Traditional processes of catalytic cracking of heavy petroleum raw materials require continuous regeneration of expensive zeolite-containing catalysts and sophisticated equipment [17-21]. The improvement of heavy oil feedstock conversion processes is mainly aimed at creating highly efficient catalytic systems and equipment. Development of methods for the activation of heavy oil raw materials by such physical influences as ultrasound, magnetic treatment, microwave, infrared radiation, mechanochemistry, ultraviolet radiation can be an alternative or addition to traditional oil refining processes. The publications of the last decade on testing unconventional methods of processing heavy petroleum feedstocks convincingly indicate the effectiveness of these methods for regulating the direction of interactions of feedstock molecules in the composition of petroleum dispersed systems [22-25]. Analysis of literature and patent data shows that the most promising method for obtaining light hydrocarbon fractions is the implementation of catalytic cracking of heavy petroleum raw materials, in the presence of air additives in the reaction medium, i.e. in an oxidizing medium [26-29]. Probably, the effect of waves on oil and petroleum products using a high-frequency electromagnetic field is associated with the presence of magnetic particles in the composition of oil, as well as the action of an electromagnetic field. It consists in the destruction of aggregates of colloidal magnetic particles and activation of their surface due to heating [30-34].

Implementation of the process of catalytic cracking of fuel oil without preliminary desulfurization and demetallization of heavy oil feedstock is of considerable practical interest. Synthesis of catalysts based on composites from natural raw materials is one of the most promising ways to increase the economic efficiency of catalytic cracking to obtain target fuels.

The purpose of this work was to study the possibility of using hollow microspheres based on fly ash from the Ekibastuz coal deposit (Kazakhstan), obtained as a result of the operation of CHPP-2 in Almaty, for purification of waste gases from sulfur dioxide to produce sulfonic acid and sulfoxides as reaction products. The catalysts based on fly ash cenospheres with addition of natural zeolite were also tested in the process of catalytic cracking of fuel oil (with preliminary electromagnetic excitation of hydrocarbon molecules) to obtain light carbon fractions.

EXPERIMENTAL

The fractions of cenospheres resulting of the combustion of coal of Ekibastuz field (Kazakhstan) at the Almaty TPP-2 (Kazakhstan) with an aluminosilicate module SiO_2/Al_2O_3 = 3.2 and an iron content of 3.03-3.67 wt. % in Fe_2O_3 (Table-1) have been used for the research. The scheme for producing mycospheres from the Ekibastuz coal ash is based on the use of dry magnetic separation methods, particle size classification and gravity separation using liquid separating media.

Table-1. Cenospheres fractions from the combustion of coal of Ekibastuz field (Kazakhstan) at the Almaty TPP-2 (Kazakhstan).

No	Fraction, mm	Composition, wt. %			SiO_2/Al_2O_3, wt. %	Crystalline phase, wt. %			Glass phase	S_{BET}, m^2/g
		SiO_2	Al_2O_3	Fe_2O_3		Quartz	Mullite	Calcite		
1	-0.19+0.09	67.71	20.95	3.01	3.2	3.4	0.8	0.5	95.4	125
2		66.50	20.68	3.77	3.2	-*	-*	-*	-*	125

*n.d. -not determined

The kinetics of oxidation of sodium sulfite with oxygen was studied under stationary conditions in a glass non-gradient thermostatic reactor of the “duck” type with a potentiometric device. The process was carried out according to the previously developed methodology [6, 11, 20, 28]. For the classification of fly ash from coal combustion a column pulsation apparatus with pneumatic pulsators and swirling partitions (with the distance between the partitions - 80 mm) has been applied. The rate of upward flow of the water was 0.005 m/s, an amplitude of pulsation was kept within 5 mm. The pulsations frequency was varied within the relationships density/specific surface area which are inherent to the two non-magnetic products (quartz sand and γ-Al_2O_3). The efficiency of the process was defined by the results of X-ray phase analysis and by means of visual control of quality of the selected products using a microscope. A vibration magnetometer AMH-500 Hysteresisograph (Italy) was used for magnetic measurements.

Processing of M-100 grade fuel oil from Amangeldy gas processing plant (AGPP, Kazakhstan) was studied during catalytic cracking on composite catalysts based on cenospheres of fly ash with addition of natural zeolite of Kazakhstan field. Distillations at atmospheric and reduced pressures were used to establish the fractional composition of fuel oil. Fractions of gasoline, light gas oil, vacuum gas oil and heavy residue (T boiling > 500°C) were taken. The content of each fraction (wt. %) was determined by gravimetric method. The sulfur content of the liquid fuel and vacuum gas oil was determined by high temperature oxidation of the samples followed by acid-base titration of the resulting sulfur dioxide. In the initial fuel oil, in gasoline and kerosene-gas oil fractions formed during cracking, the presence of oxygen and sulfur-containing compounds was determined by the infrared