Decomposition of heavy hydrocarbons in argon arc with the sunken electrodes

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Abstract. The way of decomposition of heavy hydrocarbons in the argon arc with the sunken electrodes is proposed. The chromatographic analysis of the gases appeared in the chamber and the electronic and microscopic investigation of the carbonaceous deposits formed on electrodes during experiment is carried out.

In recent years much attention is paid to search for the effective plasmochemical ways of heavy hydrocarbons refining deepening [1-2]. In these works and works [3-4] it was shown that the plasmochemical influence on heavy hydrocarbons is efficient in case when the processing is made directly inside the processed materials. It is mentioned [1-5] that the discharges were organized between the electrodes sunken in hydrocarbons. Under these conditions the arch occurs in hydrocarbon vapors. In this case the hydrocarbon vapors directly interact with the electric arch. The plasma high-temperature influence leads to intensive decomposition of hydrocarbon molecules. During the thermic decomposition process the hydrocarbons molecules appeared in the arcing zone can be decomposed to the atomic state. Subsequently new molecules can gather from these atoms, such as methane, acetylene, hydrogen, carbon nanotubes, fullerenes etc. gather. However the formation of easy fractions requires more soft modes of plasma heavy hydrocarbons processing. The use of the discharge with the drowned electrodes in buffer gas can provide implementation of these terms.

The experimental equipment to provide the discharge with the drowned electrodes in buffer gas is presented in Fig. 1. The reactionary chamber 1 represents the ceramic capacity which is hermetically closed by a hermetically cap. Cover of the chamber has a branch pipe for extraction and the subsequent collection of the formed gases and light hydrocarbons. The electrodes 4, 5 and a pipe for buffer gas supply 2 are set in the chamber. Electrodes 4, 5 with a diameter of 5 mm are built in the cover of capacity 12. The cathode 4 is set on the support 11 and remains fixed. The anode is fixed on the holder 6. Construction of the holder allows to change the distance between electrodes and to provide arcing. The distance between the pipe 2 and the electrodes 4, 5 is 3-5 mm. In our experiments buffer gas was supplied from below to discharge area though gas supply sideways was also possible.

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This pipe was connected to a cylinder 3 with buffer gas. The reactionary chamber is filled with masut on two thirds. Thus the discharge area had to be at 3-5 cm below than a masut surface. In our experiments argon was used as buffer gas.

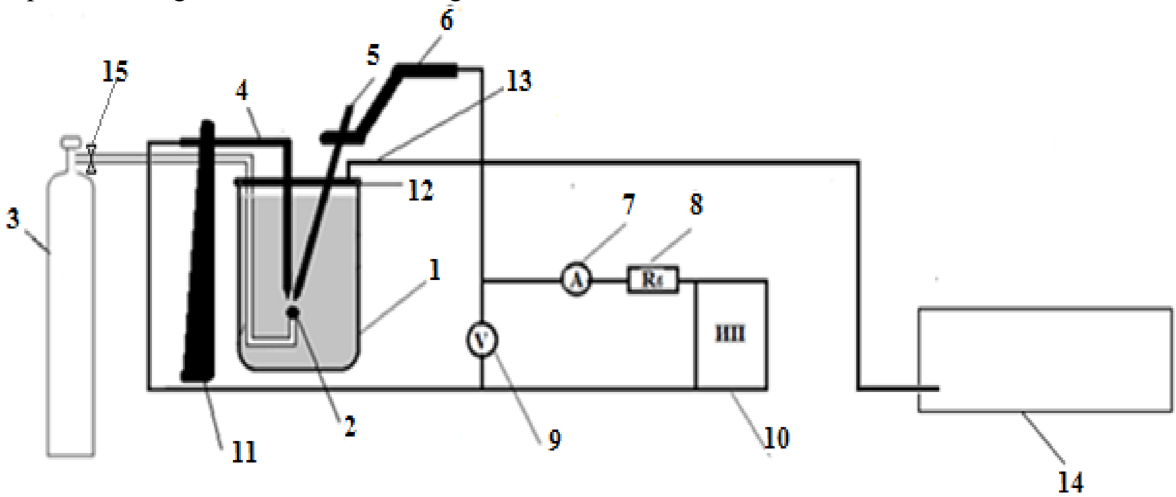

Figure 1. Experimental equipment for the decomposition of liquid hydrocarbon raw material in an argon arc with the sunken electrodes. 1 is the reactionary chamber; 2 is the pipe coupling for the buffer gas supply; 3 is the buffer gas cylinder; 4 is the cathode; 5 is the anode; 6 is the anode holder; 7 is an ammeter; 8 is ballast resistance; 9 is a voltmeter; 10 is a power supply; 11 is the cathode support; 12 is the cap; 13 is the gas extracting pipe; 14 is the capacity for gas collection; 15 is a valve.

The argon supply to discharge area has been provided before the arc ignition. The gas flow rate was 10 mg/s. Arc ignition was made by direct contact of electrodes. Arcing was followed by intensive extraction of gases from the chamber.

Burning of arc controlled by the testimonies of devices: ammeter 7, voltmeter 9 and by the intensive selection of gases from a reactionary chamber.

Let us give the analysis of the physical processes which happens when argon plasma interacts with heavy hydrocarbons. In electric arc a plasma cord argon heats up to 15000K, extends in volume and forms a gas bubble with walls of fuel oil. However on argon-fuel oil border argon temperature is not so much high. Separate atoms, ions of argon, and also electrons of plasma keep the energy sufficient for splitting the lengthiest molecules of hydrocarbons. At this time volatile and light distillates of hydrocarbons evaporate to the area of a gas bubble. The bubble is filled by gas-steam hydrocarbon fractions. The gas-steam bubble comes off area of the category and directs up. Energy of the electric field is spent for maintaining of electric arch including the argon heating, for argon ionization processes, for hydrocarbons molecules splitting, for heating of electrodes and of fuel oil.

Ethylene, Hydrogenium, methane and propane were the main gaseous products of plasmochemical decomposition of fuel oil in argon arch with the drowned electrodes. Their percentage ratios were similar to the case of decomposition without noble gas supply: ethylene (50%), Hydrogenium (30%), methane (9%) and propane (3%) in essence new at both. However, both essential increase in exit of gasoline fractions of hydrocarbons, and the structure of carbonaceous deposits on electrodes were essentially new exactly for the decomposition of hydrocarbonic raw materials in the environment of noble gas with the drowned electrodes.

Before the analysis carbonaceous deposits separately from the cathode and the anode were gathered in separate ceramic containers. Then deposites were carefully washed out in alcohol and dried in the furnace at temperature of 850 ºC ○ within 10 minutes. Further they were subjected to careful studying on the electronic scanning microscope LIBRA 120 PLUS. Fig. 2 – 4 are electronic and microscopic pictures of the received samples. Apparently from these pictures, carbonaceous deposits on the cathode consist of multilayer carbon nanotubes with the reference diameter of 9 - 15 nanometers. Their length reaches several microns.

Thus, it was shown that the electric arcing inside the heavy fuel oil allows to increase the depth of oil processing and to receive new valuable products.

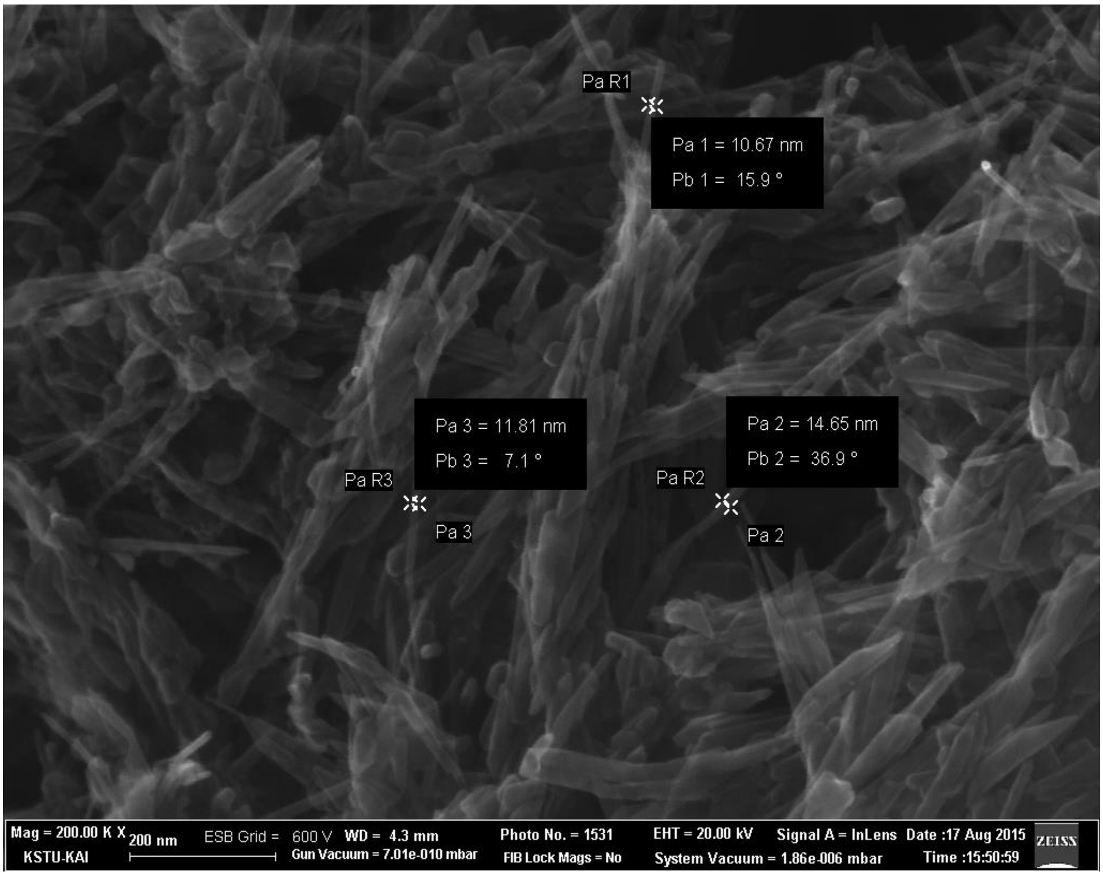

Figure 2.

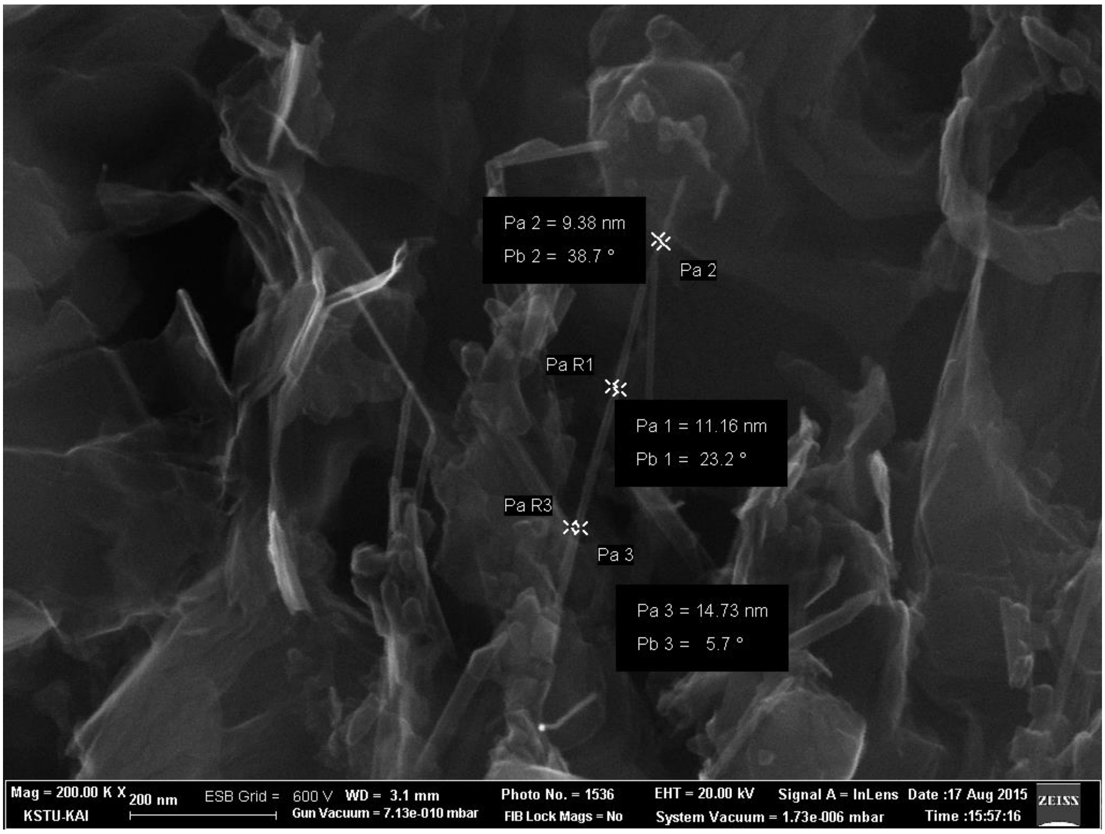

Figure 3

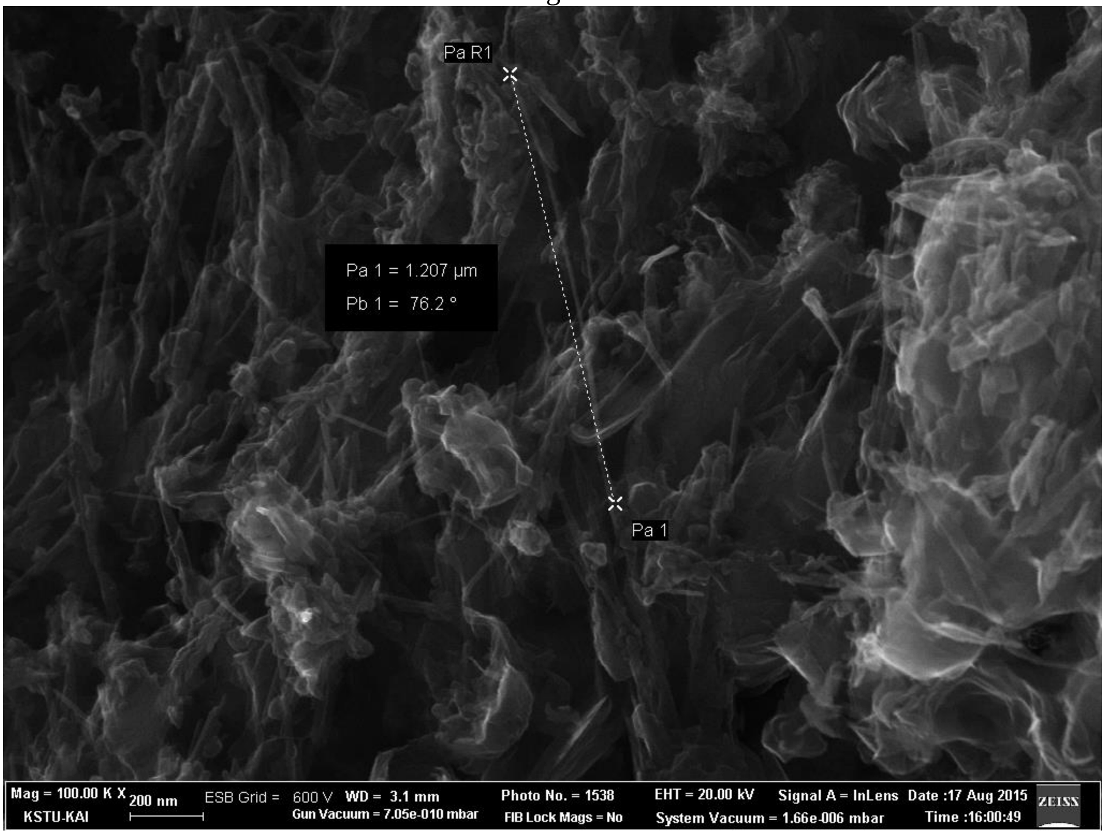

Figure 4.

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