Drying Oils in the Floor Covering Industry

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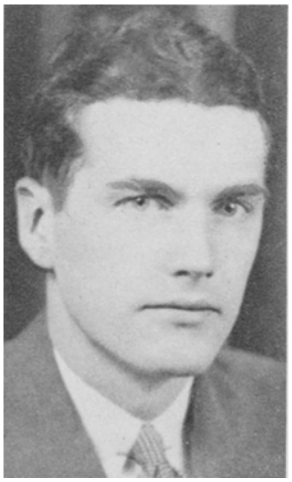
THE floor covering industry manufactures a great variety of products, probably more than any other of the building materials industries. These products are in general divided into the "soft surfaced" and "smooth surfaced" floorings. The first class includes the wool, cotton, and other fabric coverings such as carpets, etc. The "smooth surfaced" floorings may be divided into the resilient and non-resilient types. The non-resilient types are the stone, brick, vitrified tile, etc. The resilient type includes printed felt base, linoleum, asphalt tile, rubber, and plastic. The only ones which use vegetable oils to any extent are linoleum and printed felt base. This paper will therefore be limited to these two types of resilient, smooth surfaced floor coverings.



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The relative volumes of these materials produced in the U. S. in 1948 as compared to some of the other types of floor covering may be seen in the following table:

TABLE I (1)

1948 Floor Covering Production

Type	Sq. Yds. (Million)
Printed Felt Base	280
Linoleum	75
Asphalt Tile	45
Rubber Tile	6.5

As may be seen from these figures, the printed felt base amounts to a high percentage of the resilient smooth surfaced floor covering production in this country. At the present time this industry represents a tremendous capital investment in equipment, plants, etc. There are currently 12 companies manufacturing printed felt base floor coverings. These companies will produce about 280 million square yards of felt base yearly at the 1948 rate. The amount of drying oils going into these products will amount to about 80 million pounds. The growth of this industry is illustrated by the following table:

TABLE II

U. S. Felt Base Production

Year	Sq. Yds. (Million)
1911	Start
1919	25
1924	75
1929	120
1931	85
1935	125
1939	160
1941	205
1948	280

Printed felt base consists essentially of an asphalt saturated felt on which is applied a decorative baked enamel surface coating. This enamel coating is the actual wear surface of the product. This type of material was first made in Erie, Pa., in 1911 as yard goods, and shortly thereafter the first printed felt base rug was produced at Marcus Hook, Pa., under a basic patent issued to the Congoleum Company. The product is now produced in rug form and in yard goods of 6-, 9-, and 12-foot widths.

Various types of felt webs have been used in the manufacture of printed felt base. In general the felts are made from rag, wood, and paper stock and will vary in thickness from about .035" to .060". The felt is saturated with asphalt and is then ready for the application of the various paint coatings which are necessary to make up the final product.

In order to seal the asphalt and provide a smooth surface for the enamel top coat, "facing" or "coating" paints must first be applied to the saturated felt. Drying oils have been used in both the coating and enamel surface paints. The problems involved in each type of paint are different and must be considered separately.

COATING paints are generally of two types, oleo-resinous solvent-cut or emulsion. The emulsion can either be of the protein or oleo-resinous base. For good performance and results using an oleo-resinous emulsion, the oil must be readily emulsifiable into a stable paint. It must have sufficient film-forming properties to give good sealing and flexibility. This factor of flexibility is especially important because the overall flexibility of the goods will be dependent to a large extent on the coatings used. Since all the felt base products are sold in rolls, serious cracking difficulties are encountered if brittle coating paints are used.

The oils used in these paints have been for the most part linseed, soybean, fish, Chinawood, and oiticica. These have been combined with various natural and synthetic resins to give the desired oleo-resinous binder for the coating paint.

The enamel surface coating, called "print paint" in the industry, is the actual visible and wearing surface of the goods. The method of applying this paint is radically different from other application methods found in the protective coating industry. The paint is applied on a flat-bed print machine which is unique with the industry. The paint is applied by a series of blocks to which the paints are fed by inking rolls and carriages. The coated felt is carried along intermittently under the blocks and each block prints its own particular color and design. Most patterns require up to 14 different colors, but as many as 24 different colors may be used, each requiring its own printing block and paint carriage. The printed felt is then carried up into large baking ovens. This necessitates travel through a vertical position as it is fed into the top of the oven. The goods are then placed in flat racks or festooned during the drying period.

From this description of the printing technique the problems involved may readily be seen. The paint must not be sticky, or trouble from stringing will result as the blocks are raised. It must have good initial flow so that a smooth and well blended surface is obtained, and it must have good set after this initial flow to prevent sag as the goods are fed vertically into the ovens or festooned during the drying. In short the rheological properties of the paint must be under very close control during printing and stoving.

The flow properties of a print paint are generally dependent on the flow properties of the vehicles used to make the paint. Because of the flexibility required in felt base flooring, the print paint vehicles are generally of the long oil type. This means that the oils used and the methods of processing these oils will determine to a great extent the properties of the paint produced.

The oils used to make print paint vehicles are the conventional ones used by the protective coating industry. The methods of cooking these oils are also similar to those of the paint and varnish manufacturer. Chinawood, oiticica, and dehydrated castor oils are used as the "hard" or fast bodying and drying component while linseed and soybean oils are used as the soft oil component. The resins normally used are the conventional enamel resins such as pure or modified phenolics.

As mentioned previously, the attainment of the particular properties necessary in the print paint vehicle is greatly dependent on the processing of the oil in the kettle. One type of cook will be needed when Chinawood and linseed oils are used whereas dehydrated castor and linseed oils will require a different cook. It is a matter of adapting the cooking procedure to the oils which are being used to bring out best the desired qualities in the finished vehicles.

AN examination of the qualities required in a piece of printed felt base floor covering will show why certain drying oils are preferred over others. The goods must be flexible, long-wearing, and resistant to abrasion, denting, mild alkali, and soaps. The surface must be smooth, glossy, and attractive in appearance. The colors must be bright, attractive, and permanent. The print paint used must dry rapidly at baking temperatures of about 150°-170°F. to a hard, non-tacky film.

In selecting oils, we must choose the drying oils which give the best combination of these desirable qualities. In the hard oil class Chinawood oil gives good dry, alkali resistance, abrasion resistance, and flexibility. Dehydrated castor oil gives excellent color and flexibility but only fair dry. Oiticica oil gives good dry, abrasion resistance, alkali resistance, but somewhat inferior flexibility. In combination with these oils linseed gives good dry, alkali and abrasion resistance, but only fair flexibility and color. Soybean oil, on the other hand, gives excellent color and flexibility but less resistance and slower dry.

Many of the recently developed commercial materials such as the chemically modified and segregated oils have been widely used in the manufacture of printed felt base. The soybean base modified oils have given improved color and flexibility in certain products and will probably be used extensively whenever the economics are favorable. Experimental work has been carried out with many of the minor oils, but as yet none have been used to any extent. Safflower oil looks to be promising as a drying oil, and since this oil is now becoming commercially available in increasing quantities, considerable work will probably be done with this oil in the felt base industry.

It should be pointed out that many of the qualities such as color, gloss, and flexibility of the finished felt base are affected by factors other than the oil. We shall not go into these however since we are interested only in the vegetable drying oil phase of the industry.

The term "linoleum" is loosely used by many people. It is often used in reference to printed felt base or other types of floor covering, both by retailers and consumers. Genuine linoleum is the oldest of the present day floor coverings and is generally considered to be the universal moderately priced floor covering.

Linoleum in its simplest form is a plastic composition made from oxidized linseed oil, natural gums and resins, pigments, and organic fillers such as ground cork or wood flour. This composition has a base of woven or felted fabric and is usually made in thicknesses up to about 0.25 inch.

The name "linoleum" was derived from the Latin words for flax, "linum," and oil, "oleum." The first piece of linoleum was made in England in 1863 by Frederick Walton. It consisted of a mixture of an oxidized linseed oil-kauri gum-rosin cement, ground cork, and pigments. Walton had previously obtained patents covering the manufacture of oxidized linseed oil (1860) and the manufacture of a floor covering from oxidized oils (1862). This should be distinguished from floor oilcloth, which was first mentioned in 1578 and later patented in 1627 and was a fabric coated with multiple layers of paint. The first plant for the manufacture of linoleum was built by Walton in 1864, and in 1865 total sales amounted to 50,000 square yards. The first plant in the United States began operation on Staten Island, N. Y. in 1874. The oldest linoleum plant operating in America today, started in 1886, is located at Kearny, N. J.

Modern linoleum is somewhat similar in composition to that described in the original Walton patent. However many important changes and improvements have been made in equipment and methods since that time. Many of the ingredients now used are the same, but the products produced are far superior to those made years ago.

MANY improvements have been made in the production of the linoleum "cement." The original method was to allow thin layers of linseed oil to air-oxidize and polymerize to a hard tough "skin." This was accomplished by allowing boiled linseed oil to flow down over cotton scrim cloth, which is hung from the ceiling of large oxidizing "sheds." In this way a layer of oxidized oil is formed on the cloth. By successive floodings of the cloth multiple layers of oxidized oil are built up. This process was carried out at a temperature of about 125°F. and took several months before a skin of sufficient thickness could be obtained. This skin was then fluxed with natural gums at elevated temperatures, and on cooling a tough, rubbery gel resulted which was known as a "cement." Many advances have been made in oil oxidation, and the modern mechanical methods give cements in hours rather than weeks as in the old method. In making most cements conventional driers are used. The cement is used as the binder for the linoleum sheet. It is mixed with pigments (color and filler) and organic fillers (ground cork or wood flour), and then calendered on a woven or felted fabric base. The marble or striated type of pattern is formed and controlled by the method of mixing, sheeting, and calendering.

The modern "automatic Rotary Inlaying Machine" for making geometric inlaid linoleum is one of the most ingenious and interesting pieces of equipment in American industry. This machine handles four separate sheets of linoleum composition, cuts figures, inlays and presses these figures on a woven or felted fabric base, and rejects the unused composition. This is all done automatically and at a comparatively high speed. This machine represents a tremendous capital investment, and there are only three in existence in this country. These machines have revolutionized the manufacture of inlaid linoleum by their increased efficiency, improved quality, and greater volume of production.

The final step in the manufacture of linoleum is the seasoning. This is carried out by festooning the linoleum in huge ovens and allowing it to cure at temperatures of 150°-200°F. for a matter of from one to 10 weeks, depending on the type and thickness of the goods. The time and temperature of seasoning are critical factors and must be controlled closely to obtain a resilient, flexible, serviceable, and attractive floor covering.

In order fully to understand the role which drying oils play in the linoleum industry, one must first examine the qualities which are necessary for economical and successful processing. In the production of cement it is essential that the oil be readily oxidizable since the cement must be in a highly oxidized state to attain the desired binding qualities. This is also necessary since the seasoning of the linoleum sheet is essentially a polymerization of the oxidized binder. The time and nature of the seasoning, then, will be greatly dependent on the nature of this binder. This cement must lend itself readily to efficient mixing with the pigments and fillers; for this reason it must have good wetting properties.

The mix formed from the cement, pigments, and fillers is a soft plastic mass. The sheet formed from this mix must be able to support its own weight during processing so that it must have good tensile strength. The surface, decoration, and texture of the final calendered sheet are controlled by manipulation of calender pressures and temperatures and the thermoplasticity of the mix. The tensile strength and thermoplasticity of the mix are primarily dependent on the cement used.

TO summarize, any oil used to make linoleum must be readily oxidizable with and without resins to a tough, rubbery gel with good wetting properties and tensile strength; it must have, in combination with resins, a certain required degree of thermoplasticity; and it must be readily polymerizable below 200°F. The oil which seems to fit these requirements best has been linseed oil, which has always been the major binder ingredient in linoleum.

The other requirements for oils used to manufacture linoleum are that they impart certain desirable qualities to the finished product. A good piece of linoleum must be flexible, resilient, bright and clean colored, resistant to fading, abrasion, soiling, denting, and resoftening, and should withstand mild alkalies and soaps. It must not continue to cure after removal from the stove since this would give hard and brittle goods. This would mean poor handling and installation qualities. The surface must be smooth and lend itself to easy maintenance. The oil used in the cement is a major factor in the flexibility, color, and resistance of the linoleum. The thermoplasticity and wetting power of the cement will determine to a large extent the surface qualities of the goods. Again it has been found that linseed oil gives the best combination of these qualities.

Many oils other than linseed have been used to produce linoleum. By a partial replacement of linseed with other oils a good combination of qualities may be imparted to linoleum, and actually many replacements have been made during the development of the linoleum industry. The comments which follow are for complete replacement of the linseed oil.

Soybean oil gives a more flexible end product with excellent color. The serious objection to soybean oil is the slow time of cement making and seasoning. The partial replacement of linseed by soybean oil however has given linoleum of excellent quality. Considerable work using chemically treated or segregated soybean oils has indicated that these oils give improved processing and seasoning times over raw soybean oil. Enough linoleum has been produced using many of these new soybean oils so that the product containing these oils can be fully proven during the next few years. If no adverse effects are noted with these oils, they could become an important factor in the linoleum industry.

Hard oils of the Chinawood-oiticica type have not given good results as a binder in linoleum. These oils are of the "polymerizing" type, and do not yield the necessary oxidized type of cement. The gel has low tensile strength and poor binding properties. The sheet made from the gel is dry and weak.

Dehydrated castor oil gives results similar to Chinawood-oiticica oils. The deficiencies in the processing of these oils are far too great to give much consideration to the good qualities that they might impart to the finished linoleum.

Perilla oil has been used as a linoleum raw material to a limited extent. Cement-making time is good, but the finished linoleum is harder, more brittle, and shows more discoloration than the linseed product. The cost and limited availability of perilla oil have been important factors against its use in linoleum.

The problem of availability is most critical when any oil is considered for possible use in linoleum because of the tremendous quantities of oils used by the industry. For this reason many oils such as safflower, sunflower, and milkweed seed, which are available in only limited quantities, have not been fully investigated as floor covering raw materials. It is probable that as they become available, many of them will be used in the manufacture of linoleum.

In conclusion it is interesting to consider a few facts and figures which illustrate the scope of the floor covering industry and which show the relative amounts of the various drying oils which have been used (Table III).

From these figures it may be seen that of the combined amount of oils consumed by the floor covering

TABLE III (2)

Oil Usage—Paint and Varnish vs. Floor Covering

Year	Paint and Varnish lb. (million)	Floor Covering lb. (million)
1938	326	77
1941	505	135
1945	465	77
1948	577	147
1949	429	119

and paint industries, the floor covering industry uses about 20% of this total. Since there are only about 12 floor covering manufacturers in the country as compared to the hundreds of paint manufacturers, it may be readily seen that the large floor covering manufacturers must be among the largest single users of drying oils in the country.

It is interesting to note the trend toward soybean oil in the floor covering industry during the past few years. Table IV illustrates this.

This sharp trend toward soybean oil can be attributed to the price differential which existed between linseed and soybean oils during these periods as well as to the greatly improved drying and finished film properties which the recently developed modified soybean oils have shown. From the amount of soybean oil consumed by the industry in 1949 (32.5 million pounds), it must be acknowledged that soybean oil has now taken a place along with linseed oil as a major drying oil in the floor covering industry.

TABLE IV (2)

Soybean and Linseed Oil Consumption Floor Covering Industry

Year	Linseed lb. (million)	Soybean lb. (million)	Ratio Linseed: Soybean
1938	55	3.5	16/1
1941	110	7	16/1
1946	66	6.5	10/1
1947	88	23	3.5/1
1948	110	22	5/1
1949	76	32.5	2.3/1

For a final consideration it is interesting to note the relative amounts of the various oils which are used in the floor covering industry. Table V gives this data for 1948.

TABLE V

Floor Covering Drying Oil Consumption—1948

Oil	Lb. (million)
Linseed	110
Soybean	22
Chinawood	9
Fish	5
Dehydrated Castor	0.7
Oiticica	0.16
Other	0.13

From this table one may readily see that the drying oils used in the manufacture of floor coverings are the conventional oils of the paint industry. This is understandable of course from the fact that the large floor covering manufacturers are among the top few paint manufacturers in volume of paint produced annually.

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