

Extrusion of Cosmetic Products

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Presented September 6, 1967, New York City

Synopsis—The manufacturing methods of cosmetic eyebrow and lipliner pencils are discussed. It has been found that both wax and/or pigment changes can affect the mechanical properties of extruded leads. The thixotropic character of wax systems was also evaluated.

INTRODUCTION

Cosmetic products on today's market that could be considered extruded are limited to eyebrow and lipliner pencils. The most recent statistics indicated that 42% of the female population use eyebrow pencils with regularity. This number accounted for about \$16,000,000 in sales in 1966 in the United States and Canada.

Extrusion in its simplest definition is the forcing of a mass through a die of given dimensions. Extrusion has found application in industries as diverse as steel and food, in plastic manufacturing, and in brick plants. The advantage of extrusion lies in its use as a continuous or semicontinuous operation. It can reduce handling of material, and, in some steps, completely eliminate certain operations.

EXTRUSION

The type of material that is to be extruded is the limiting factor in the choice of extrusion equipment. Three types of systems have been encountered in cosmetic formulation that limit the type of equipment necessary for extrusion.

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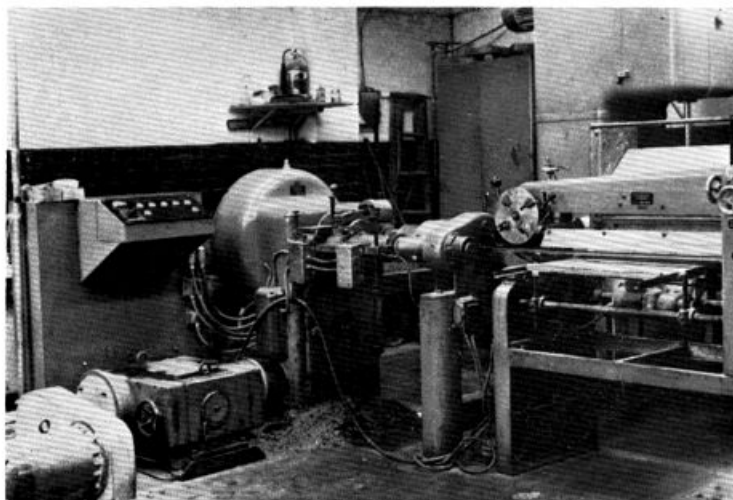


Figure 1. Lead extruder, Fr. Erhardt, Nurnberg, West Germany

The first system could be considered ideal in that it is completely pressure-dependent; that is, when a given pressure is applied to the mass it will extrude through the die. This type of system would not usually be of a wax base.

The second system has properties of a thixotropic nature; that is, on the application of pressure the system experiences an isothermal-reversible sol-gel transformation. This is usually observed in wax-oil systems such as carnauba wax and mineral oil combination.

The final system is one that is frequently encountered in cosmetic lead manufacturing. This system is such that it will not flow when initially put under pressure, but rather it will compress until the internal friction has generated enough heat to lower the viscosity, and the mass will flow through the die. This system is both temperature- and pressure-dependent.

The various systems that are encountered in cosmetic lead manufacturing require an extrusion apparatus that can be regulated for both pressure and rate. Hydraulic units for lead manufacturing are rare and in most cases they cannot attain the pressure required for all formulations. The lead industry, both graphite and cosmetic, has relied on an extruder that attains high pressures by the use of gears and a screw mechanism. The equipment shown in Fig. 1 is a specially adapted lead extruder for cosmetic use.

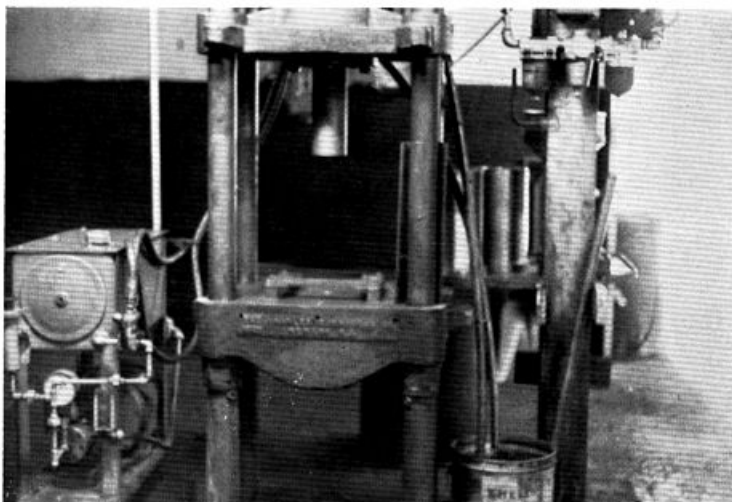


Figure 2. Hydraulic lead extruder, Red Cedar Pencil Company, Lewisburg, Tenn.

This machine is a constant-pressure, variable-rate extruder. The large box at the base of the control panel contains a gear system to regulate the rate of extrusion. The ram is a large screw, turned by a series of gears, that has a force of 90 tons. The lead is extruded through the die, picked up by the belt, and cut to the size of the boards. The cut lead travels on the belt until it is pushed onto the board. It is then cut to the required length and packed. Two cylinders are used in this operation; one is being filled while the other is extruded. This type of equipment is satisfactory for most cosmetic leads.

For a system that is pressure-dependent, the extruder shown in Fig. 2 has been used. This is an oil hydraulic system that can attain pressures of 75,000 psi. The rate of extrusion is regulated by the amount of oil allowed into the cylinder. In this case, the lead is extruded through the bottom of the cylinder and put on lead boards by hand.

The preparation of the material prior to extrusion is similar to that of lipstick manufacturing. The waxes are melted and the pigments are dispersed by means of a triple-roll mill. An important difference, however, is the removal of air prior to extrusion. Figure 3 shows the result of air in cosmetic leads. This type of air is easily observable and the lead can be discarded by the operator. In some cases, air does not appear on the surface of the lead but remains in the body of the wax. Results of this type of air are shown in Fig. 4.

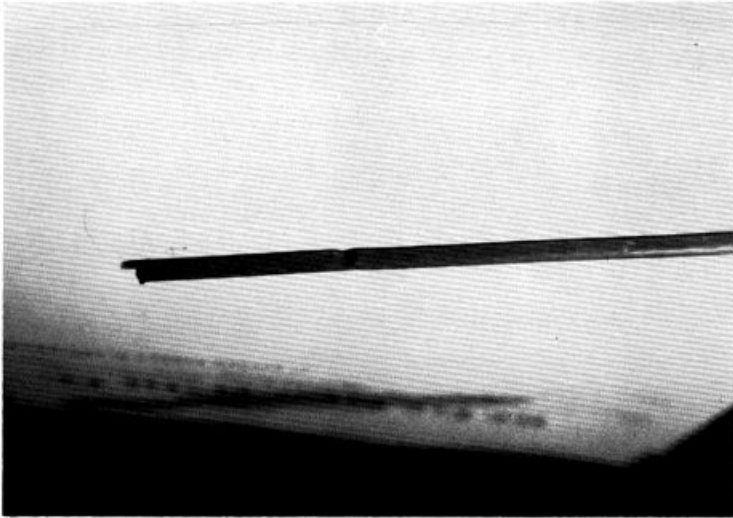


Figure 3. Air in leads



Figure 4. Air in finished pencil

The problem of air is common to both graphite and cosmetic lead manufacturers. Solutions to this problem have been approached in many ways. Originally, a weight was repeatedly dropped on the lead mass until it was believed all air had been expelled. In recent years, investigations into vacuum filling of cylinders and pouring molten wax into the cylinders have been carried out. These various methods have found

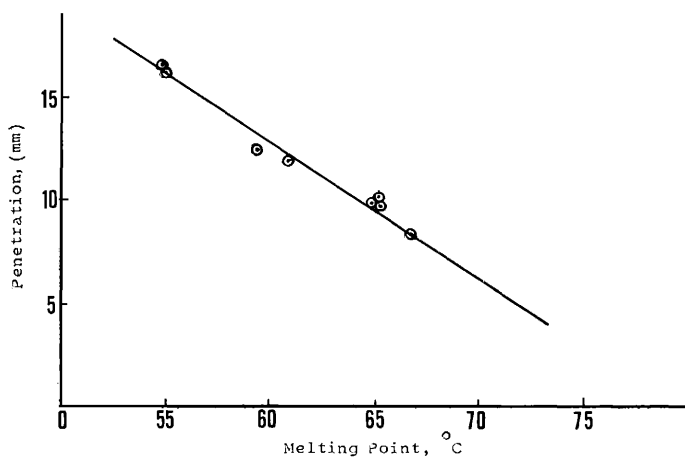


Figure 5. Melting point as a function of penetration

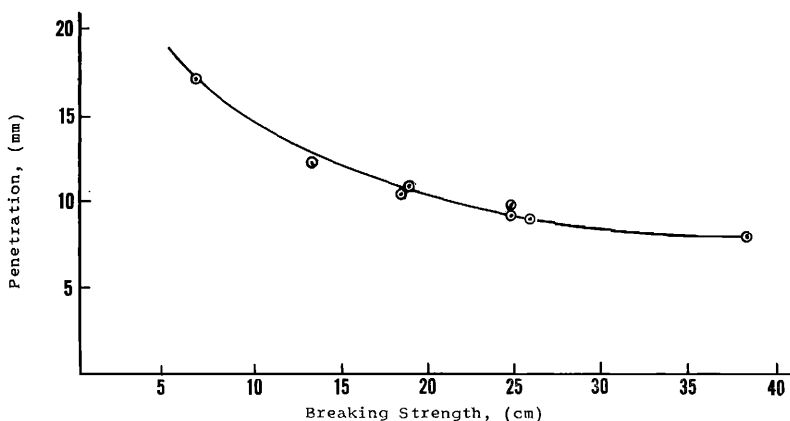


Figure 6. Breaking strength as a function of penetration

application for some materials but a universal method for all materials has not yet been perfected.

FORMULATION

The formulations for eyebrow and lipliner pencils are similar in many respects to lipstick and stick eyeshadow. Sagarin (1) notes that eyebrow pencils are formulated similarly to cream-type eyeshadow. Harry (2) has made reference to a black eyebrow formulation which consists primarily of hydrogenated castor oil, hydrogenated cottonseed oil, and lanolin.

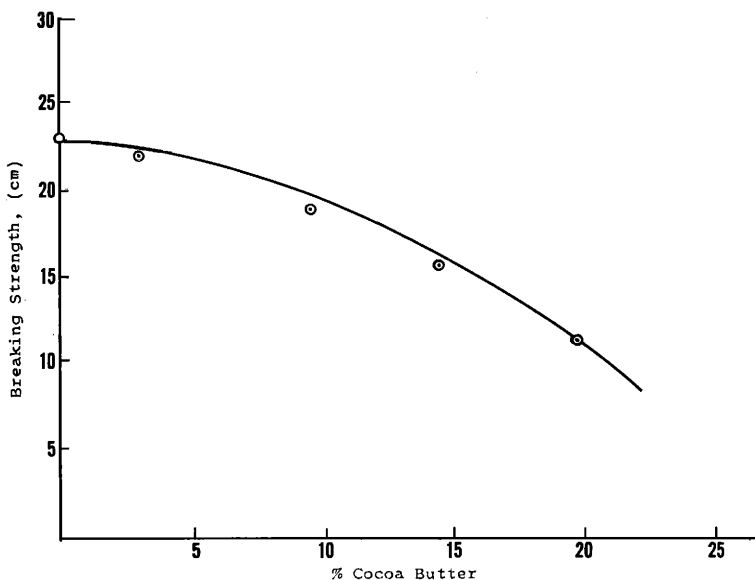


Figure 7. Breaking strength as a function of cocoa butter concentration

Cosmetic leads are formulated principally from waxes, fats, and oils. The characteristics of these waxes and combination of the waxes can be found in the works of Bennett (3). Beeswax, carnauba, and ceresine are used primarily for body and strength in the stick. Lanolin, mineral oil, and cocoa butter are good emollients. Japan wax is used because it has certain qualities that improve the sharpening of cosmetic leads. Micro-crystalline wax, carnauba wax, and mineral oil add thixotropic properties to the product. Various blends of these component waxes could give products with qualities of lipsticks and/or cosmetic leads. A typical formulation for cosmetic lead could be the following:

Japan wax	25%
Beeswax	15
Ceresine	4
Carnauba	6
Mineral oil	3
Lanolin	20
Cocoa butter	10
Pigment	17

A lead of various hardness could be formed by changing the ratio of the lower-melting waxes to the higher-melting waxes.

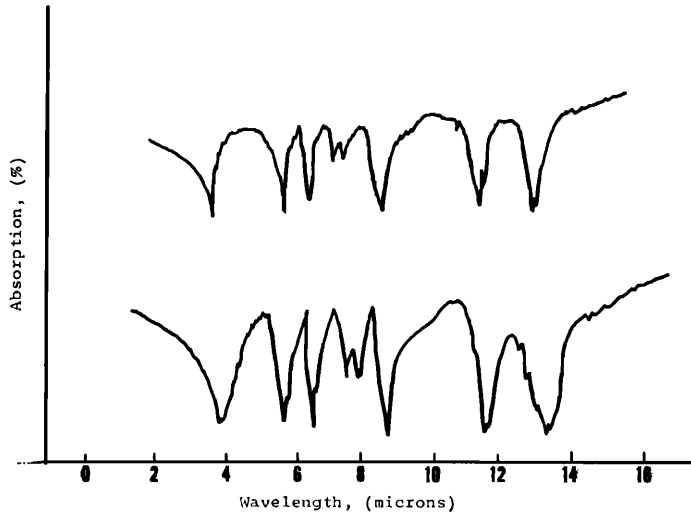


Figure 8. IR spectra of triglycerides

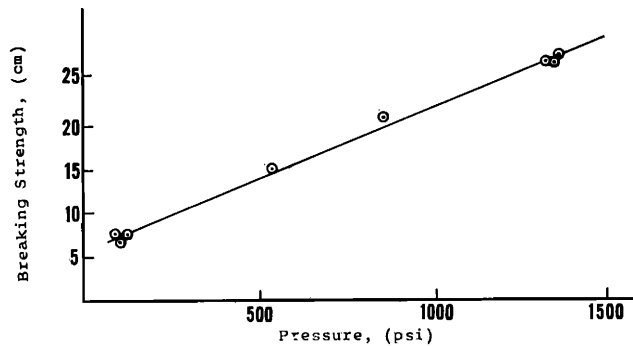


Figure 9. Breaking strength as a function of extrusion pressure

PHYSICAL PROPERTIES

The characteristics most sought after in stick formulations are the strength of the stick and the release properties of the product. These relationships can sometimes be equated to the penetration of the wax base and its melting point.

Figure 5 shows the relationship of melting point to penetration of the cosmetic lead formulation previously discussed. This relationship is only applicable to this particular system. It has also been found that

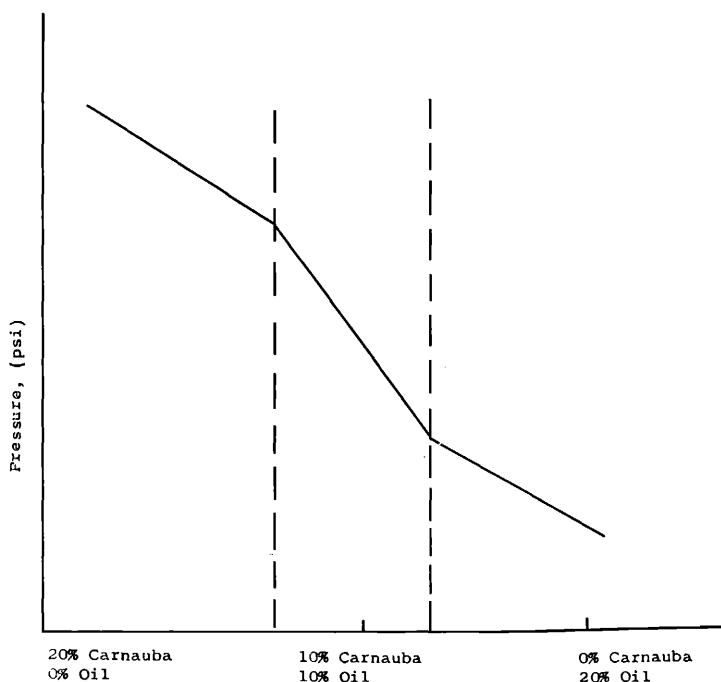


Figure 10. The extrusion pressure of a wax system as a function of the concentration of carnauba wax and mineral oil in a thixotropic system

there is frequently no relationship between melting point and penetration.

The strength of stick-type products is usually measured by the weight required to break the product. One method of measuring the strength involves a moving weight on a fulcrum with the lead placed under the end of the fulcrum. When the weight travels a certain distance of the fulcrum the lead breaks and the distance is recorded. In Fig. 6, penetration is compared to breaking strength for a 0.162-in. diameter black lead.

The addition of different waxes to a system can have varied effects on the resulting mixture. A high-melting wax such as carnauba usually will increase the melting point of a wax mixture. On the other hand, a cocoa butter substitute, which has a low melting point, may not affect the melting point of a wax mixture. It can, however, change other characteristics such as breaking strength. These data are shown in Fig. 7.

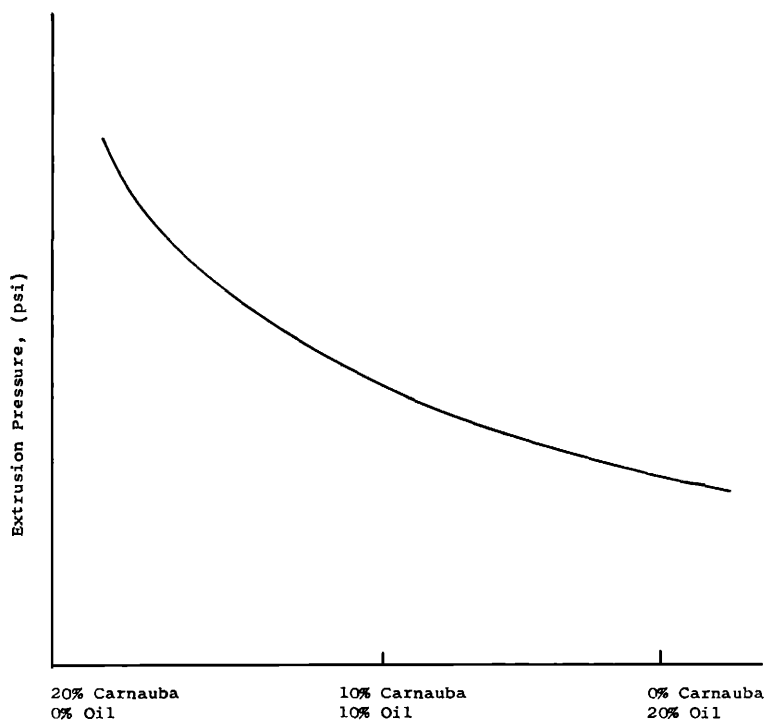


Figure 11. The extrusion pressure of a wax system as a function of the concentration of carnauba wax and mineral oil in a nonthixotropic system

It is frequently desirable to have effects similar to those of cocoa butter where the melting point is not affected, but the release, or other properties, can be changed. However, the addition of triglycerides, such as cocoa butter or cocoa butter substitute, can lead to other problems. It is well known that triglycerides can exist in various polymorphic forms; that is, they have various crystal structures designated α , β' , and β . The α form is the most unstable and rapidly converts to the β' form. The β' form slowly converts to the most stable β structure. During the change from α to β , the triglyceride has a certain mobility within the wax system and frequently will deposit on the outer surface of the lead. This is commonly called bloom and has plagued the chocolate industry for a number of years. Bloom was intentionally grown on the surface of a cosmetic lead for investigation. This material was carefully scraped off the lead and examined by IR. Figure 8 compares the original triglyceride of the formulation to the scrapings.

Table I
Effect of Pigment on the Breaking Strength and
Extrusion Pressure of Cosmetic Leads

Pigment	Breaking Strength (cm)	Extrusion Pressure (psi)
Black (carbon black)	22.50	1100
Black (iron oxide)	13.00	350
Brown (iron oxide)	10.80	300
Red (iron oxide)	9.00	175
Yellow (iron oxide)	10.00	250
Green (chromium oxide anhydrous)	9.00	175
Green (chromium oxide hydrated)	10.00	200
Blue (ferric ferro cyanide)	14.00	300

Table II
Effect of the Addition of Wax on the Extrusion
Pressure of a Standard Wax Base

Wax Added (%)	Extrusion Pressure (psi)				
	0	5	10	15	20
Carnauba	900	1100	1150	1200	1225
Ceresine	900	950	1025	1100	1150
Cocoa butter	900	850	700	625	550

The control of bloom is usually accomplished by the substitution of materials, such as Eutectol[®],* which have only one crystal form. If this is not feasible, a controlled-temperature process known as tempering is employed. This step in the manufacturing process involves the controlled cooling of the wax mixture so that the stable β form is encouraged. The use of surfactants has also been shown to inhibit bloom (4).

PIGMENT EFFECTS

The pigments employed to attain the various shades required in eyebrow and lipliner pencils can also affect the strength of the resulting product. It is frequently necessary to have completely different wax bases for various pigments. The effect of adding various pigments to a wax base on the pressure required for extrusion and the breaking strength of lead is shown in Table I.

* A&S Corporation, 10 Summit Rd., Verona, N. J.

THIXOTROPIC SYSTEMS

At this time there are not sufficient data available to form conclusions on the extrusion of true thixotropic mixtures. These data are being partially obtained by the study of extrusion pressures of various formulations. The study of the addition of three waxes to a basic formulation is shown in Table II.

The data in Table II were taken on a standard wax base with the addition of 30 wt % of carbon black. The relationship of extrusion pressure to breaking strength is shown in Fig. 9.

The extrusion pressure should be dependent on the concentrations of the lower and higher melting wax additives. A thixotropic system would not be completely dependent on the individual waxes but more on the ideal concentration of the two materials to give the optimum thixotropic effect. A hypothetical curve for this system is shown in Fig. 10. A nonthixotropic system would act as shown in Fig. 11.

CONCLUSION

The potential for extruded cosmetic products lies in the hands of the formulator. Stick toiletries, such as preshave sticks and deodorant sticks, could easily lend themselves to extrusion. The advantages for extrusion over molding are many. The product would have more strength; problems such as air and flaking could be reduced; and, finally, the production cost could be reduced by 30 to 50%. Cake mascara has been extruded from a standard production formulation with good success. There is also a possibility that pressed powder could be extruded in rectangular form and cut to the required length for godets. Depending on the type of information obtained from these thixotropic studies, lipstick and stick eyeshadow could possibly be extruded.

The investigation of wax systems and new raw materials of a wax nature can lead to the development of formulations that might better be extruded than molded or pressed. The production cost saving in extrusion manufacturing warrants further studies by the cosmetic chemist.

(Received December 12, 1967)

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