the herbicide, as occurred in this study.

Future of Soybean Oil in the Application of Herbicides

Reducing the carrier volume to very low amounts was the major benefit observed from the use of SBO with rotary nozzles. This greatly increases the efficiency of spray operations because the frequent refilling associated with current application methods is eliminated. This also will decrease the cost of spraying since a greater area can be sprayed each day and there is little need for trucks hauling carrier to the field. The initial greater investment associated with rotary nozzles compared to conventional sprayers would be recovered in several years.

The most immediate promise for the widespread adoption of SBO is as an additive to postemergence herbicides applied with conventional sprayers, because investment in new equipment is not needed. Results from the johnsongrass study (Table III) and more recent research indicate that it is equal to PCOC in enhancing the activity of essentially all postemergence herbicides.

Growers using SBO as a carrier will need to clean their equipment frequently because a film of oil deposits on it during spraying. Compatibility between the SBO and each herbicide will need to be determined in advance to preclude problems in the field. In addition, applicators may need to wear protective clothing more routinely because the oil may increase absorption of the herbicide through the skin.

Studies are continuing at Southern Illinois University and at other universities to further evaluate the potential of SBO as a carrier and additive for herbicides.

TABLE III

Evaluation of Soybean Oil Concentrate vs. Petroleum Oil Concentrate as Enhancing Agents with Postemergence Herbicides for Johnsongrass Control in Soybeans, Murphysboro, 1983

Herbicide	Rate	% Control[c], Aug. 10 Additive, 2.3 L/ha		
		None	PCOC[a]	SOC[b]
	(G/ha)			
Nontreated				
Sethoxydim	84	8 d	18 d	28 cd
Sethoxydim	140	18 d	37 cd	37 cd
Sethoxydim	210	33 cd	45 c	47 c
Fluazifop-butyl	84	35 cd	30 cd	37 cd
Fluazifop-butyl	140	62 bc	80 ab	55 bc
Fluazifop-butyl	210	75 b	83 ab	77 b
HOE 581	70	37 cd	52 c	32 cd
HOE 581	105	48 c	57 bc	55 bc
HOE 581	140	62 bc	67 bc	52 c
HOE 581	175	80 ab	–	–
DPX-Y6202	18	8 d	40 cd	5 d
DPX-Y6202	35	38 cd	73 b	27 cd
DPX-Y6202	53	67 bc	90 a	40 cd
DPX-Y6202	70	77 b	–	–

[a]Petroleum oil 83% plus emulsifiers 17%.

[b]Fully refined soybean oil 85% plus emulsifiers 15%.

[c]Values within and between columns followed by one or more like letters are not different at the 5% level according to Duncan's Multiple Range Test.

REFERENCES

1. Robbins, W.W., A.S. Crafts and R.N. Raynor, Weed Control. McGraw-Hill Book Co., Inc., New York, 1942, pp. 160-165.
2. Crafts, A.S., and W.W. Robbins, Weed Control. McGraw-Hill Book Co., Inc., New York, 1962, pp. 575-584.
3. Jones, G.E., and G.W. Anderson. Res. Rept., North Centr. Weed Contr. Conf. 20:27-29, 1964.
4. Miller, G.R., and W.W. Nelson, Res. Rept. North Centr. Weed Contr. Conf. 28:123-125, 1971.
5. Nalewaja, J.D., Proc., North Centr. Weed Contr. Conf. 23:12-13, 1968.
6. Nalewaja, J.D., Res. Rept. North Centr. Weed Contr. Conf. 29:294, 1972.
7. Anonymous, U.S. Dep. of Agr. Agricultural Statistics, 1983.

Trends in Industrial Use of Vegetable Oils in Coatings

RICHARD W. FULMER, Research Center, Cargill, Inc., P.O. Box 9300, Minneapolis, MN 55440

ABSTRACT

Alkyd resins continue to be a major factor in coatings. Increased oil consumption in alkyd manufacture is not expected to be significant. Projections indicate a modest growth in total coatings usage at 2-3% per year. The industry is facing diverse coating performance demands that will bring unusual, more costly ingredients into use, probably at the expense of traditional oil-based alkyd resins. Offsetting this oil usage decline, perhaps, will be the continuing cost advantage of the relatively low-priced vegetable oils and the general versatility of alkyd resins. Increased use of oil-based resins is expected in emulsion (latex) paint modifiers to improve adhesion and early water resistance. The coatings industry, at least in maintenance and industrial coatings, is adopting a cost/sq ft/year economic evaluation, facotoring in the useful life of the coating.

INTRODUCTION

Very few indicators, if any, point to significant change in the overall consumption of vegetable oils in the surface coatings industry in the U.S. during the next five years. Projections indicate a modest, continued physical growth of 2-3% per year in coatings consumption, more particularly in resin solids. Fluctuations are anticipated in total coatings dollar value due to business cycles, inflation rates and variations in raw material supply costs.

The impact of changes in coatings consumption or technology on vegetable oil usage will be difficult to discern. Industrial usage of vegetable oils is small compared with total food uses. Estimates vary, but generally agree, that only 5-7% of total vegetable oil consumption occurs in nonfood uses. Therefore, it is difficult in an established industry such as surface coating resins to discuss changes that would demonstrate a significant impact on total oil industry volume.

Nevertheless, this paper will examine the paint industry in the U.S. with comments toward expected technical developments in film-forming resin compositions.

DISCUSSION

Any useful perspective requires some understanding of the paint industry and its raw materials.

From 1970 to 1982, U.S. paint production increased from 830 million gallons to 930 million gallons, with a peak year of 1065 million gallons in 1979 just prior to the economic downturn in automobiles, housing and durable goods. During the same period, the value of U.S. paint production rose from \$2.6 billion to \$8.3 billion.

Value per gallon steadily rose during the 12-yr period from \$3.00 to \$9.00, reflecting increased raw material costs, higher cost/higher performance coatings and inflation.

Total 1982 U.S. surface coatings fall into the three categories shown in Table I.

Chemical Economics Handbook-SRI International (2) has provided the latest (1982) coatings raw material picture (Figure 1).

Of the 2,245,000,000 lbs of film-forming resins, vegetable oils or the corresponding fatty acids are a component in the alkyd, epoxy ester, urethane (oil modified or urethane-alkyd), and some polyester resins, in addition to drying and semi-drying oils. Dimer acid-based polymeric solids also would be included.

Alkyds range from zero ("oil-free" alkyd polyesters) up to about 65% oil base, depending on end use and curing methods. It is difficult to estimate the amount of vegetable oil consumption in this as well as other coatings applications.

A recent industry review (3) reports 1983 volume consumption up about 12% from 1982. First half 1984 gallons shipped are reported 9-12.3% larger than the corresponding six months of 1983. Architectural coatings have enjoyed a large share of this growth; product coatings also increased. This represents housing and automotive trends in particular.

The numbers for the various types of resins are not yet available for 1983 or 1984. However, housing would include both oil- (alkyd) and non-oil-based resins; interestingly, the drive toward lower volatile paint solvent emissions is converting some auto makers from high solvent lacquers to alkyds, followed by clear top coats.

TABLE I

Use and Value of U.S. Surface Coatings, 1982

Coating type	Percent of volume	Value, billions of \$
Architectural coatings[a]	51	4.0
Product finishes/DEM[b]	29	2.6
Special purpose coatings[c]	20	1.7

[a]Includes undercoatings, sealers, primers, topcoats, stains, varnishes.

[b]Includes paper, film, foil, furniture, metal, pipe, appliances, industrial and consumer coatings.

[c]Includes automotive, high performance maintenance, machinery refinishing and traffic paints.

Positive industry trends that indicate continued use of vegetable oils include a growing use of water-reducible alkyds, containing less volatile organic solvent, and a resurgent consumer interest in wood stain finishes (either solvent or water based). Attractive stable prices in the 25-35¢/lb range for vegetable oils continue to make them the lowest cost of any alkyd film-forming ingredient.

Negative trends may develop from general business changes and swings in decorator styles (use of wallpaper, carpeting, tile, glass). Specialty performance demands may require coating resins with no, or low, oil content. Many significant long-term coating applications now are evaluated by a newer economic measure; namely, cost/sq ft/year. Not

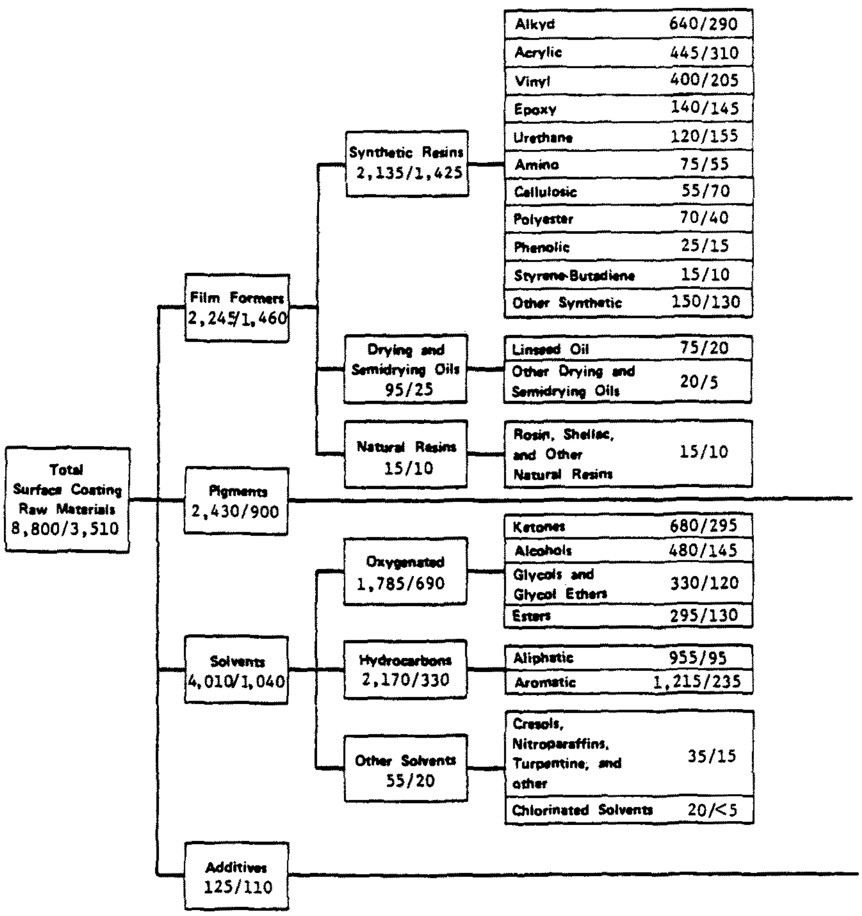

FIG. 1. Estimated U.S. consumption of surface coating raw materials in 1982. (Millions of pounds/millions of dollars.)

only does this factor in the original cost of paint, but projects its useful functional life, time lapse until repaint, substrate quality and preparation for repaint. Labor costs for each segment are included in overall cost calculation.

Oil usage in surface coatings already has experienced some decline due to performance and availability of alternate systems and the historical growth of the oil-free emulsion (latex) paint resins. While modest growth of total surface coatings is anticipated, there is an expectation of flat to slightly reduced vegetable oil consumption.

REFERENCES

1. The Paint Report, Chem. Eng. News, p. 26, Oct 3 (1983).
2. Chemical and Economics Handbook-SRI International. Fats and Oils 220.5003K and private communication.
3. Coatings Industry, Chem. Eng. News, p. 51, Oct 1 (1984).

Growth Potential for Soybean Oil Products as Industrial Materials

NORMAN O.V. SONNTAG, Consultant, 306 Shadow Wood Trail, Red Oak, TX 75154

ABSTRACT

Crude soybean oil, as a major source of edible oil for the world, is available on such a scale that it serves additionally as the origin for many industrial applications and for such materials as phospholipids (lecithins, cephalins), tocopherols (for vitamin E), sterols (for pharmaceuticals) and recovered fatty acids from acidulated soapstocks. The latter always have offered the oleochemicals manufacturer a low cost source of valuable fatty acids, and soybean oil itself, after hydrogenation, serves as the most readily available, lowest cost source of 90% stearic acid from among all fats and oils. As an alternative to alkali refining and the soapstock produced, physical refining of the degummed soybean oil is a potential source for fatty acids and for recovery of larger amounts of valuable sterols and tocopherols, but this process severely degrades the oxidation stability of the fatty acids.

The largest potentials for growth in industrial applications are for soybean oil itself in pesticide dispersion and grain dust control; triglycerides and fatty acids split therefrom for 90% stearate oleochemicals and selected food additivies; fatty acids from soapstocks up-graded medium-grade oleochemicals, medium-grade soaps for industrial cleaning operations, and in animal feeds and pet foods; phospholipid gums in fractionated and modified lecithins and cephalins; soy deodorizer distillates containing α-tocopherol (vitamin E) and sterol-derived sex hormones. Inclusion of food additives, feed and pet food additives with the more usual industrial markets results in the conclusion that industrial utilization of soybean oil could reach 12% of total consumption in the U.S. within five years.

INTRODUCTION

Price usually determines which fat or oil is used in an industrial C-18 application. Technology exists that permits interchangeable use of fats or oils to produce the desired oleochemical product. Cheaper, inedible, bleachable fancy tallow might be the preferred primary feedstock, but the manufacturer could use cheap fatty acids from acidulated vegetable oil soapstocks, if quality was not too objectionable.

In mid-1980, the price of crude soybean oil reached a low of 20-22¢/lb, and this material quickly came into competition with tallow. The oleochemical producer has an advantage over the edible product manufacturer because the latter requires a refined, deodorized grade of soybean oil, traditionally priced about 5¢/lb higher than the crude oil. However, degummed oil is usually a minimum requirement. Although low-cost soybean oil soon disappeared (30-40¢/lb range, May 1984), a number of vital lessons were learned. First, although priced substantially higher than inedible tallow and somewhat higher than edible tallow, soybean oil usually can compete with tallows as the more economical choice for the manufacture of 90% stearate-type derivatives. Second, in a growing number of cases, the distribution of fatty acids, both before or after hydrogenation, affords soybean oil a number of advantages that tallows do not possess.

PHOSPHOLIPIDS

U.S. raw material capacity for soybean phospholipids is quite large. The gum content of crude solvent extracted soybean oil varies from 1.5-2.5%. With a 1983-84 crop of about 2 billion bushels of soybeans, and exports accounting for about 50% of this, U.S. production of crude oil could amount to 11.2 billion lb. Assuming two-thirds of this oil is degummed, there is the latent potential for about 150 million lb of phospholipid material. Less than half of this has been deoiled with acetone in the past to yield commercial lecithin products. An even smaller fraction of these products, say 1%, is fractionated with aqueous ethanol to afford separated phosphatidylcholine (alcohol soluble), phosphatidylethanolamine (distributes between alcohol soluble and insoluble compounds), and inositol phosphatide (alcohol insoluble) products, which have applications in food emulsification and stabilization, feed amplification, as pharmaceuticals and for other uses.

Eichberg (1) reported that 1981 commercial lecithin production in the U.S. was 59.4 million lb (worldwide production, 200 million lbs; western Europe, 60 million lb). We estimate the 1984 U.S. production of commercial lecithins at about 65 million lb. Bulk prices for the six grades of commercial lecithins in the various "natural," "bleached" and "double-bleached" types for both fluid and plastic products ranged from $0.26-0.36/lb, but specialty products can command premium prices: a 48% fluid in oil product for paint additive use, $0.505/lb, and a special product, 35-38%, FDA-approved for sliced cheese use, $4.80/lb. For the period 1980-84, it is apparent that the percentage growth of lecithins is slightly higher than that of soybean oil. Obviously, the production capacity for lecithin products far outweighs the present market for these products.

The existing uses for commercial lecithin products have been summarized by Socca (2), Eichberg (2), Niewenhuysen (3) and Szuhaj and List (4) and include functional applications such as an emulsifier, stabilizer, conditioning and release agent and antioxidant. Lecithin is used in foodstuffs such as baking products and mixes, in candy, chewing gum, chocolate, dehydrated foods, edible oils and fats, ice cream, instant foods, macaroni and noodles, margarine and whipped toppings. Industrial uses include applications in cosmetics and soaps, dyes, insecticides, paints, petroleum products, rubber, sealing and caulking compounds, textiles and pharmaceuticals and as a release agent in plastics. Animal feed applications are based upon its performance as an emulsifier, wetting and dispersing agent, caloric source, antioxidant, source of choline, organically-bound phosphorus and inositol and as a lipotropic agent.

Whenever a naturally-derived versatile product, such as