Analysis Interpretation For The Layman

What the Various Terms Used in Fatty Oil and Sulfonated Oil Analysis Mean

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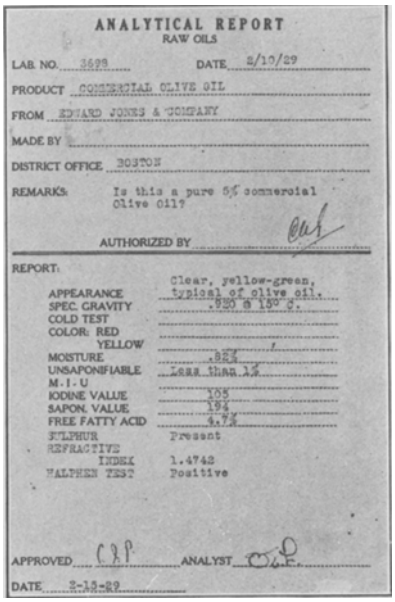
IN COMPILING this brief collection of terms which appear most frequently in oil analysis, an attempt has been made to explain as clearly as possible the meaning of these terms to those who have had little or no chemical training. The definitions are well cross-referenced so that a strange term appearing in any definition may be found defined in another place. In order better to illustrate the use of these definitions and also that they may serve as a glossary rather than a dictionary, the following two analyses of a raw oil and a sulfonated oil are included.



ANALYTICAL REPORT
RAW OILS

LAB. NO. 1628 DATE 2/10/29
PRODUCT COMMERCIAL OLIVE OIL
FROM EDWARD JONES & COMPANY
MADE BY
DISTRICT OFFICE BOSTON
REMARKS: Is this a pure 5% commercial Olive Oil?
AUTHORIZED BY

REPORT:

APPEARANCE	Clear, yellow-green, typical of olive oil.
SPEC. GRAVITY	.920 @ 15° C.
COLD TEST	
COLOR: RED	
YELLOW	
MOISTURE	.85%
UNSAPONIFIABLE	Less than 1%
M.I.U.	
IODINE VALUE	105
SAPON. VALUE	194
FREE FATTY ACID	4.7%
SULPHUR	Present
REFRACTIVE INDEX	1.4742
HALPHEN TEST	Positive

APPROVED CRP ANALYST C.I.P.
DATE 2-13-29

REMARKS

This sample has the typical olive oil color and an oil of rosemary odor indicating its use as a denaturant.

The specific gravity, however, is too high for olive oil and suggests immediately the presence of cottonseed oil as do also the high iodine value and refractive index. Rapeseed oil is excluded by the saponification value which is much too high for that oil, but all right for both cottonseed and olive.

The presence of cottonseed oil was confirmed by an extremely positive specific color reaction, the Halphen test.

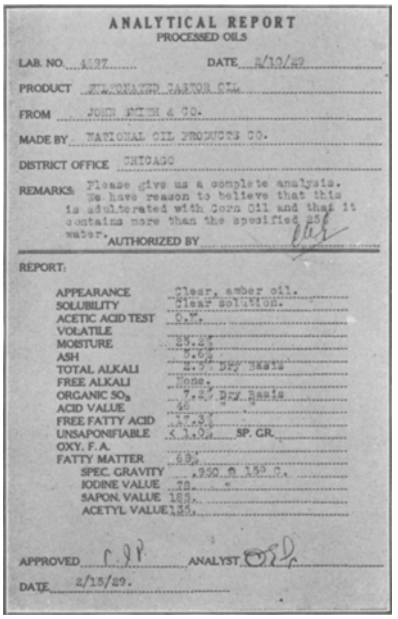
A positive sulfur test indicates the presence of an extracted oil and the color and free fatty acid practically limit the possibilities to olive oil foots.

We report this sample as being over 90% cottonseed oil and the remainder 5 to 8% olive oil foots.

They are shown on the regular report forms; the analysis itself, with necessary relevant information as to the source of the sample, appears on the face of the report, all explanations leading to an interpretation of the analysis appearing on the reverse side.

The amount of adulterants present in the raw oil sample is purposely exaggerated in order better to illustrate the points which are brought out. It should not, therefore, be regarded as a typical olive oil sample or one ordinarily met in the course of an oil chemist's experience. The sulfonated oil sample, on the other hand, is a pure sulfonated castor oil and its full analysis is given as a model of the proper analytical figures for the most common sulfonated oil on the market.

1. **Acetyl Value**—The acetyl value is a measure of the presence of oxy or hydroxy acids in an oil. The higher the acetyl value, the greater the number of these acids. Practically, without exception, the fatty oils have acetyl values of 20 or under. The one great exception is Castor Oil, having an acetyl value of 155. This determination has



ANALYTICAL REPORT
PROCESSED OILS

LAB. NO. 4127 DATE 2/10/29

PRODUCT SULPHONATED CASTOR OIL

FROM JOHN ROTH & CO.

MADE BY NATIONAL OIL PRODUCTS CO.

DISTRICT OFFICE CHICAGO

REMARKS: Please give us a complete analysis. We have reason to believe that this is adulterated with Corn Oil and that it contains more than the specified 25% water.

AUTHORIZED BY

REPORT:

APPEARANCE	Clear, amber oil.
SOLUBILITY	Clear solution.
ACETIC ACID TEST	O.K.
VOLATILE	
MOISTURE	25.2
ASH	0.08
TOTAL ALKALI	2.7% Dry Basis
FREE ALKALI	None.
ORGANIC SO_3	7.8% Dry Basis
ACID VALUE	40
FREE FATTY ACID	20.2%
UNSAPONIFIABLE	1.1% SP. GR.
OXY. F. A.	
FATTY MATTER	75%
SPEC. GRAVITY	.930 @ 15° C.
IODINE VALUE	78
SAPON. VALUE	165
ACETYL VALUE	135

APPROVED C.P.P. ANALYST O.S.D.

DATE 2/15/29.

REMARKS

This is a pure sulfonated castor oil. The light color indicates the use of #1 castor oil as the raw material rather than #2 or #3 and suggests strongly the absence of corn oil. The moisture content of 25.2% is entirely within specifications for 75% oil.

The low total alkali and acid value together with the high organic SO_3 indicate an oil of high sulfonation and low subsequent decomposition, and enable us to predict that it will be stable in acetic acid solution. This has been verified by the acetic test.

The low unsaponifiable precludes the presence of mineral oil.

The high acetyl value of the separated fatty matter definitely indicates the absence of corn oil. Pure castor fatty acids have an acetyl value of about 150 which has been lowered slightly in the sulfonation process to 135.

The iodine value of the fatty matter is 78, as compared to 90 for castor fatty acids. This slight lowering is typical of sulfonated castor oil. All other oils show a large drop in I. V. when sulfonated, due to the different type of reaction occurring between sulfuric acid and the fat. This is caused by the absence of hydroxy groups in all common oils except castor.

great value in the detection of the presence of Castor Oil in sulfonated Olive Oil.

2. **Acid**—Broadly speaking, an acid is a compound which contains one or more atoms of hydrogen and which gives free hydrogen ions in solution. Acids turn litmus red and phenolphthalein colorless. Some common examples are: Hydrochloric acid—HCl, Sulphuric acid—H_2SO_4, Acetic acid—$HC_2H_3O_2$, Stearic Acid—$HC_{18}H_{35}O_2$, Oleic Acid—$HC_{18}H_{33}O_2$, Linoleic acid—$HC_{18}H_{31}O_2$.

3. **Acid, Fatty**—The fatty acids are a type of organic acid. That is, they contain nothing but carbon, hydrogen and oxygen in the molecule as distinguished from the inorganic acids which may contain chlorine, sulphur, phosphorous, etc. A good general way to distinguish fatty acids from other organic acids is that they usually contain hydrogen atoms greatly in excess of carbon atoms. (See Stearic, Oleic and Linoleic Acids, under Acid.)

4. **Acid, Combined Fatty**—In a sulfonated oil, part of the fatty acids may be still combined in the form of a soap or glyceride. This portion is termed "Combined Fatty Acid" and is given in percent.

5. **Acid, Free Fatty**—That part of the fatty acids in an oil which is free and exists as such is termed "Free Fatty Acid." Since the nature of the fatty acids in various oils varies greatly, it has been necessary to adopt a standard by which to report the free fatty acid content of an oil. Oleic Acid is the one which has been adopted, since it is of such general occurrence in most of the fatty oils.

6. **Acid, Total Fatty**—The sum of "Combined" and "Free" fatty acid in an oil is the "Total" fatty acid.

7. **Acid, Oxidized Fatty**—The fatty acids normally contain two atoms of oxygen to the molecule. (See Stearic, Oleic, and Linoleic Acids under Acid.) When oxidized, either by blowing or by exposure to air, these acids take up one or more atoms of oxygen to form new compounds. Cod Liver Oil when oxidized forms the well known Moellon Degras.

8. **Acid, Mineral**—These are inorganic acids which do not necessarily contain carbon and oxygen and which are not of organic origin. Hydrochloric acid—HCl, Sulphuric acid—H_2SO_4—Nitric acid—HNO_3 are the best known examples.

9. **Acid Value**—The acid value of an oil is a measure of the free acid present. The higher the acid value the greater the acidity. The acidity of an oil is usually reported in terms of acid value, but it may very readily be converted into percent free fatty acids by dividing by 2. This will give a very close approximation to the free fatty acid content, in terms o f oleic acid. (See Acid, Free Fatty.)

10. **Acidity**—This is simply a relative term used to express the acid strength of an oil or solution. The presence of a good deal of acid means a high acidity. A small amount of acid means a low acidity.

11. **Alcohol**—An alcohol is to organic chemistry what an alkali is to inorganic. They both have the distinguishing hydroxyl radical. An alkali reacts with an acid to form a salt and water, while an alcohol reacts with an acid to form an ester and water:

Sodium hydroxide	+	Hydrochloric acid	=	a Salt + Water.
$NaOH$	+	HCl	=	$NaCl + H_2O$.
Ethyl Alcohol	+	Acetic Acid	=	an Ester + Water.
C_2H_5OH	+	$HC_2H_3O_2$	=	$C_2H_5C_2H_3O_2 + H_2O$.

The most common examples are methyl (wood) alcohol—CH_3OH, ethyl (grain) alcohol—C_2H_5OH, glycerol (glycerine) $C_3H_5(OH)_3$, cholesterol—$C_{26}H_{43}OH$.

12. **Alkali**—An alkali is an inorganic compound containing one or more OH (hydroxyl) radicals and giving free hydroxyl ions in solution. It is invariably a compound made up of some metal and the hydroxyl radical. Alkalis turn litmus blue and phenolphthalein red. Common examples are sodium hydroxide (caustic soda) — NaOH, potassium hydroxide (Caustic Potash) KOH, calcium hydroxide (slaked lime) —$Ca(OH)_2$.

13. **Alkali, Combined** — The percent of alkali (e.g. sodium hydroxide) present, combined with fatty acids in the form of soap (e.g. sodium stearate). In an analysis, Combined Alkali is always reported in terms of percent of potassium hydroxide, although the alkali used may be sodium hydroxide, ammonium hydroxide, or any other. This is simply for the sake of uniformity.

14. **Alkali, Free**—The percent of alkali present in excess of fatty acids, and fat, and which, therefore, exists in free form. Free Alkali, also, is always reported in terms of percent of potassium hydroxide, although the actual alkali present may be of a different nature.

15. **Ammonia**—Ammonia is a gas composed of three atoms of hydrogen chemically combined with one atom of nitrogen and having the formula NH_3. Ammonia dissolves in and combines with water in the following way to give ammonium hydroxide, or ammonia water, NH_4OH

$$NH_3 + H_2O = NH_4OH$$

This is therefore an alkali, since it contains the hydroxyl radical, and the NH_4 or ammonium radical acts in a good many ways exactly like a metal. Ammonium hydroxide reacts with fatty acids to give soaps just as sodium or potassium hydroxide would. When the term ammonia is used in the oil, soap and fat industries, it almost invariably refers to a water solution of the compound, which, to be strictly correct, should always be referred to as either ammonium hydroxide, ammonia water, or aqua ammonia. In the ice plant and refrigerant industries, where the anhydrous ammonia principally is used, the term ammonia is used in its correct sense, and refers to the compound NH_3 instead of NH_4OH which is used in the soap industry.

16. **Ash**—The ash, in any analysis of oils, is that portion of the oil which remains when the sample has been subjected to a red heat for some time. The organic portion burns off leaving a residue, or ash, of inorganic salts, such as sodium chloride or sodium sulphate.

17. **Baumé**—This is the name given to two scales for expressing in simple numbers the specific gravity of liquids both heavier than and lighter than water. In the former class, belong solutions of mineral acids, salts, alkalis, etc. Taking water as a standard, having a specific gravity of 1.0000 and a Baumé reading of zero degrees (0°), the scale goes up to a specific gravity of 2.0714 or a Baumé of 75°. In the lighter than water class are the vegetable and mineral oils. Starting with water again, it is given a Baumé of 10° and the scale goes down to a specific gravity of .5833 or a Baumé of 110°. Thus we see that with liquids lighter than water, the lighter the liquid the greater its Baumé reading. Different instruments must be used in the two classes of liquids.

18. **Carbonate**—A carbonate is a salt and is the result of the combination of any alkali with carbonic acid. Our most common example is sodium carbonate or soda ash—Na_2CO_3.

19. **Caustic**—Any strong alkali, (e.g. sodium or potassium hydroxide). These two compounds are generally referred to as Caustic Soda and Caustic Potash, respectively.

20. **Chloride**—A chloride is a salt and is formed by the action of any alkali with

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Analysis Interpretation

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hydrochloric acid according to the following reaction: $NaOH + HCl = NaCl + H_2O$. The salt formed in this case is sodium chloride or "common salt."

21. **Cholesterol** — This is an alcohol which is present in all animal oils and the presence of it enables us to distinguish animal from vegetable oils. The latter contains a similar alcohol called phytosterol.

22. **Cloud Test**—The cloud test is run on oils for the purpose of discovering the presence of any impurities which may settle or separate out at lower temperature. The oil is chilled and the temperature taken at which it becomes cloudy. For some purposes an oil which becomes cloudy at too high a temperature cannot be used.

23. **Cold Test**—The cold test of an oil is the temperature at which the oil will just flow. It is of importance that this point be known fairly accurately in certain oils, e.g. Neatsfoot oil.

24. **Degras**—Degras is a common name for wool grease. It is a greasy exudation from the skin of sheep and is obtained by the washing of wool.

25. **Degras, Moellon**—This is not to be confused with ordinary degras. It is an oil obtained as a by-product in the process of currying leather and is formed by the oxidation of the fish oil in the leather. It is a mixture of unchanged fish oil, free fatty acids, and oxidized oil.

26. **Degras Former**—This is a resinous substance in Moellon Degras and consists principally of oxidized oil. The amount of it can be used as a measure of the extent to which the Moellon contains oxidized acids.

27. **Emulsify**—We emulsify two liquids when we so treat them as to form an emulsion. An emulsion is a suspension of very fine droplets of one liquid in another liquid. These droplets may be so small as to not be seen through an ordinary microscope. Emulsions are usually milky in appearance. Milk itself is a true emulsion of butter fat in water. Most sulfonated oils when added to water form a milky emulsion of oil in water.

28. **Extraction** — Extraction is the removal of a liquid from a solid by means of dissolving it in another liquid. No. 3 castor oil is made by treating the beans (from which No. 1 oil has been crushed) with some solvent such as carbon disulfide or petroleum naphtha. This solvent dissolves and extracts the oil from the bean pulp.

29. **Fire Test**—This is the lowest temperature at which an oil will give off vapors which when ignited will burn continuously. This is an important test in certain classes of mineral oils.

30. **Flash Test**—This test is used to determine the flash point of an oil. The flash point is the lowest temperature to which an oil must be heated to give off vapors which, when mixed with air, produce an explosive mixture.

31. **Glyceride**—A glyceride is an ester (see Alcohol) formed by the action of a fatty acid on glycerol or glycerine. Our most common glycerides are those of palmitic, stearic and oleic acids and are called respectively: palmitin, stearin, and olein. Glycerides constitute by far, the major portion of all fatty oils.

32. **Glycerine**—Glycerine or glycerol is an alcohol which is found in the majority of fats and oils in combination with fatty acids as glycerides. If these glycerides are treated with an alkali, a soap is formed and free glycerine is liberated.

33. **Gravimetric**—If, in analyzing a substance chemically, the amount of any constituent is determined by weighing, then the analysis is called gravimetric.

34. **Gravity**—Gravity is the force of attraction between any two bodies in space. We are principally interested in the force or pull exerted by the earth upon bodies on the earth. This pull is determined by weighing.

35. **Gravity, Specific**—Specific gravity is the measure of the pull of the earth on a unit volume of a substance, or the weight of a unit volume of a substance, when referred to pure water as a standard of 1.0000. Substances having a specific gravity of less than 1 are lighter than water. Those having a specific gravity of more than 1 are heavier than water. All fatty and mineral oils have specific gravity of less than 1 and are therefore lighter than water, and will float on it. Due to the expansion and contraction of oils with change in temperature, the temperature at which the specific gravity is taken must always be included in a report. For instance, the specific gravity of Palm Oil is .9236 at 15° C.

36. **Hydrogenation** — This is the term used for the treatment of certain oils with hydrogen gas at high temperatures in the presence of small amounts of foreign substances known as catalysts. The hydrogen combines with the oil to form solid fats having a much higher titre (See Titre) and