Separation Methods in Processing Edible Oils

E.R. BUTTERWORTH, Filtrol Corporation, 5959 W. Century Blvd., Los Angeles, CA 90045

ABSTRACT

There are four generally recognized methods of separating undesirable portions of a fluid from that fluid: mechanical, which is filtration, settling or centrifuging; electrostatic precipitation; chemical, such as solvent extraction precipitation or adsorption; and thermal, such as distillation and freeze drying. Techniques of separation as applied to fats and oils are discussed in this paper.

INTRODUCTION

The previous paper analyzed many aspects of adsorption. In this paper let's look at the importance of a mechanically sound filter system when using adsorbents for bleaching oils. An adsorbent may have done its job of selectively removing a color body, but, if the filter system does not remove and retain the adsorbent from the liquid, nothing has been accomplished. In fact, just the opposite can happen; if the adsorbent with color bodies attached gets through the filter system, it can act as a catalyst to trigger off additional color development.

DEFINITIONS

Filtration is one of many methods of separation. Others are settling, centrifugation, distillation, freeze drying precipitation, solvent extraction, electrostatic precipitation and adsorption.

Filtration is the process of passing a fluid through a permeable filter media in order to separate particles from the fluid. The particles may be either in suspension or solution. A filter medium is a porous material and one which allows a fluid to pass through yet which will retain the particles to be removed. Examples of filter media are filter paper, filter cloth, filter screen and membranes. Filter aids such as diatomite, perlite or cellulose are usually used in conjunction with filter media to protect its surface.

CATEGORIES OF FILTRATION

For the analysis of filtration, it is desirable to first categorize as to: (a) Surface Filtration, which is limited to low solid loads but provides precise clarity; or, (b) Depth Filtration, which can handle high solid loads, but which usually does not achieve the degree of clarity associated with surface filtration.

The filter aid in the precoat portion of a filtering operation is considered surface filtration; yet when body feed is used, the resultant filter cake is considered depth filtration; this is readily evident from a photo-micrograph of a diatomite filter cake and the torturous path thru which particles must pass. The second aspect of filtration to be considered is the size of particles to be removed. Correlation of the grade of filter aid to the particle size retention capability of a filter cloth or screen will show either the finest grade of filter aid that can be retained on a particular screen, or the mesh of the filter screen necessary to retain a particular grade of filter aid. The smaller the filter aid particle, the smaller the opening between particles and vice versa.

At the same time, consideration must be given to the desired flow rate and clarity necessary to produce an acceptable effluent. The smaller the particle of filter aid, the better the clarity but the lower the flow. Conversely, the larger the particle of filter aid, the worse the clarity but the higher the flow. Other than flow rate, clarity and filter screen porosity, suspended solids characteristics should be analyzed. A general rule-of-thumb is to use the coarsest grade of filter aid that will give the desired clarity.

FILTRATE CLARITY

Techniques or equipment used to measure turbidity or absence of turbidity provide means for determining the effectiveness of a filtration. These are conductivity meters, membrane/microscope, gravimetric analysis, chemical analysis, visual observation, particle counters or optical instruments. The attention given these techniques or equipment may in many cases determine whether profit goals can be achieved.

PRINCIPLES OF FILTRATION

There are three steps to filtration: precoating, filtration with or without body feed and cleaning. The purpose of the precoat is to protect the filter screen, provide immediate clarity and to aid in filter cake removal during cleaning. Without a precoat the screen would blind and the flow would stop. The amount of precoat varies from 10-25 5 to 11 kg per 10 square meters of filter area and is put in place by making a slurry of filter aid and liquid, and, allowing the liquid to carry the filter aid to the filter, depositing it on the filter screen and returning to the precoat tank to pick up more filter aid.

In order to obtain optimum performance from a filer, the flow rate during precoating should be the same as during filtration. A filter with too slow a precoat rate or with uneven hydraulic flow will produce an uneven precoat which results in blinded screens and short cycles.

If a filter is put on stream with only a precoat, the usual result is that solids will blind on the precoat causing short cycles. This problem may be overcome by the continuous addition of filter aid called body feed, which mixes with turbidity, providing flow around the turbidity. Body feed is added by preparing a slurry of filter aid and injecting it into the system prior to the filter. Body feed pumps are usually either diaphragm or piston type. Regardless of the type pump, proper maintenance, such as flushing with fresh water, is very helpful.

COMPOSITION OF SOLIDS

Turbidity or suspended solids are usually considered rigid or deformable. Deformable solids will elongate under pressure and actually extrude through the filter cake, slowing or blocking flow. To overcome this problem, increase the amount of body feed so that it will coat-out on the deformable solids allowing them to be retained in the filter cake.

OPTIMIZING THE FILTER OPERATION

Variations in manufacturing conditions usually affect filtration conditions. Regardless of whether the filtration is constant pressure or constant flow, it is desirable to record either the increase in differential pressure or decrease in flow vs. time, or both. Such data will provide pressure/time or flow/time curves which help in the analysis of a filtration.

Short cycles are usually the result of: (a) inadequate body feed; (b) too high a flow rate – causing packing of the

solids; (c) too low a flow rate – allowing settling of solids in the filter shell; (d) blinded screens – resulting in reduced surface area; or (e) solid load too great for that particular filter – optimum is where differential pressure is reached at the same time the cake space is filled.

FILTER CLEANING

Once the filter cycle is complete, the filter cake may be removed by sluicing, backflow or dry cake discharge. Virtually all filters sold today are dry cake discharge. Disposal of the spent filter cake is important since many municipalities prohibit dumping of spent filter aid cakes containing organics. However, most spent filter cakes are sewered, processed with cattle feed, dried for land fill, or regenerated. Most regeneration systems are costly and, as such, are limited to high volume filter aid users.

FILTER TYPES

Filters used in filter aid/adsorbent filtrations have changed little in recent years. The plate and frame filter is widely used, but requires more man-hours than pressure leaf filters. Vertical tank/vertical leaf filters require minimal floor space, but usually high vertical space. Also, the leaves are not as accessible as in other filters. Horizontal tank/vertical leaf filters have proven very successful on oil filtration, providing accessibility to the leaves for cleaning and inspection along with reliable filtration. The latest filter to prove acceptable in oil or high viscosity liquid filtration is the vertical tank/horizontal circular leaf filter. Since it only filters on the top of the leaf, more consistent clarity is achieved. The dry spent filter cake is removed by spinning the leaves, causing the cake to fly off the leaf, hitting the side of the filter, dropping to the bottom and being removed mechanically.

One of the major problems in filtration of oils is lack of adequate hydraulic flow in the filter. If the flow isn't sufficient to suspend solids throughout the filter shell volume, the solids will settle toward the bottom, giving an uneven precoat resulting in short cycles. To overcome this problem, install a small recirculation line from the top of the filter, back to the suction side of the pump. This provides a good flow across the leaves and allows solids to deposit evenly.

A well designed, mechanically and hydraulically sound filtration along with the proper filter media and adsorbent can produce an oil that will meet both your and your customers' product specifications and help to achieve management's profit goals.