Use of Bleaching, Clays, in Processing Edible Oils

LOUIS L. RICHARDSON, Filtrol Corporation, 5959 W. Century Blvd., Los Angeles, CA 90045

ABSTRACT

Bleaching of fats and oils is a process whereby the clay adsorbent is mixed intimately with the oil under specified conditions to remove unwanted color bodies and other contaminants. This paper describes the process and discusses the parameters and economics involved.

INTRODUCTION

The two types of commercial bleaching clays used in processing edible oils may be characterized as "Natural Bleaching Earth" and "Activated Bleaching Earth." Natural Bleaching Earth is usually a bentonite clay which exhibits adsorptive properties in its "natural state." The processing of this bentonite clay from mine to consumer is limited to "physical" as opposed to "chemical" methods. Figure 1A is a simplified flow diagram of such processing.

Activated bleaching earth is also produced from bentonite clay, but from a type which contains a high proportion of montmorillonite. The processing includes chemical treatment which serves to alter the clay and impart the high bleaching activity. Figure 1B is a simplified flow diagram of processing in production of activated bleaching earths.

It may be of interest to note that most bentonites exhibiting high natural bleaching power are not suitable for activation, and most clays used for activated clay products are poor in natural bleaching activity. Since it is essentially impossible to predict the bleaching potential of a new source clay by analytical procedures, it becomes necessary to apply the full processing in Figures 1A and 1B followed by laboratory and commercial performance testing to evaluate new clays. In today's processing of edible fats and oils, the use of acid treated clays far exceeds that of the natural clays. This is due to the much higher bleaching efficiency of activated clays, particularly when with very dark oils and when the cholorphyll content of the oil is high. Therefore, the overall economics will favor the use of acid treated clays over the natural clays for most commercial applications.

HOW BLEACHING CLAYS ARE USED

Use of bleaching clays in processing of edible oils is simply that of mixing the clay and oil, applying suitable agitation, elevating the temperature for the proper period of time, and filtering to remove the spent clay.

Mixing and Agitation

In order for a bleaching clay to perform satisfactorily, it must be mixed intimately with the oil and must remain in intimate contact during the bleaching or contacting cycle. In atmospheric type bleaching, the agitation must be sufficient to keep the clay in suspension but not so strong

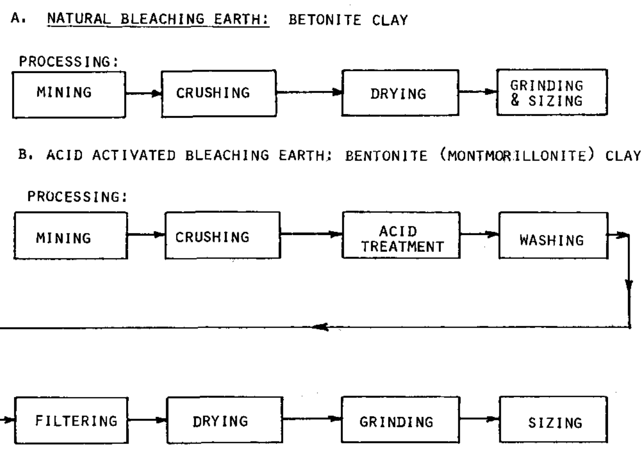

FIG. 1. Types of bleaching clays.

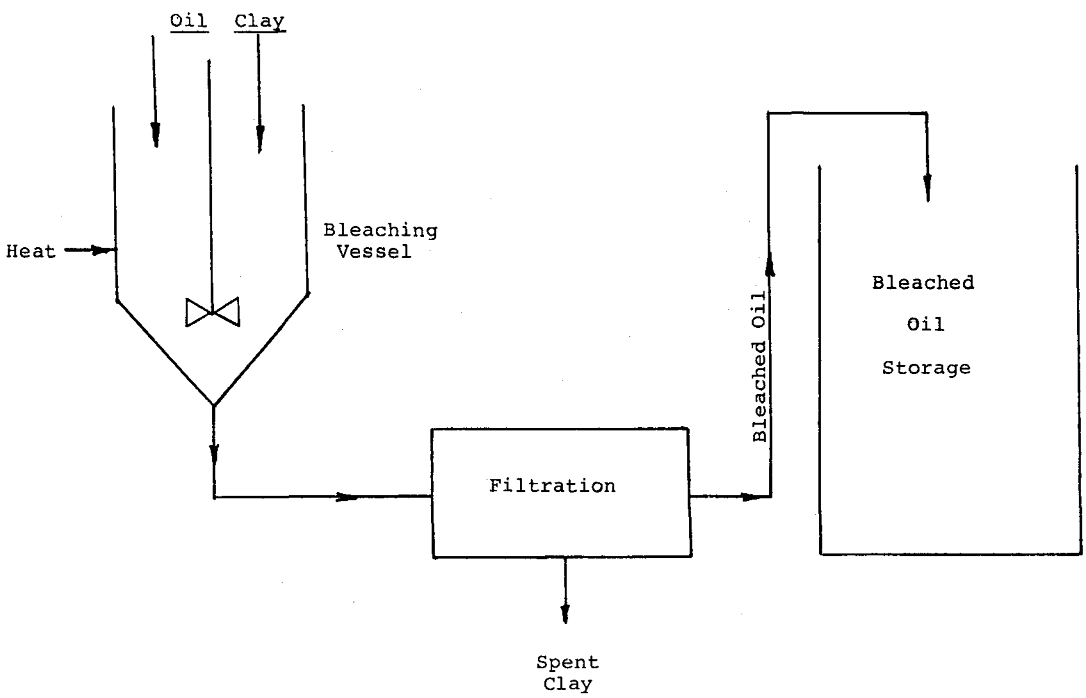

FIG. 2. Simplified bleaching process.

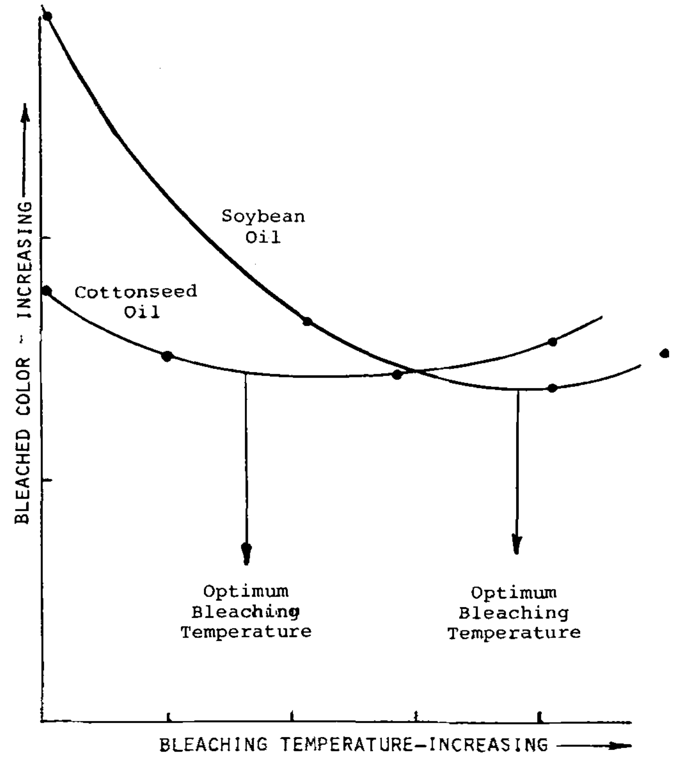

FIG. 3. Effects of temperature on bleaching.

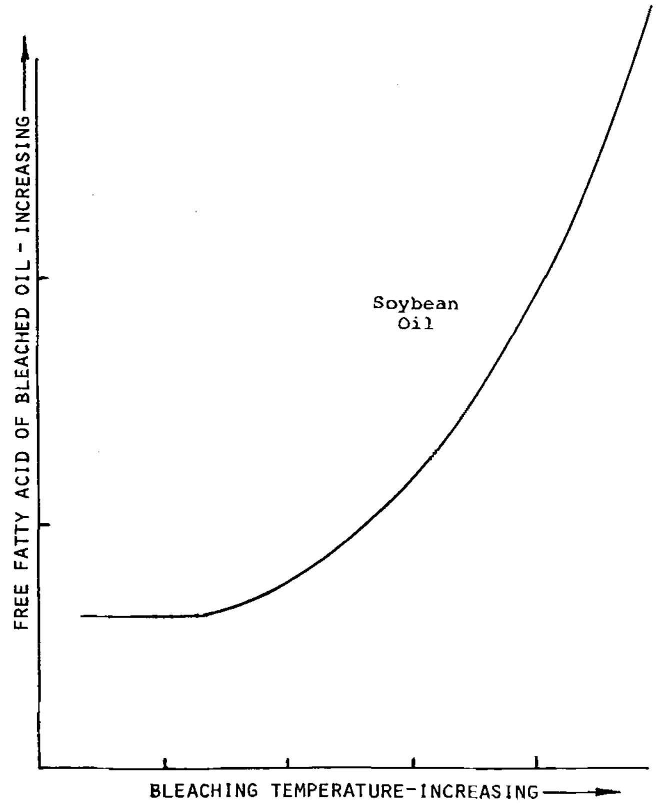

FIG. 4. Effect of bleaching temperature on FFA.

TABLE I

Recommended Bleaching Temperatures[a]

	Top decolorizing temperature (° F) atmospheric	vacuum	Time at top decolorizing temperature (min.)
Grease (inedible)	230	180	30
Lanolin	230	180	30
Lard	160	160	20
Lard oil (inedible)	220	180	20
Oleo stock	160	160	20
Tallow (edible)	220	180	20
Tallow (inedible)	230	180	30
Tallow oil	230	180	30
Coconut	230	180	20
Corn	220	180	20
Cottonseed	220	180	20
Linseed	190	170	20
Palm kernel	230	180	20
Palm	325	325	20
Peanut	220	180	20
Rapeseed	220	180	20
Soybean	220	180	20
Sunflower	220	180	20
Tall	150-200	---	30
Tung	---	180	20

[a]Speed of agitation ....50-100 R.P.M.
Degree of agitation................Strong but not violet
Temperature of oil when adding adsorbent ....Atmospheric - 160 F vacuum-temperature of oil when tank is filled
Vacuum ....28" (minimum)

that air is mixed with the oil, thereby causing oxidation of the oil. In vacuum bleaching operations, the effects of oxidation are negligible and agitation is usually more vigorous.

Temperatures

The optimum contacting temperature is dependent upon the oil type and whether or not bleaching is done at atmospheric pressure or under vacuum. Table I shows maximum temperatures recommended for various oils.

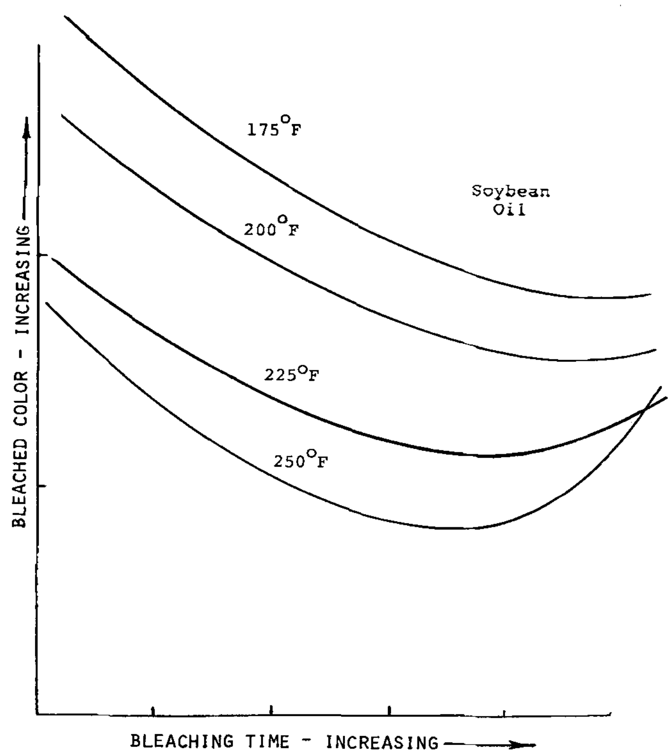

FIG. 5. Effect of time on bleaching.

Note that temperatures for vacuum bleaching are lower than for atmospheric to reach optimum color removal. The effects of temperature on bleaching are shown in Figure 3. This confirms a rule-of-thumb in bleaching, or adsorption, that clay activity increases as temperature increases. As we can see, however, decolorization starts to decline after an

TABLE II

Commercial Acid Activated Bleaching Clay

Property	Typical value
Volatile matter, wt. %[a]	20
Free moisture, wt. %[b]	15
Acidity, mg KOH/GM (PHEN.)	1.7
Particle sizing, wt. %	
Tyler standard screens	
Thru 100 mesh	100
Thru 200 mesh	94
Thru 325 mesh	75
Oil retention, wt. % (laboratory)	35
Filter rate, CC/MIN (laboratory)	45
Activation index	100
Bleaching efficiency @ 3.0R	100

[a]Loss at 1700 F.
[b]Loss at 105 C.

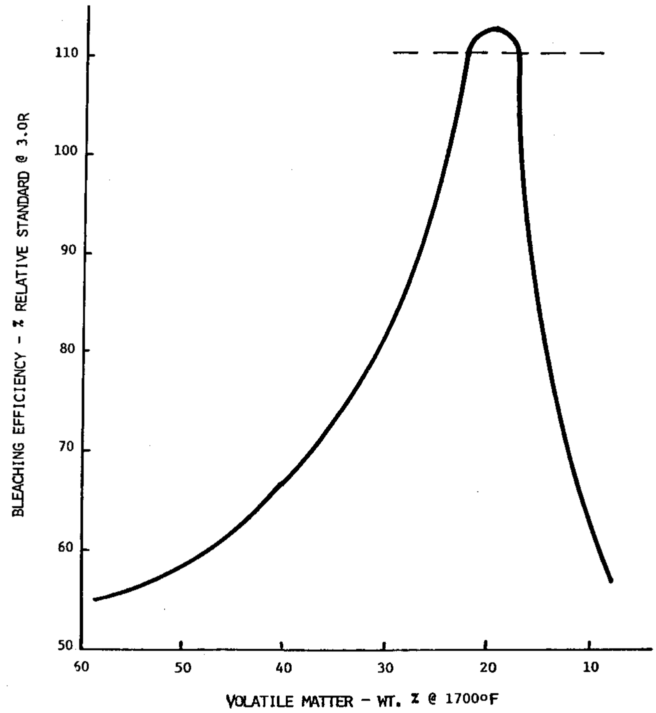

FIG. 6. Effect of drying upon bleaching efficiency.

optimum temperature has been reached.

Temperature also affects certain other properties of the oil. One important such property is content of free fatty acid (FFA). The relationship between bleaching temperature and FFA of the contacted oil is shown in Figure 4.

These relationships, then, dictate that temperature should be kept as low as possible to minimize FFA increase from the bleaching operation, but high enough to yield the desired color.

Time at Top Temperature

The time at top temperature of the bleaching operation is not nearly as critical as the actual temperature. Again a rule-of-thumb is that color removal increases as time increases. However, the breakpoint is usually substantially longer than the optimum time available, from a production standpoint, and does not come into play. The curves in Figure 5 illustrate this effect at various temperatures. Most refiners have settled on 20 min as a practical maximum time at top temperature.

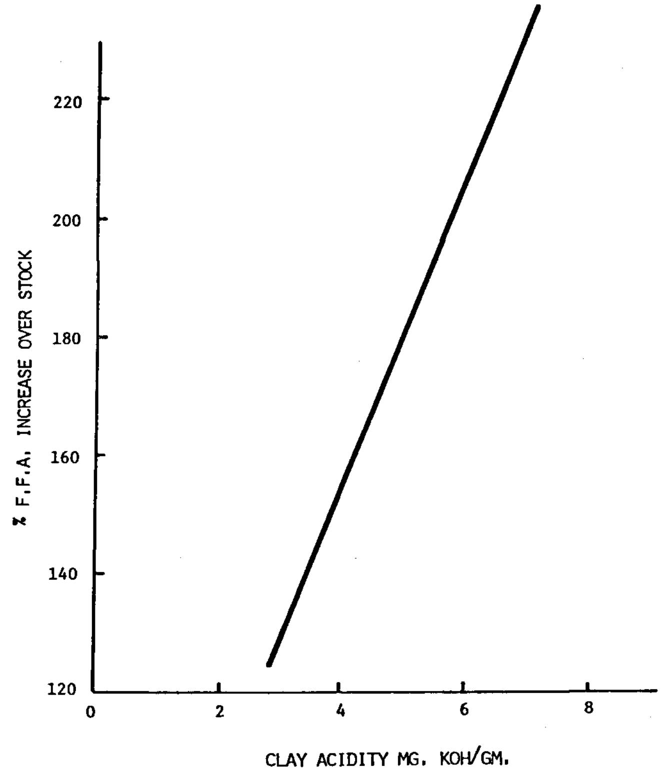

FIG. 7. Effect of clay activity upon FFA Increase.

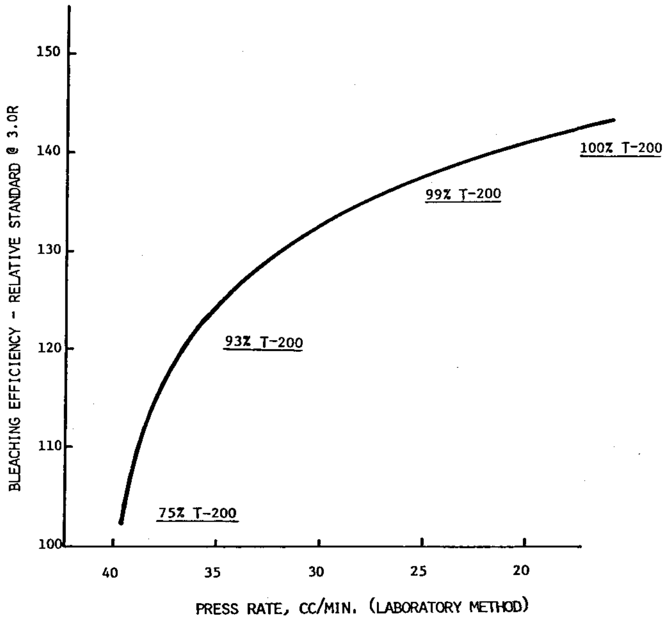

FIG. 8. Effect of particle size upon press rate.

TYPICAL PROPERTIES OF ACTIVATED

Typical properties of a currently popular commercial activated bleaching clay are shown in Table II. These properties may be described as "physical properties" and "performance properties." The "chemical properties," i.e., chemical composition, are not pertinent to use and performance.

Volatile Matter

After washing and filtering, activated clays must be dried to facilitate handling and to maximize bleaching power. It

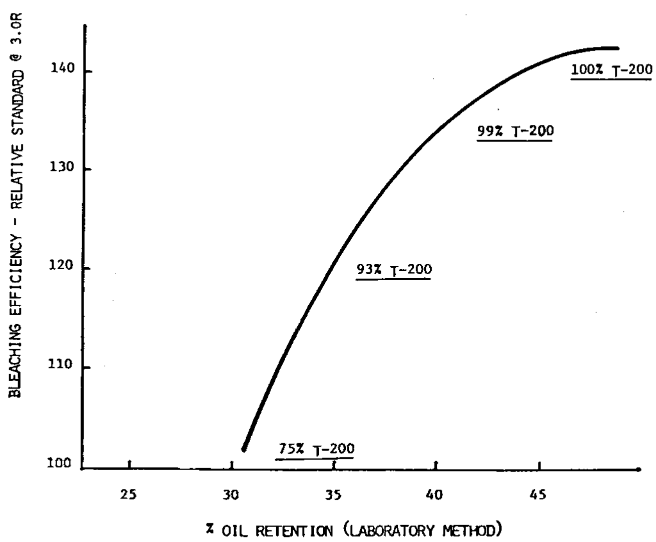

FIG. 9. Effect of particle size upon % oil retention.

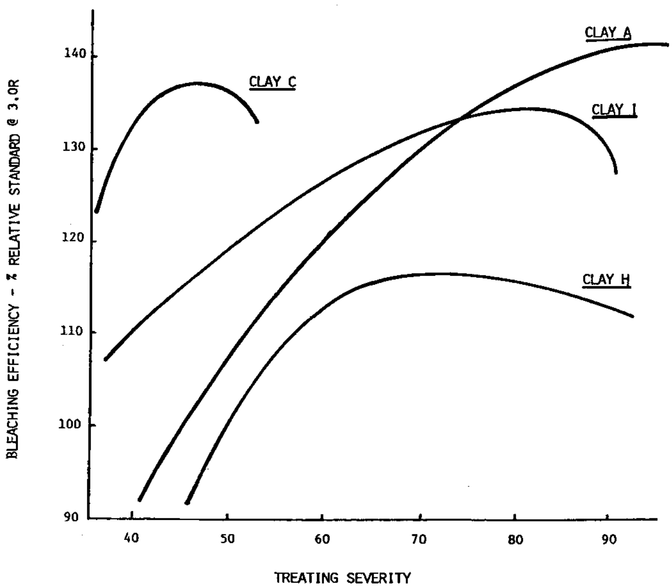

FIG. 10. Raw clay selection.

has been determined that maximum bleaching power of the clay represented in Table II lies between 18 and 22 wt % volatile matter (determined at 1700 F). Figure 6 is a graphic illustration of this effect. In regard to "free" moisture content (loss at 105 C.), this property is not usually controllable except as it follows as a function of total volatile matter. In addition to drying the clay to a specific volatile matter level, the method of drying is significant. It has been determined that speed of drying affects bleaching power. Therefore, flash drying (high speed) equipment is widely utilized to take advantage of this phenomenon.

TABLE III

Bleaching Economics

Bleaching cost formula:

$$\frac{\text{cost}}{\text{1000 Lbs. Oil}} = \frac{E\,(F + G)}{200} + \frac{E\,J\,H}{10}$$

B = Oil retention of press cake – wt.% dry basis
D = Moisture of adsorbent as charged – wt.%
E = Dosage of adsorbent – wt.%
F = Price of adsorbent – \$/LB delivered
G = Handling cost of adsorbent – \$/LB
H = Price of decolorized oil – \$/LB
J[a] = Oil retention of press cake – wt.% of clay as charged

[a]Oil retention = $\frac{B\,(100\text{-}D)}{100\text{-}B}$.

Clay Acidity

If the activated clay is washed completely free of residual acid, the bleaching power is drastically reduced. If the acid value of the clay is left at a high level, the increase in FFA of the finished oil will be unacceptable. Therefore, a compromise must be reached for the clay in question. Figure 7 illustrates the relationship between FFA increase and clay acidity.

Particle Sizing

The particle size of the finished clay is relatively easy to control by air separation following the grinding step. It has been determined that grinding to extreme fineness will increase the bleaching power markedly. However, the factors of filter rate and oil retention will be adversely affected. Again, compromise is necessary. The particle size data seen in Table II represent that compromise. The effect of particle sizing on filter rate is shown in Figure 8 and on oil retention in Figure 9.

Activation Index

The activation index of a clay is an arbitrary value assigned to a specific product of the clay activation process and corresponds to the bleaching efficiency compared to a standard clay. Details concerning this property are proprietary to the clay producer and vary greatly among different clays. Examples of the extremely great variations found between source clays for activation can be seen in Figure 10. All of the clays pictured here have been used commercially for the production of activated clays. Unfortunately, the better clays such as "Clay C" have been long since depleted. Thus, the use of the more difficult clays has become necessary and is an important factor in clay costs.

ECONOMICS

Unfortunately, the economics of bleaching clay use is often based upon the cost of clay without considering overall costs. In this regard, I would like to present a simple mathematical formula which may be used to compare use economics of different clays - Table III. This formula is valid for use with laboratory data as well as data from plant tests.