Variables in Powdering of Floor Finishes

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ABSTRACT

Powdering of floor polishes represents the breakdown of a film on the floor, which occurs particularly under cold, low humidity conditions; this has presented a serious problem to the industry. Factors in the powdering or dusting of floor polish films are reviewed. Variables include the effect of measurement technique, humidity, ambient temperature and floor tile surfaces. Correlation between laboratory and field test results is noted, and high correlation is evident provided that extraneous factors such as soil residues are eliminated.

The powdering of floor finishes represents the breakdown or crystallization of the film on the floor. Such powdering occurs particularly under cold, low humidity conditions as might be encountered in the winter, but powdering also occurs in the summer and during any period of the year when air conditioning systems are used and conditions are dry. The "crystallization" is accelerated, depending on the amount of traffic and abrasion on the floor. This has presented a serious problem to the industry because this in essence is a failure of the product, and product failure increases maintenance costs and labor costs. When such failure occurs the material becomes tracked around, and is even observed on carpeting in adjacent areas. The only recourse left to maintenance personnel is to remove the powder, strip the floor, and administer a reapplication.

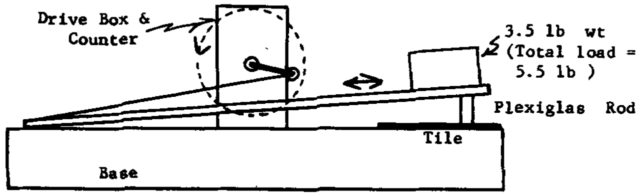

FIG. 1. Schematic diagram of motorized crockmeter.

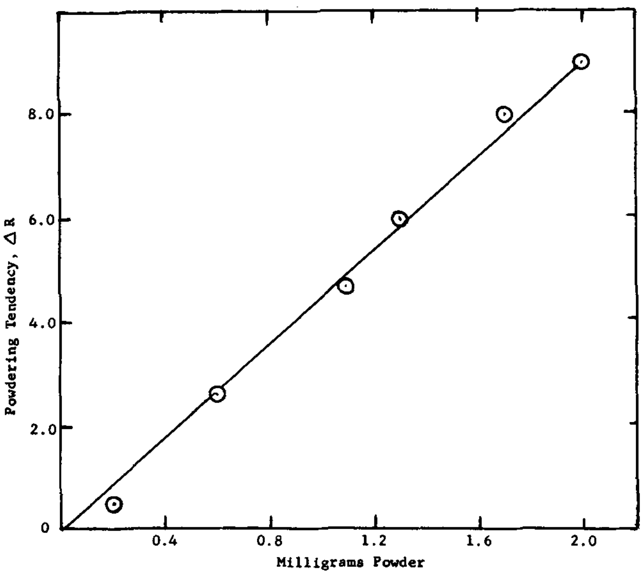

FIG. 2. Reflectance vs. milligrams of powder collected on felt.

This paper is an examination of some of the factors in the powdering of floor finishes, focusing on variables in the measuring technique. A cursory review of the literature suggests that relatively little has been published, and there is little factual data. Pezzuto (1), in a 1967 review of floor polish polymers, at Polyvinyl Chemical noted a basic approach to powdering measurement and reviewed a procedure. He suggested the use of a crockmeter and rubbing with green felt swatches to abrade the film, and collected powdering material. He reported that more powdering occurs if the humidity is reduced. In 1972, Sweet (2) briefly reviewed polymeric properties and noted that the characteristics of the polymers, e.g., the minimum film-forming temperature, influence powdering results depending upon the test conditions. He noted, by a formula adjustment such as the level of plasticizer, that one can tailor a floor finish to suit the various seasonal conditions. It was implied that one might have a winter and a summer formula.

EXPERIMENTAL PROCEDURES

We followed the basic approach of Pezzute, i.e., the crockmeter method, and also used a controllable temperature and humidity environment. A special attempt has been made to put the data on a more formalized and quantitative basis.

A Plexiglas (Rohm & Haas) glove dry box with a crockmeter positioned inside was employed, and a cylinder of nitrogen gas was used to sweep the atmosphere free of moisture. Measurement was started after sweeping with nitrogen. Also, a vacuum pump was used to remove most of the air and moisture prior to the introduction of dry nitrogen.

At the base of the dry box was placed a tray of desiccant

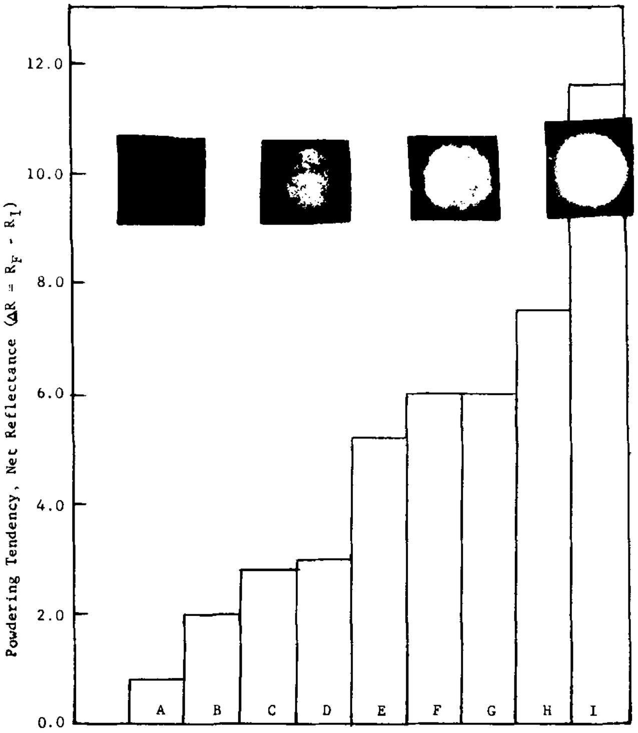

FIG. 3. Results for floor finishes.

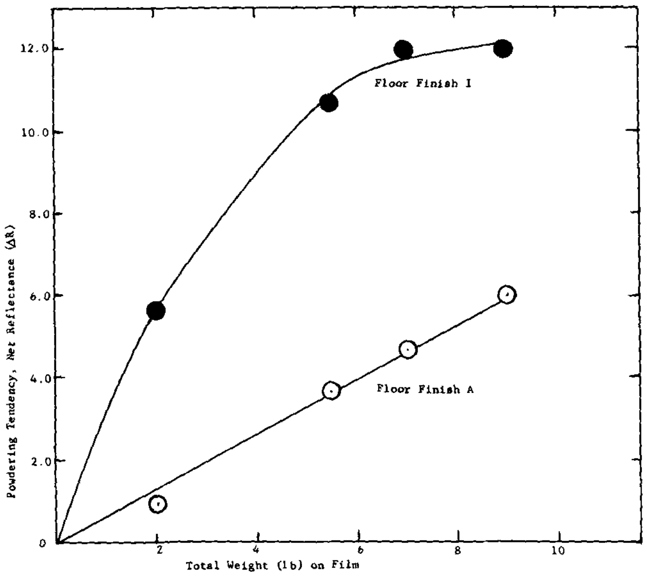

FIG. 4. Weight effect on degree of powdering from crockmeter.

to help obtain low humidities. With the desiccant and the vacuum pump, we achieved relative humidities that were essentially zero and held this condition for the test run. Slabs of dry ice were placed on top of the dry box, which permitted achievement of very low temperatures and humidities. A heating rod and fan were employed inside the box to maintain high temperatures. To measure relative humidity within the box we used a sling psychrometer stored in a plastic bottle inside the dry box. The crockmeter was motorized and is available from Testing Machines Institute. Positioned over the sliding arm was a 2 lb weight.

Figure 1 is a schematic diagram of the motorized crockmeter. This device consists of a sliding arm with a counter, and the Plexiglas rod is moved in a reciprocating fashion over the floor tile film. At the base of the rod, there is placed a small felt pad, which is rubbed against the film. The felt pad collects white powder, which becomes evident because of the green background. In our studies, the bulk of the work was done with a 5.5 lb total load, which was adjusted by adding a 3.5 lb weight to the platform. The resulting weight approximated 27 lb/in^2, which is similar to the force from an average person.

Material can be collected that does not represent powdering material but rather soil or surface dust. This illustrates that one can be misled in sampling a given floor area, since the appearance of surface dust can be mistakenly interpreted as powdering; this has resulted in some confusion in field observations. In our experiments, foreign substances such as soil or dirt were avoided and high correlation with field experience resulted.

The assessment of powdering has been quantified. A Photovolt Reflectometer (Model 610, Photovolt Corp.) equipped with a green tristimulus filter is positioned over the powdered area. This total reflectance reading is adjusted by subtracting a background value for the initial reflectance of the untreated swatch.

RESULTS AND DISCUSSION

The relationship between the reflectance values and the net weight of powder material on the test felt is shown in Figure 2. The essential linearity of the results for the region tested was encouraging and suggests support for the reflectance measurements as a uniform measurement tool.

A comparison of results for various proprietary floor finishes is shown in Figure 3. Swatches of the billiard cloth are superimposed to show corresponding appearance of the powdered swatch. Results are given for conditions of 10-15% relative humidity at a temperature of 75 F. These finishes are plotted in order of increasing powdering as measured by reflectivity. The results suggest a wide diversity among floor finishes in powdering tendency. Formulations with very low powdering tendency can be achieved through a balanced formulation technique.

TABLE I

Effect of Tile on Powdering

Tile	ΔR. for finishes A	ΔR. for finishes I
Asphalt	0.6	5.7
Vinyl asbestos	0.9	7.4
Vinyl	0.3	8.5

TABLE II

Temperature and Humidity Effect

Temperature, F	Relative humidity %	Powdering tendency, ΔR[a] of floor finishes A	I
0[b]	12[b]	1.6	12.8
0[b]	100[b]	0.0	0.0
20	7	0.0	12.0
69	58	0.0	3.8
75	9	1.0	12.0
94	Ess. 0	2.0	10.0
94	80	0.0	7.2
110	Ess. 0	2.0	10.0
118	Ess. 0	1.2	6.6
118	100	0.0	0.0

[a]Net reflectance: ±0.3, 95% confidence limits.
[b]Conditions in vicinity of test tile; not equilibrium conditions.

Figure 4 shows the effect of increasing weight on the test area. At the most commonly used weight of 5.5 lb, the region of measurement is essentially linear. The 5.5 lb total weight was adopted because it gave uniform results and corresponded to the weight of 27 lb/in^2, which is similar to the force of a 150 lb human.

The effect of tile substrate is examined in Table I. The dominant influence is the floor finish composition and not the substrate, although for composition *I* vinyl appeared to yield higher powdering than either vinyl asbestos or asphalt. Such results are consistent with the commonly observed result that adhesion is lowest for straight vinyl tiles.

Data in Table II show how performance is effected by temperature and humidity conditions. Again results are directed mostly by the floor finish composition, comparing *A* to *I*. Note, particularly with *I*, that powdering becomes nil at high humidities and is promoted by dry conditions. With *A*, powdering was generally zero to slight and was promoted by elevated temperature in addition to the low humidity environment.

An examination of the chemical nature of the powdering was done by using an IR spectrum for the collected powder vs. the spectrum for total solids representing the total floor finish composition. The essentially superimposed results for the two curves suggest that the total powder is represented by the total finish, which is essentially the polymeric components.

In summary, we have reported on a more systematic approach to investigating powdering of floor finishes. The basic powdering measurement utilizing the crockmeter has been placed on a more quantitative basis through use of reflectance measurements. Low humidity and elevated temperature promote powdering, but the chief variable is the floor finish type or formulation. Tile surface has less of an effect than either variables on powdering, although increased powdering can be observed for vinyl presumably because of lower adhesion. The other paper in this series examines the effect of floor finish composition in greater detail (3).

ACKNOWLEDGMENTS

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REFERENCES

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