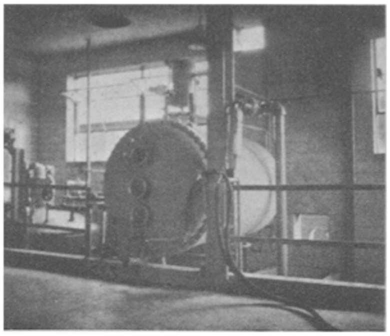
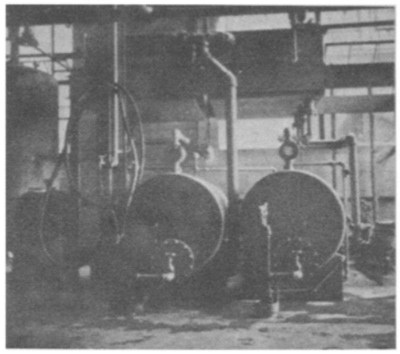
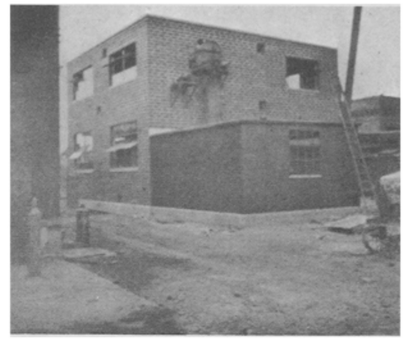


Preliminary Still "K" in Which the Greater Part of the Solvent Is Removed from the Oil-Solvent Solution. The Top of Mixer Tank "B" Is at the Left.



Water Separators "I" and "P" Under Condensers "H" and "O."



Extraction Plant Building Under Construction. The One-Story Section Is Used for Storing Spent Bleaching Materials as They Are Brought Over from the Refinery.

practically all condensed. The condensate and remaining vapors are picked up by the Direct Acting Vacuum Pump "N" and pumped into the Atmospheric Condenser "O" where condensation is completed. The condensate flows off through the Water Separator "P," the solvent going to Tank "J" and the water to the sewer.

The partially stripped fat-solvent from the Preliminary Still "K" flows into the Still "L" where the remainder of the solvent is removed by blowing with live steam. Both Stills "K" and "L" and Condenser "M" operate at about 24-26 in. vacuum, depending upon the temperature of the available condensing water.

The tanks are all of steel, welded construction. All Pumps are Direct Steam Driven, either Simplex or Duplex. The Condensers are made up of cast iron sections of the type used in the petroleum industry. All Electric Motors and Starters are located outside of the building, using totally enclosed motors with the shafts passing through stuffing boxes in the walls. All movable parts are grounded. Shovels and scrapers used in handling the spent and extracted earth are made of bronze or aluminum to avoid the possibility of sparks.

The building is of steel and tile construction, with large windows, and special attention paid to ventilation. Scuppers at the floor level are provided with fixed louvers which cannot be closed. Lights and light switches are of the approved type, the lamps being enclosed in heavy vapor-proof globes.

The equipment will handle one and one-half tons at a charge and two runs can easily be made in twenty-four hours. 1,200 gallons of Skellysolve "B," boiling point 146-156 deg., are used for each wash. The extracted earth will average about 3.0 per cent fat on a dry basis. The color of the extracted oil will, of course, vary with the kind of oil on which the earth is used. In this plant, where corn, cottonseed, soya bean and cocoanut oil are being handled, the color of the extracted oils has been as dark as 18-R—35-Y and as light at 6-R—20-Y. The free fatty acid content has varied from 1.00% to 2.50%.

Extraction of spent earth from Filter Presses which have been blown with steam only gives the best results. One extraction of spent earth, which had been used for bleaching cottonseed oil and which had been blown in the Press with air, gave a dark, viscous oil with an iodine number of 84.6.

The operating cost in this plant is about $45.00 per day which includes labor, power, steam, water, solvent loss, and supplies. This makes a cost of $15.00 per ton of spent earth handled.

Fat Recovery By Solvent Extraction From Animal By-products

By R. H. LAMPING

JOHN J. DUPPS CO., CINCINNATI, OHIO

Abstract

It is shown that solvent extraction, although using an inflammable solvent can be made safe. Operating difficulties are discussed, including corrosion caused by decomposition products of animal matter. Costs and returns are shown to demonstrate the profits available.

THE subject of solvent extraction of fat from animal by-products has hardly been touched in literature. Though solvent extraction has been used for many years by laboratories for the determination of the amount of oil or fat in many classes of material including animal by-products such as tankage, meat scraps and so forth, its development into an industrial enterprise has been markedly slow.

A study made of the material produced by fifty rendering plants in the state of Ohio during the year 1936 showed an average fat content of 11.44%. With this as an average, the production of one-quarter of a million tons of this material represents a loss of fat economically available, of $2,600,000.

The rendering industry had the opinions, based on a few old attempts at solvent extraction, that the extracted meal would contain an odor of solvent and the extracted fat show darkening of color due to the use of high temperatures in trying to remove the final traces of solvent. With properly designed equipment and suitable choice of solvent, these opinions are false. Therefore the development of safe, satisfactory and profitable extraction plants has been handicapped.

The safety of the plant, mentioned as the first point, is probably thought of first when solvent extraction is considered. Safety enters the foreground whenever naphtha or any other inflammable solvent is used. For many reasons, practical and economical, naphtha remains the outstanding and most satisfactory solvent for use in the extraction of fats and oils, though plants can be designed to handle any suitable solvent. With naphtha therefore, safety is the first problem and yet a simple one. The following of several precautionary measures and the application of a little diligent effort can change danger to safety. The details of construction of the building to house an extraction plant are very well outlined by the underwriters, and offer no difficulties or unusual costs. The most important point is ventilation. With plenty of air circulation, the explosive limit of a solvent-air mixture cannot be reached. With the machinery and equipment properly designed, naphtha or naphtha vapors will not be present in the atmosphere of the extraction room and all precautions become safety factors.

The second point in describing an efficient plant was satisfactory operation. It can be shown that with the development, in the past years, of well defined, uniform cuts of naphtha, with narrow boiling ranges and definite chemical composition, all traces of solvent can be removed from the extraction products. In addition, better equipment and methods permit the use of lower boiling range solvents which simplifies the removal of the solvent and at lower temperatures.

The average of a group of tests run on animal by-product material before extraction, showed the fat in the material to have 0.8% Unsaponifiable Content. After extraction, the fat remaining in the material showed 0.84% Unsaponifiable and the fat extracted 0.87%. This latter figure shows a maximum increase of 0.07% in a product that represented only 18% of the original material before extraction.

Corrosion presents a difficulty in the proper design of extraction equipment for the animal by-product industry. A close study of metals plays an important part in this design. The vapors coming off during the cooking operation of the raw materials are corrosive, with the extent of corrosive action in proportion to the degree of decomposition of the materials.

The chemical composition of these vapors would be difficult to predict, as the time interval between the death of the animal and its dissection would vary, as well as the temperatures to which it was exposed before processing. These factors affect the amount of decomposition of the nitrogenous materials, starches and fats. The composition of the vapors will also change while the material is being cooked. The chief volatile decomposition products that have been detected, are Ammonia and amines, with Acetic Acid, Caproic Acid and others being detected in measurable quantities.

Perhaps it is not possible to state exactly how these various products are formed but nevertheless a very plausible line of reasoning can be followed that yields the same products. To start off with, protein can hydrolyze to yield amino acids which might be decarboxylated by enzymes, bacteria or putrefaction, to yield a series of amines. These amines having small enough molecules are volatile and have a corrosive action similar to Ammonia. As for the Ammonia, under the conditions of decomposition and during cooking it might be split off at any time. The presence of Acetic Acid and the others can best be traced back to the starches and sugars present in the animal's body. The starches could be hydrolized to sugars and with bacterial action ferment to a series of acids of which Acetic, Caproic and Valeric would be the most volatile, particularly in the presence of steam. Little could happen to the fats as far as volatile decomposition products are concerned. The fats hydrolyze to some extent, liberating glycerine and yielding fatty acids. These acids are chiefly Oleic and Stearic Acid and are not volatile under the conditions present. Any parts of the equipment that might come into contact with the above decomposition vapors must be constructed with the corrosive action in mind.

In the operation of the plant, extracting the fat from the rendered material, only one problem of any import is encountered, and this will occur whether the material being extracted is from dead stock, packing house waste or butcher shop scraps. This problem is the presence of small particles of protein material known as "fines," in the naphtha fat solution being drawn out of the extractor. If this solution is distilled as is, the presence of a large amount of these fines might cause slight darkening of the fat and will cause a high insoluble matter content that will be difficult to remove from the fat.

This problem of "fines," at its worst, does not affect the feasibility of extraction but is a problem that must be faced. The fines have high enough gravity to settle out of the naphtha solution but the presence of lime soaps from the bones, being colloidally soluble in naphtha, aids the suspension of these fines and inhibits their settling to a marked extent, unless the material being extracted has been allowed to retain 10 per cent to 12 per cent moisture. With 10 per cent to 12 per cent moisture in the material, the fines are sufficiently wetted out to cause settling. In other methods of fat recovery, it is necessary to cook down to from 5 per cent to 7 per cent moisture and it is in the extraction of these materials, from which additional fat can be economically recovered, that the trouble with fines is experienced.

The simplest answer is to have settling tanks within the closed system, where the solution of fat can be allowed to settle for at least 8 hours. The bulk of the fines will have settled out by this time and can be drawn from the bottom of the tanks back into the system and recovered, though the solution being drawn into the still may have appreciable amounts of this material still in suspension. The fat, when drawn from the still, must be clarified in any of the usual ways, if the percentage of fines is too high to enable the sale of low MIU fats. This settling method, though not directed at the source of the trouble, remains the simplest to date.

Filtration of the naphtha-fat solution is difficult because of the gelatinous nature of the lime soaps present tending to plug up the cloths or screens of the filter. There has been no satisfactory method of filtration found as yet, though the method is being worked on and offers some encouragement.

Centrifuging is not satisfactory because of the difficulty of avoiding vapor losses.

Chemically there are two methods that are satisfactory. The first, a caustic treatment, is not entirely dependable because of the chemical control necessary. If to the naphtha-fat solution a solution of sodium hydroxide is added in amounts just sufficient to neutralize about 40 per cent of the fatty acids present, the fines will settle quickly. This is probably due to a wetting out action.

The second chemical method offers one difficulty in that the addition of some fairly expensive equipment is necessary. Methyl Alcohol is soluble to some extent in the naphthas used. If about a 5 per cent solution of Methyl Alcohol in naphtha is used for extraction, the fines will settle almost immediately. The alcohol dissolves the lime soaps and therefore removes the protective colloid of the suspension and the fines settle out. This method makes it necessary to recover any water distilled off from the system, so that the alcohol which it will contain can be recovered by distillation.

The final requisite for the solvent extraction system was for the plant to be profitable. The profits possible from such a plant are very easily demonstrated. In the beginning of this paper it was pointed out that one-quarter million tons of meat scraps, an animal by-product, with an average fat content of 11.44 per cent, were produced last year in the state of Ohio. For economical and practical reasons, it is most desirable to reduce the fat content to about 3 per cent in the extracted material; the costs for this extraction, including labor, steam, power, depreciation and maintenance, interest on investment and so forth, would be as a figure $4 per ton.

If the one-quarter million tons of meat scraps at 11.44 per cent fat had been extracted to 3 per cent fat, the yield of fat would have been 174 pounds per ton or a total of 43,500,000 pounds. Assuming a value of 6 cents per pound for this fat, the return per ton from the extraction would have been $10.44. The value of the protein has not changed; though the weight of material has been reduced, the protein percentage has risen in proportion. The net profit from the extraction would therefore be the return of $10.44 less $4, cost of extraction, or $6.44 per ton. For the state of Ohio alone, this represents a clear profit of $1,610,000.

The above figures only show the profit available from extraction after the material had been processed with some other means of fat recovery. Had the material been extracted after cooking, eliminating a handling and operating cost, the profits would have been higher.

The material after extraction will not decompose for an almost unlimited time. With high fat contents, a process of fat hydrolysis is going on continually, liberating fatty acids which are very detrimental for animal and poultry feeding, but with low fat contents, this action is inhibited. The fatty acid content, based on the weight of the material, is reduced appreciably on extraction due to the reduction in fat content. It is the fatty acid content that is particularly harmful to animals and poultry. Fat does very little to aid the growth of an animal, so that a low fat and consequent low fatty acid content feed should show beneficial results. Today finds many of the larger feed mills preferring low fat content meat scraps for blending into animal and poultry feed.

The right of existence of solvent extraction for the recovery of fat from animal by-products has been shown. Though handicapped and deterred in the past, it should soon take its rightful place and be in step with progressing industry.

The Nutritive Value Of Soybean Oil Meal Prepared By The Different Methods Of Oil Extraction

By J. W. HAYWARD
DEPARTMENT OF NUTRITIONAL RESEARCH,
ARCHER-DANIELS-MIDLAND COMPANY, MINNEAPOLIS, MINN.

Abstract

This article is primarily a review of the literature pertaining to the subject. Solvent extracted, hydraulic, and expeller soybean oil meals all contain, if properly cooked, protein of high biological value, similar to that of milk protein. Solvent extracted meal has a higher percentage of protein. Since expeller and hydraulic meals contain more oil than solvent extracted soybean oil meal, they naturally have a slightly higher vitamin A and D potency, but the amounts of these vitamins contained in any type of soybean meal or even in the whole soybean are not significant. Levine's assays reveal that solvent process soybean oil meal contains roughly 2.8 I.U. of vitamin B per gram of solids compared to 1.0 I.U. for hydraulic meal. According to results of Cornell experiments, the vitamin G content of soybeans is not materially affected by any of the common methods of processing. Kraybill reports that expeller and hydraulic pressed soybean oils contain more "lecithin" (total phospholipins) than hexane extracted soybean oil. Therefore his results indicate that our domestic solvent extracted meal contains slightly more "lecithin" than expeller meal. "Lecithin" in soybean oil meal may be valuable as an antioxidant to stabilize the vitamin A contained in mixed feeds.

WE have heard much recently about the use of soybean oil meal or its protein in plastics, paper coatings, paper sizing and for glue, and we know there has been an appreciable volume of soy flour used in dog foods and in edible foods such as meat products and baked goods. The outlet through these channels for the residue of the soybean remaining after oil extraction is not to be discounted; but the fact remains that about 95 per cent of the total output of the residue from the soybean processing plants in this country has been in the form of soybean oil meal which is used as a protein supplement in feeds for farm livestock and poultry.

In this country we are now using three methods for extracting oil from the soybean, namely, the hydraulic, the expeller, and the solvent processes. The resulting oils and meals are known according to the method of extraction employed. In addition the hydraulic and expeller meals are frequently spoken of as "Old Process" soybean oil meal and the solvent meal as the "New Process" soybean oil meal. I imgaine that most of you are fairly well acquainted with the machinery and general operations involved in the hydraulic and expeller methods of oil extraction since both methods have been used in this country for many years. However, the first extensive use of the continuous method of solvent extraction in this country dates back only four years, when the Archer-Daniels-Midland Company began processing soybeans in their newly installed unit at Chicago. If you are interested in this development and the many details involved in operating this type of processing equipment, I suggest that you read the article by Schmidt on this subject (1934).

The soybean contains less oil than most oil bearing seeds such as flaxseed, cottonseed and the peanut, and when we apply average prices for its two principal products, soybean oil and soybean oil meal, on the basis of the average yield of each from the same unit quantity of beans, we find that the