The Raw Linseed Oil Acetone Foots Test. II. Notes on an Anomalous Relationship Between the Heated and Chilled Gravity Foots, Resolved by the Centrifugal Method

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IN the preceding paper data showing the ratio of the chilled gravity foots to the chilled centrifugal foots (chilled ratio, G/C) indicated that the ratio was either approximately 3.3 or approximately 7, depending on the quantity of heated foots present in the oil; for example, as to whether the oil tested is a relatively high foots "crude" raw or whether it has been processed to remove most of the foots matter. In addition, observation made on a typical plant clean-up operation (partial coagulation of gums with water, followed by filtration) in which the heated gravity foots was reduced from 1.8 to 0.1%, a reduction of 94.5%, showed that the indicated chilled gravity foots was actually increased from 2.0 to 2.4%, an altogether irregular occurrence further illustrating the questionable significance of the gravity foots test indications. It was not expected that the same proportionate reduction in the chilled foots test would occur as noted for the heated test since the oil was not chilled in the process of removing the gums measured as heated foots. However since the chilled foots test measures the content of gums covered by the heated test, in addition to such waxes and saturated constituents as remain separated under the conditions of the test, it seemed logical to expect that such an extensive reduction in the heated test would be accompanied by an equal reduction in the chilled test result expressed as a percentage of the original oil. To study this more closely and to see if such anomalous behavior obtained when the oils were tested by the centrifugal foots method, two samples of raw linseed oil were processed in the laboratory following the same plant procedure mentioned above. The results of the chilled foots test by the gravity and the centrifugal methods are shown in the table.

TABLE I

Chilled Foots Reduction Compared to Heated Foots Reduction Upon Processing Raw Linseed

Foots Method	Gravity Settled		Centrifugal	Chilled Ratio
	Heated	Chilled (=G)	Chilled (=C)	G/C
Test 1. Original oil, % foots.....	2.4	3.0, 2.8	1.08	2.68
Test 1. Processed oil, % foots.....	0.4	1.8, 2.0	0.16	11.9
% foots reduction				
% of raw.....	2.0[a]	1.0[a]	.....	.....
% of original foots.....	83.4	34.5	85.1	.....
Test 2. Original oil, % foots.....	2.3	2.4, 2.4	1.12	2.14
Test 2. Processed oil, % foots.....	Trace	1.5, 1.5	0.16	9.36
% foots reduction				
% of raw.....	2.3	0.9	.....	.....
% of original foots.....	Almost complete removal	37.5	85.7	.....

[a]Average.

On both oils the chilled foots reduction measured by the gravity method was less than half of the heated foots reduction, but when the chilled foots reduction was measured by the centrifugal method, the percentage reduction was of the same order of magnitude as that obtained in the heated test. More significantly, the heated foots removal effected by the oil processing, 2.0 and 2.3%, is not nearly matched by a corresponding reduction in the value of the chilled foots test by the gravity method, as we should expect from the nature of these two tests. The chilled foots test is reduced by only 1.0 and 0.9% of the oil; the latter value is considerably less than half of the indicated removal based on the heated test. As another aspect of this relationship we find the chilled ratio G/C to be of the same order of magnitude for the original oil as the usual value of the heated ratio G/C, but on the treated oil it is over four times as great. The conclusion is that when the heated gravity test is somewhat less than 1.0%, the foots layer emulsion in the chilled gravity test contains abnormally large quantities of the oil-acetone solution, indicating a chilled foots content much higher than expected, as referred to the actual quantity of undesirable saturated and non-oil materials present. The way in which the phosphatides and gums reduce the relative volume of the chilled foots emulsion is unknown, but these results indicate that they have a condensing or "binder" action on the waxes, etc., which separate in the chilled test.

In testing a sample of oil prepressed cold from flaxseed before solvent extraction, we recently had a further and rather striking illustration of the peculiar response to the chilled gravity foots test of a raw linseed oil with low gums content. This high quality oil had a heated foots test of only .5% by the official gravity method. However in the chilled foots test, the foots layer failed to consolidate even after settling for several days. This emulsion appeared silky or fibrous by transmitted light. Had it been necessary to report a value, it would have been 36%, an obviously ridiculous figure, especially as the chilled centrifugal foots result was 1.08%. This value for the centrifugal test, incidentally, showed that the oil was indeed unusual as it implies a "normal" chilled gravity foots value of around 7.5%, based on the average G/C ratio mentioned above.

Summary

The volume of the emulsion produced in the chilled gravity foots test, as presently applied to linseed oils, and hence the indicated magnitude of the result, depends to some extent on the percentage of heated foots (a measure of gums and phosphatides) present in the oil. Consequently raw oils processed to remove the gums in order to meet the Federal and A.S.T.M. heated foots specifications may at times show an increase in indicated chilled foots content, as measured by the gravity test. The application of the chilled centrifugal foots test to such oils results in a more accurate and significant measure of the quantity of materials (non-oil constituents, or foots) which it is the intent of the test to measure. The value of the centrifugal method for foots in the investigation of raw linseed oil properties is demonstrated.

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