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THE ORIGIN OF HYDROCARBONS AND WATER. THE ROLE OF HYDROGEN

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Abstract—The origin of petroleum and natural gas and all studies related with this pheonomenon of our life are very interesting and deserve special attention. Besides, an understanding of the basic mechanism of complicated processes in the earth will help us to develop good models and effective life-supply processes. Furthermore, we will be able to explain the mechanism of water origin on the earth. The role of hydrogen and its permeability in the different geological structures are discussed in this paper.

INTRODUCTION

It is well known how the origin of oil is explained in different textbooks. The main idea is that the progressive thermal process of breakdown of organic matter in sedimentary rocks (kerogen) had an essential contribution in the origination of petroleum, natural gas and coal in the earth. Accordingly, water originated long before biological matter appeared on the earth. There is no strong theory of the origin of water. We know that approximately 70–89% of the weight of animals consist of water. It is hard to imagine how high the population of animals would have to be on earth to create an inexhaustible supply of oil, natural gas and coal. Besides, why is there a very small amount of nitrogen organic compounds in petroleum, etc.? Where is the main fragmentations of peptides? On the other hand, if we accept the theory, why do we not have any optical activity for oil. Even if we observed it, it was not related to induction of chiral carbons and there was no contribution from the major chromophor groups such as C=O, Ph, etc. The dispersion of optical activity of oil does not correspond to Cotton's effect, which is essential for any chemical compounds originating from or with the help of biological substances. The contribution of hydrogen in the origin of oil and water is discussed in this paper.

THE ROLE OF HYDROGEN, CARBONATES, SULFATES AND NITRATES

According to the observations and analysis we could have the following situation which could have had an esential contribution in the oil, natural gas and coal origination processes. At the time of the earth's beginning, we know that in the depths of earth there existed very active thermonuclear reactions. Hydrogen was the one of the main products of those reactions. Carbonate, sulfate and nitrate type salts of metals were an abundant part of the earth's structure, so we had plenty of hydrogen (in fact an inexhaustible supply and production) and carbonates, etc. at high temperature and pressure. This is ideal for consecutive destruction reactions of carbonates and other salts to metal, metal oxides, CO_2, SO_2, NO_x, etc. and then reduction of these products to hydrocarbons (Fischer–Tropsch reaction), H_2S, nitrogen and water.

$$MeCO_3 \rightarrow MeO + CO_2 \text{ thermal decomposition} \quad (1)$$

$$MeSO_4 \rightarrow MeO + SO_2 + 1/2O_2 \text{ thermal decomposition} \quad (2)$$

$$MeNO_3 \rightarrow MeO + NO_2 \text{ thermal decomposition} \quad (3)$$

$$CO_2 + H_2 \rightarrow CO + H_2O \text{ shift reaction} \quad (4)$$

$$(2n + 1)H_2 + nCO \rightarrow C_nH_{2n+2} + nH_2O$$
Fischer–Tropsch reaction (5)

$$2nH_2 + nCO \rightarrow C_nH_{2n} + nH_2O$$
Fischer–Tropsch reaction (6)

$$2nH_2 + nCO \rightarrow C_nH_{2n+1} + (n-1)H_2O$$
Fischer–Tropsch reaction. (7)

This first group of thermal decomposition reactions represents the processes of CO_2, SO_2, NO_x formation at high temperature conditions. The contribution of the Fischer–Tropsch reactions (4)–(7) [1] is different and depends on the geological structure of the environment, the composition in close order and the catalytic role of the different active constituents such as nickel, cobalt, ruthenium, iron etc. For example, it is well known that the Fischer–Tropsch reaction yields gaseous and liquid paraffine hydrocarbons in the presence of promoters such as ThO_2 and MgO at 170–200°C [1]. On the other hand mainly methane and paraffinic hydrocarbons plus small yields of alcohols and other oxygenated molecules can be obtained in the presence of ThO_2, Mgo, MnO and K_2O at 170–450°C [1].

Predominantly olefinic hydrocarbons, about 10% oxygenated products, chielfy alcohols, can be obtained in the presence of Cu, MgO, Al_2O_3, CaO, ZrO_2, TiO_2, K_2CO_3, etc. at 190–400°C [1]. Reduction of CO_2 could lead to carbon in the first stage, which generates aromatic hydrocarbons through acetylene or graphite in the earth. The following schematic reactions ocur during the formation of oil and gas in the earth. The contribution of each of them cannot be estimated and additional research involving high pressure reactions is required:

$$CO_2 + 2H_2 \rightarrow :C: + 2H_2O \tag{8}$$

$$2:C: \rightarrow :C{=}C: \tag{9}$$

$$n:C: \rightarrow \text{graphite} \rightarrow \text{diamond}. \tag{10}$$

The product of the reaction (9) can be easily hydrogenated by yielding acetylene:

$$:C{=}C: + H_2 \rightarrow CH{\equiv}CH. \tag{11}$$

Acetylene is a good raw material for the generation of benzene (12) and other benzene type hydrocarbons such as naphtene, anthracene, etc.

$$3CH{\equiv}CH \rightarrow C_6H_6. \tag{12}$$

The cycloparaffinic hydrocarbons in oil could originate from graphite hydrogenation, decyclization and recombination processes, or by the benzene hydrogenation processes, so the hydrogenation processes at high temperature and pressure yielded cyclic hydrocarbons with the saturated and unsaturated structures. Part of the saturated cyclic hydrocarbons (mainly six-angle) was decycled to linear paraffins. Unsaturated cyclic hydrocarbons remained as benzene, naphthene, etc.

THE ROLE OF THE GEOLOGICAL STRUCTURE ON THE COMPLETION OF THE HYDROGENATION PROCESS

For efficiency and completion of these processes of petroleum origination the hydrogen should not have any opportunity to leave the reaction zone and exit to the surface of the earth. In other words, the residence time of hydrogen for the intimate reactions should be large enough. If the residence time is short the petroleum origination process will not be completed and we will have a semiproduct of this reaction — coal.

If we will take in the consideration the amount of CO_2 and an unlimited amount of hydrogen as a product of thermonuclear processes in the earth, one can see that all the above mentioned processes in general might be generators of not only oil, gas and coal, but also of water. As suggested earlier, the earth originated when fragments of rock flying through space came together by gravitational attraction. It is unlikely that large volumes of free water existed in the earth's surface at that time. The earth originally had little or no water, and water now covers three-quarters of the earth's surface. What processes produced the gigantic volume of water available today?

It is now accepted that when plate collisions began and magma formed in the subduction process, gases such as CO_2, N_3, H_2, H_2S, SO_2 and CO were produced in the accompanying volcanic eruptions [2]. This principal gas released was water vapor [2]. This theory explains the origin of salted water above oil layers in the earth. Water vapor generated uner these conditions hundreds of millions of years ago was evacuated and it dissolved mineral salt yielding salty pillows. Again, this salted water did not permit gas to come out and exit from the surface of the earth. These processes were due to low gas solubility and permeability of salted water. Similar processes happened in areas close to the arctic circle, except for one fact: instead of salt pillows we have frizzed soil and ice. Hydrogen, as produced in thermonuclear reactions, had to react via the scheme mentioned above, so something had to block paths for hydrogen to exit to the surface of earth. In other words, we have three cases:

(1) hydrocarbons originated when we did not have path for hydrogen exit to the surface;

(2) coal and natural gas (the semiproduct of oil origination) originated when we had some permeability for hydrogen exit to the surface;

(3) no hydrocarbons or coal originated when hydrogen found total peremability to exit the reaction zone and the earth's surface.

In case 1, the oil generating reactions take place as a result of extremely low hydrogen permeability. The primary subsurface material which prevented hydrogen escape was sodium chloride salt "pillows". Actually, most of the oil and gas fields in the world are famous for the deficit of sweet water, and there are plenty of salt "pillows" underground (above oil level). All oil fields of this type are located near to the equator and at close altitudes. Why the salt "pillows" locate near to the equator can be explained if we take the general mechanic laws into consideration (centrifugal forces, etc.).

In some cases, we have other minerals with low hydrogen permeability (granite for instance, according to the theory of Thomas Gold.).

In case 2, due to the absence of salt "pillows", the residence time of hydrogen in the reaction zone was small, and as a result the petroleum origination process was incomplete and we had coal or natural gas as the main product. For mechanical reasons the salt "pillows" could not originate in locations far north or far south of the equator. As a result, in those part of the earth we have mainly coalfield, tar sand and natural gas.

Concerning the organic and inorganic sulfur compounds and elemental sulfur in nature, we can say that they are the result of thermal decomosition of metal sulfates to sulfur dioxide and reduction of sulfur dioxide by hydrogen to hydrogen sulfide:

$$SO_2 + 3H_2 \rightarrow H_2S + 2H_2O. \quad (13)$$

Further, in the pores of the upper limestone layer the catalytic Claus reaction produces elemental sulfur at temperatures close to dew point of sulfur, and elemental sulfur accumulates:

$$2H_2S + SO_2 \rightleftarrows 3/xS_x + 2H_2O. \quad (14)$$

A small part of the hydrogen sulfide reacted with unsaturated hydrocarbons or with the intermediate products of the hydrocarbon origination processes and yielded mercaptans, thiophene and other sulfur containing organic substances. Concerning NO_2 (or NO_x) reduction by hydrogen, the processes below could follow reaction (3):

$$2NO_2 + 2H_2 \rightarrow N_2 + 2H_2O. \quad (15)$$

So, for each 2 mol of water 1 mol of nitrogen should correspond on the earth and the atmosphere. It should be mentioned here that all our attempts to balance the numbers of oxygen, carbon in hydrocarbons and nitrogen atoms on the earth and in the atmosphere are based on rough numbers, which do not include a relatively small contribution of the biological mechanism of oil origin.

It seems to us that the reactions (5) and (6) are the major contributors in the origin of oil. If we take this assumption one can see that from the brutto balance of oxygen atoms in water the number of carbon atoms in oil can be determined. If we know the amount of water on the earth and we assume the average molecular weight for hydrocarbons (oil and coal), we can calculate the reserved amount of hydrocarbons in oil and coal. For example, if we will assume that the average molecule of oil consist of 20 atoms of carbon one can say that 1 mol of water corresponds to 1 mol of organic compounds with the 20 atoms of carbon in the structure. Furthermore, the reserve of hydrocarbons with the 20 atoms of carbons in structure is 20 times less than water. These hydrocarbons are concentrated mainly in oil, natural gas and coal fields.

CONCLUSION

A new hypothesis of the origin of hydrocarbons (oil, natural gas, coal) and water has been developed and discussed. The residence time of hydrogen was involved in the different reduction processes in the earth depended on the geological structure. This theory may be applied for the development of a new method for the discovery of new oil and natural gas and condensate fields.

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