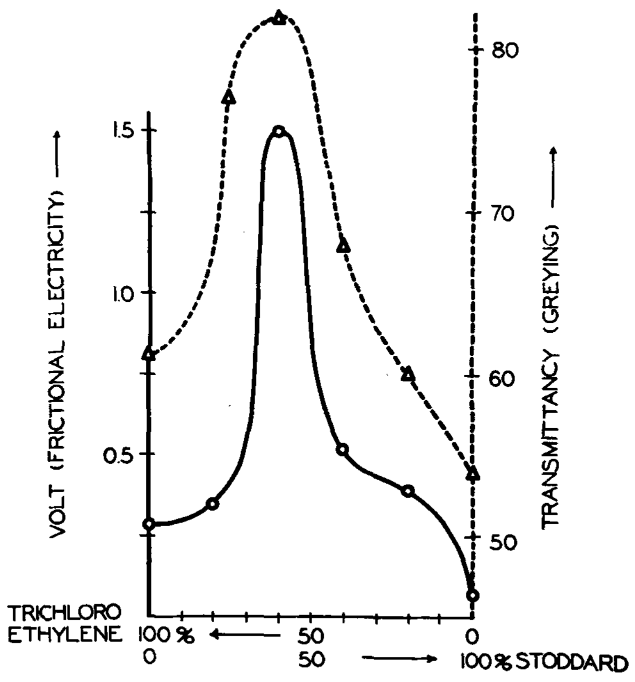

Fig. 2.

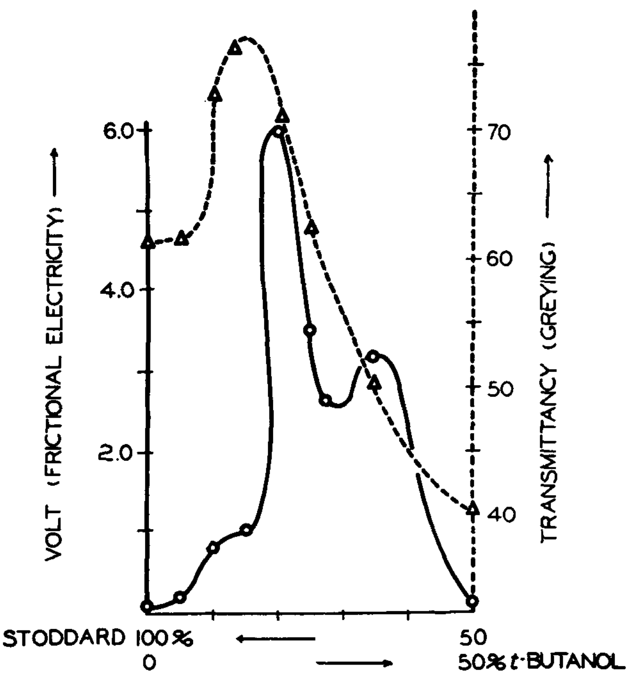

Fig. 3

soil suspension gave a 42% transmittancy in a Cenco-Sheard B-2 Photelometer and the gabardine sample gave a reflectivity of 72% in a Hunter reflectometer with green filter and a standard backing of 69.6% MgO whiteness.

Experiments and Discussion

Under the described experimental conditions we observed for the commercially used dry cleaning fluids steady voltages ranging from 0.02 to about 0.70 volt ± 30% and from 10^{-11} to 10^{-9} amperes. Different sizes and shapes of equipment give of course higher or lower voltages. If the relative distance between electrically charged materials is changed during the experiment, the high voltages mentioned in the literature are observed (see for instance [6]).

In the particular experiments reported in Figure 2 Stoddard solvent gave 0.07 volt while trichloro ethylene gave 0.28 volt. When mixtures of these two solvents were used, a maximum of frictional electricity was observed for a mixture of 60 ml. trichloro ethylene and 40 ml. Stoddard (1.50 volt).

Another two-component system we studied was Stoddard-tert. butanol (Figure 3), which shows a sharp maximum of frictional electricity at 78% and Stoddard-22% tert. butanol ± 2%, followed by a minor peak at 65% Stoddard. The curve trails then at very small + or — voltages toward 100% butanol.

When these experiments were repeated in our equipment the observed voltages deviated so that a bundle of curves was obtained, yet the reported maxima and minima duplicated within less than ± 2% of the indicated solvent composition.

In general, we observed two-component systems with one or more maxima and/or minima. We found also some two-component systems in which the frictional electricities are a fairly linear function of the percentage composition. In all cases high frictional electricity was concomitant with high greying by the colloidal graphite suspensions, and it was of special interest to correlate these data for two-component systems showing a maximum as reported in Figures 2 and 3.

Summary

1. Frictional electricities in two-component solvent systems have been measured with an electronic amplifier by use of metal cells in which relative motion was produced by a rotating shaft covered by a textile sleeve.

2. The observed voltages and amperages depend upon the rate of agitation, the relative size of cell and rotor, and upon the less well controlled influence of atmospheric and mechanical conditions on the textile materials. The described equipment allows a reproducibility of ± 30% for the measurement of frictional electricity.

3. Mixtures of solvent pairs were tested, and one or more maxima and/or minima of frictional electricity were observed in these two-component systems with a reproducibility of ± 2% by volume composition.

4. Samples of textile materials were subjected to tests for greying by colloidal graphite-stearic acid suspensions in two-component solvent systems. The greying was found to increase and decrease with the observed frictional electricities.

5. Data are reported for frictional electricity and greying observed in Stoddard-trichloro ethylene and also in Stoddard-tert. butanol mixtures.

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