Different Types of Oils and Possible Causes of Their Formation

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As a result of many years of study of the composition of oils, condensate and ordinary natural gases, and of phase equilibria of hydrocarbon systems, the author has recognized systematic variations in the composition of oils and natural gases. Some of these regularities and their causes are examined in the present paper.

Back in 1938 we noted that among the oils are often encountered varieties in which the benzine and even part of the kerosene fractions are absent and there are no light methane hydrocarbons. They contain hydrocarbons in the molecular composition of which are not less than two cycles (rings). Since not less than 5 atoms of hydrocarbon enter into each ring in the naphthene hydrocarbons found in oils, then even the lowest boiling bicyclic hydrocarbons boil at a temperature considerably above 100°C. Volatilization of the light fractions from these oils could not lead to removal of only methane and naphthene mono-cyclic hydrocarbons, because it is a function of the vapor tension. But among the methane and mono-cyclic hydrocarbons, of course, there are those which have the same vapor tension as various bicyclic hydrocarbons. The solubility in water of the naphthene and particularly of the bicyclic hydrocarbons is greater than that of methane hydrocarbons of the same molecular weight. Consequently, this does not explain the absence in the oils of the types of methane and mono-cyclic naphthene hydrocarbons.

The oils that do not contain benzine fractions are found in many regions of the Soviet Union and in other countries. Some data on them are presented in Table 1.

Under natural conditions these oils contain a small quantity of methane in a dissolved state. For example, only 5 m³ of gas are expelled from 1 ton of oil with a drop of pressure to atmospheric in the case of the Yareg oils. Ethane, propane, and butane are absent in such oil.

If this type of oil is designated according to the lowest boiling hydrocarbon (not counting methane) as naphthene bicyclic, then the other extreme type would be the methane, that is, consisting in the light benzine fraction only of single methane hydrocarbons. Such oils do not actually occur in nature. But oils in which (in any case in the light fractions) methane hydrocarbons prevail sharply are widespread. To such a type are referred oils of many fields of the North Caucasus, the Ural-Volga, West Ukraine, and others. The methane hydrocarbons (if methane is not counted) boil beginning with a temperature of 88.6°C (ethane). According to this the methane oils under formation conditions as a rule contain considerable quantities of gas hydrocarbons: ethane, propane, (b. p. of 42.1°C), isometric and normal butane (b. p. of −11.7°C and −0.5°C) because they are all members of the methane series. These oils generally contain a large quantity of the fractions that boil off up to 100°C (an average of 7%), and therefore the yield of benzine from them is high. (According to GOSTu automobile gasoline should boil off by 50% at a temperature not exceeding 105°C).

Also widespread are those oils, in the benzine and kerosene fractions of which there is a sharp predominance of naphthene hydrocarbons with a single naphtha ring in the molecule. Therefore, we provisionally designate this type of oil as naphthene-monocyclic. It is very common among the oils of the Baku and Emba region.

Cyclopentane is present in the oils in an insignificant quantity; therefore, the very lowest boiling hydrocarbon in the naphthene monocyclic oils should be methyl cyclopropane, boiling at 72°C. But this type of oil is not found in the pure form; however, some of the methane hydrocarbons are generally in the benzine fractions. Therefore, the beginning of boiling of these oils will be below 72°C; however, their content of fractions boiling up to 100°C is generally low (average of about 3%), and the yield of benzine is generally considerably lower than for oils of the methane type.

In the casing head gas of the oils of the monocyclic naphthene type, the content of ethane, propane, and butane is often less than 1%; all the rest, just considering the hydrocarbons, is methane.

Consequently, methane oils under formation conditions contain all the saturated gas hydrocarbons; monocyclic naphthene oils contain almost exclusively methane; and the bicyclic contain only methane and further do not contain liquid hydrocarbons that boil up to 170-200°C.

There are also oils that are intermediate in composition between the methane and monocyclic, and between the monocyclic and...