aqueous solutions of glycerols, including dynamite and C.P., may be determined by refractive index, using the immersion refractometer, with an accuracy of about 0.10%.

The refractive index of crude glycerols is so strongly affected as to be meaningless by the highly variable amounts of inorganic salts contained in such samples.

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Evaluation of Activated Carbons

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WHEN activated carbons are to be evaluated, one naturally thinks in terms of the question, "What carbon will be most economical for removing color from our product?" It is in this way that one often fails to realize that results other than decolorization may be obtained by the proper selection of an activated carbon. We will, therefore, take up as thoroughly as possible, all the various factors which might be accomplished.

Tastes in products for human consumption are becoming very vital factors in the minds of the public. The salesman is able to break down resistance if he can prove that his material is more palatable than his competitor's product. I once had the opportunity of seeing a very clever soap salesman succeed in selling five cases of soap to a little corner grocery store-keeper on the fact that his soap tasted better. The salesman palmed the samples he was supposed to be tasting, but the storekeeper was not so clever, and at last ordered five cases in order to save himself from taking any more of the bitter medicine. As a result of this I have always been very hesitant about tasting any materials which under ordinary conditions, have a taste far from pleasing to my palate. However, an occasion arose when it was necessary that I taste some vegetable shortening or possibly incur the ill-will of the plant superintendent. After considerable hesitation, I finally consented to taste the supposedly obnoxious material and, much to my surprise, I had to report that the shortening had no taste whatever. The manufacturer attributed his success almost wholly to the type of activated carbon which he was using. Since that time I have not been quite so hesitant about tasting materials treated with activated carbons and consequently have noticed immense improvements in the palatability of such materials as sugars, syrups, water, oils, gelatines, fruit juices, cordials and even wines and liquors. Tests have shown that not all activated carbons are suitable for improving the flavor of a definite solution, or compound. It is, therefore, necessary to carry on tests in order to determine the type of activated carbon best suited for this purpose. In carrying on such tests it is well to remember that the tastes among various individuals may vary considerably. It is, therefore, advisable to have at least five persons taste the various samples and select the carbon which receives the approval of the majority. In the edible oil industry it has been found that activated carbon will correct off-flavored oils, and also will correct the "earthy" flavor imparted by a fullers earth. In some cases the use of a preservative will impart an "earthy" taste and this has also been corrected with an activated carbon.

Odor is very closely allied to flavor, and in general it can be said that an improvement in flavor is usually accompanied by an improvement in odor. (Some psychologists hold that taste is merely a secondary reaction of the olfactory organs.) Edible fish oils and lard are very good examples. However, certain cases arise where odor improvement is an important factor and taste improvement is not essential. Dry cleaners solvent is a good example. Where activated carbons are not properly used it is very difficult to remove the last traces of odor from a garment, and the cleaner is bound to receive complaints. In this case the carbon acts to remove the last traces of free fatty acids and soap and anything of a rancid nature. The presence of any of these materials in a solvent may result in a sour or gasoline odor in the clothes.

Activated carbons are beginning to find application in removing odors from air. The most notable example of this is in the ice-box or refrigerator. The carbon will absorb such odors as those emanating from onions, and vegetables in general, fish, fruits, etc., and prevent these from penetrating into such materials as butter, milk or eggs which have a strong adsorptive power of their own. It seems that since activated carbon is a more powerful adsorbing agent, the odors are preferentially taken up by it.

The natural question comes up as to whether the most efficient decolorizing carbon is also the most efficient for improving taste and odor. It is impossible to make any general statement which would answer this question. It has been found that one type of activated carbon is usually the most efficient for improving the taste and odor. The type referred to is manufactured in several different grades, according to their efficiency in decolorizing. Tests indicate that there is very little, if any, difference in the efficiency of these various grades for correcting taste or odor. It would therefore appear that the most important factor for making a good deodorizing carbon is the proper selection of a raw material.

The value of a carbon for correcting the odor or flavor of a solution is largely dependent upon the particular material being treated, and the clientele served. Let us take for example the treatment of water with activated carbon. Here is a case where taste and odor are of prime importance and decolorization with activated carbon is very seldom a matter of any consideration. It has been remarked previously that the tastes of various individuals will vary considerably. This is especially true in the case of water. It has been my experience to go into a community and find the water supply to have a very perceptible off-taste. Upon inquiry I have been

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informed that most strangers dislike the taste of the water and yet the regular inhabitants think the water is the best in the state, country, or world, depending upon the imaginative powers of the party addressed, while another community demands the use of activated carbon continuously even in the absence of taste because it seems to impart a pleasant flavor to the water.

This shows very conclusively that the degree of taste and odor correction must be considered from the point of view of the ultimate consumer. We have taken the case of water as an example where the correction of taste and odor is the most important consideration in selecting the proper activated carbon. The same consideration should be given to any food product which is consumed with any degree of relish. I refer particularly to such materials as fruit juices and gelatines, and indirectly to lard, salad oils, etc.

As indicative of the stabilizing action of highly adsorbent activated carbon, I might refer again to its use in municipal water supplies with which you indirectly come in contact as consumers. The use of as little as 1 p.p.m. (.0001% by weight) in the raw water with the usual coagulants will exert such purifying action by the adsorption of bacteria, decomposed vegetable matter and microörganisms that it is possible to reduce appreciably the amount of chlorine required for sterilization and the chemicals necessary for precipitation of such impurities. Even then the activated carbon does not cease to work, for as it is settled in the sedimentation basin by the action of the coagulants, it will adsorb taste and odor producing compounds such as arise from industrial pollution and imprison them within its porous structure, thus keeping the sludge sweet and preventing putrefaction with consequent contamination of incoming water. Similar action is exerted by the activated carbon in removing resins, phosphetids, enzymes, mucilaginous and waxy substances from crude oils, thus producing a stabilizing effect that prevents rancidity with its attendant losses. Carbon being inherently a reducing agent, prevents oxidation. This permits processing at temperatures where mineral adsorbents alone would promote oxidation.

Soap and free fatty acid removal have already been mentioned in the case of dry cleaners solvent. It has been found that activated carbon will remove completely the last traces of soap in oils. The free fatty acids in oils have also been considerably reduced. We have found that certain activated carbons at comparatively low percentages will reduce the free fatty acids 50% or more in such cases as olive oil, refined cottonseed oil and lard. The removal of these impurities will enhance considerably the keeping quality of the material being treated and tend to retard the development of objectionable odors in the finished product.

The chemical impurities of a carbon may limit its use. A very good example of this is U. S. P. glycerine, where the maximum ash content is limited to .007% by the Pharmacopoeia. It is recommended that the chemical analyses be made on the liquid before and after treatment. The reason for this is that, although an activated carbon may contain certain impurities, it may, due to its adsorptive quality, tend to purify rather than contaminate the solution being treated. The pH of the water extract of a carbon is also an important factor to be considered in the case of some solutions.

Since so many different factors may enter into the selection of the proper activated carbon for a definite solution it is impossible to make any definite recommendations as to the best procedure for evaluating a carbon. All that can be advised is that proper consideration be given the above factors, and the carbons which do not yield a product which will come up to the standard desired, should be eliminated from consideration. We now come to the evaluation of an activated carbon in so far as decolorization is concerned. In order to determine properly the suitability of a specific type of activated carbon it is well to bear in mind that laboratory conditions should approximate as closely as possible those to be encountered in actual plant operation. This refers specifically to such variable factors as: concentration of the solution to be treated, temperature, time of contact, speed of agitation, degree of decolorization desired, and the pH of the solution. If the carbon is to be used as an adjunct to another decolorizing medium such as activated earth or fullers earth, the materials must be used in exactly the same proportions as in the plant. It is necessary to run a series of tests using various percentages for each carbon-earth mixture under examination to determine the percentage giving maximum decolorization. Misleading results are often reported because the point of optimum decolorization has already been reached and increased amounts of decolorizing materials will not give results commensurate with their additional cost. It is necessary to use some type of tintometer or colorimeter which will give accurate results in terms of degree of color removed so that results may be plotted as a curve. It is advisable to have at least five values for plotting the curve, four of which should be under the maximum degree of decolorization.

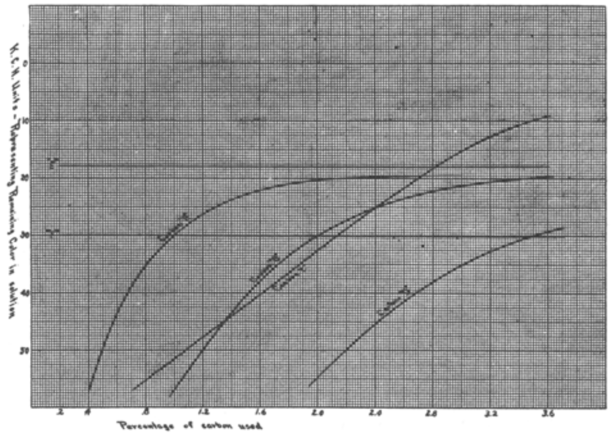

Chart showing decolorizing results from use of activated carbons on pineapple juice.

The accompanying graph represents the decolorizing results obtained by using various activated carbons on a solution of pineapple juice. The abscissa represents the percentage of carbon used and the ordinate represents the amount of color actually remaining in the solution. It will be noted that curve "A" represents a carbon which is very effective for decolorizing, especially at low percentages. As the amount of carbon is increased there is a very marked falling off of efficiency in decolorizing and maximum decolorization is actually accomplished at 2.6 per cent. Curve "B" represents a carbon which acts very similar to that of curve "A," with the exception that increased amounts of the carbon give better relative efficiency in decolorizing. It is very interesting to note that the carbon represented by curve "C" is inferior to "B" between the percentages of 1.4 and 2.4. However, both below and above these percentages it is more efficient. Also at percentages of 2.8 or over, carbon "C" is even more efficient than carbon "A." A study of these curves will show very conclusively that the degree of color to be removed is a very important consideration in the proper selection of an activated carbon. Let us assume that it is desired to obtain a remaining color value of 18, which is represented by the line "E." Since curve "B" is the only one which crosses this line it can readily be seen that this is the only carbon which would be suitable and the other carbons would, naturally, have to be eliminated.

However, let us take as more representative, the color represented by the line "F." It will be noted that 1 per cent of carbon "A" will be required to give the desired color. Likewise 2 per cent of the carbon "B," 2.2 per cent of carbon "C" and 3.5 per cent of carbon "D" will be required. Naturally, if the prices of these various carbons were all the same, carbon "A" would be the natural one to select. However, if carbon "A" would cost 25c per lb., "B" and "C" 10c per lb. and "D" 5c per lb., it would be necessary to determine the cost for accomplishing the decolorization. Since 1 per cent of carbon "A" at 25c per lb. is required, the cost for decolorizing 100 lbs. of the solution would be 25c. Carbon "C" of course could be entirely eliminated from consideration since carbon "B" is more efficient at the same price. Since 2 per cent of the carbon "B" is necessary, the decolorization costs in this case would be 20c per 100 lbs. of the solution as the value of "B" is 10c. Carbon "B" is, therefore, more economical than carbon "A." Similar calculations in the case of "B" show that the decolorizing cost would be 17½c so that it can readily be seen that the least efficient decolorizing carbon in this particular case is the most economical when the prices are taken into consideration.

Where it is found that two or more activated carbons are very nearly alike for efficiency in color removal, it is desirable to select the one which will best accomplish the other results above mentioned.

Water Washing of Crude Cottonseed Oil

By JAMES J. GANUCHEAU and E. L. d'AQUIN

THIS paper, prepared as part of the work of the Committee on Crude Mill Operations, is intended to show to what extent concomitants other than free fatty acid and neutral oil in crude cottonseed oil effect the refining loss. It is our firm opinion that low refining losses are made in the crude mill and not in the refinery.

The composition of crude cottonseed oil has been determined by Jamieson,[1] and can be roughly divided into three components, namely,

Neutral Oil
Free Fatty Acid
Minor constituents consisting of resins, phosphatides, pigments, etc.

The percentage of neutral oil in crude cottonseed oil can be obtained by the Wesson method.[2] The usual caustic soda refining of crude cottonseed oil consists of the following losses:

1. Free fatty acid
2. Neutral oil (*oil entrained or emulsified in "soapstock"*)
3. Fat saponified
4. Loss-not-fat (*minor constituents*)

The theoretical refining loss is, then, the free fatty acid loss plus the "non-fat" loss.

In commercial practice, and for purposes of fat accounting, in analyzing crude oil losses these minor constituents are erroneously referred to as non-fats (*lecithin, for example, being a compound of phosphorus, glycerine and fatty acid, cannot be classed as a "non-fat"*).

Previous experiments have shown that a synthetic crude oil made by mixing refined oil and separated fatty acids will often show a higher refining loss, when refined by A. O. C. S. standard rules, than some crude cotton-

DATA SHEET

	F. F. A. after W. Ref.	F. F. A. rebuilt to orig.	Per cent water for agitation.	Time of agit. in minutes.	Per cent loss on refining low-lye. 6.7% at 16°B	Per cent loss on refining high-lye. 8.4% at 16°B
Experiment No. 1—						
Original crude	....	2.00	..	..	6.8	7.6
After 1st w. ref................	1.85	2.00	10	7	5.3	6.2
After 2nd w. ref................	1.80	2.00	10	14	5.9	7.3
After 3rd w. ref................	1.80	2.00	10	21	7.8	8.1
Experiment No. 2—						
Original crude	....	2.00	..	..	6.8	7.6
After 1st w. ref................	1.80	2.00	10	15	6.2	7.4
After 2nd w. ref................	1.80	2.00	10	30	7.3	8.3
After 3rd w. ref................	1.76	2.00	10	45	7.7	8.5
Experiment No. 3—						
Original crude	....	1.10	..	..	8.7	...
After 1st w. ref................	1.00	1.10	10	30	9.0	...
Experiment No. 4—						
Original crude	....	0.90	..	..	4.4	...
After 1st w. ref................	0.82	0.90	10	15	5.9	...
After 2nd w. ref................	0.78	0.90	10	30	6.1	...
After 3rd w. ref................	0.78	0.90	10	45	6.5	...

Note: All agitation was done at 250 r.p.m. using the official laboratory refining machine. In experiments 4 and 5, only the low lye refinings were made. Temperature of the oil during agitation was 40 deg. C., except in experiment No. 2—here it was 60 deg. C.

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[1] *Journal of Oil and Fat Industries,* Vol. 3, No. 10, October, 1926.

[2] *Cotton Oil Press* 6; 4, 33. August, 1922.