The total cost of the recovery operation for one RBMK unit is 2.5 billion rubles. Special devices for RRC and reactor's calibration cost 1.5 billion rubles. Replacement of the cracked fuel channels costs about 1 billion rubles. When this method is applied, the reactor's operating time increases for 5-15 years which can help our country to prepare for the future reactors' decommissioning and their gradual replacement.

In conclusion it's necessary to add that it is obvious that RRC is better than the first method, because it is more efficient and it can save huge amount of money (2.5 billion rubles vs. 400+45 billion rubles) and RRC can help to prepare for further reactors' decommissioning and their gradual replacement in the RF.

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## THE DEFINITION OF ACTIVATION ENERGY OF ANTHRACITE COMBUSTION


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### Introduction

The current energy source trend around the world points toward Coal Fired Power Plant (CFPP). Coal is currently the largest energy source in many countries, such as the Russian Federation, the UK, the United States of America, India and China. The generation of energy through coal combustion is a method applied at all coal fired power plants. To minimize the costs various technologies are developed. There is a long way of experiments and research before employing a new technology which will be economically viable and environmentally friendly [1].

Nowadays with the development of IT and computer engineering the ability to solve difficult engineering problems was appeared. One of such problem is the modeling of the combustion process in a boiler furnace. The modeling of the combustion process involves the solution of several differential equations like: energy equation, continuity equation, Navier–Stokes equations, diffusion and chemical kinetics equations. Constants which are included in these equations should be determined experimentally. Therefore, the purpose of this work is to define the activation energy of the combustion process. It is to be noted that in transition-state theory, the activation energy is the difference in energy content between atoms or molecules in an activated or transition-state configuration and the corresponding atoms and molecules in their initial configuration [2]. The activation energy is represented by the symbol E in mathematical expressions [2].

**Materials**

As a material for experimental research powdered anthracite of Kuzbass deposit was used. Fuel choice is associated with the fact that anthracite has a very little amount of volatiles. This fact is favorable for experiments because in this case volatiles don't affect the combustion process.

The size of the particles used in this experimental study doesn't exceed 80 microns. The mass of the sample is 25 mg.

**Experiment description**

The experimental data were obtained using thermo-gravimetric analysis (TG). The experiments were performed on the NETZSCH Jupiter analyzer. During the experiments the samples were exposed to heating at different heating rates, namely: 5, 20, 30 °C/min (room temperature) to 1300 °C. The heating atmosphere was air.

**Results and discussion**

The main equation in chemical kinetics is Arrhenius equation, which associates reaction speed with kinetic parameters [3]:

$$\frac{d\alpha}{dt} = Aexp\left[-\frac{E}{RT}\right]f(\alpha),$$

α – conversion;

t - time ;

A – pre-exponential factor;

E – activation energy;

R – gas constant;

T – absolute temperature;

f(a) – function depending only on the conversion level.

The conversion level is numerically equal to the proportion of the product which has already reacted. This conversion level can be calculated as follows:

$$\alpha = \frac{m_i - m}{m_i - m_f},$$

$m_i$ – initial mass;

$m_f$ – final mass;

m – current mass.

Direct application of this equation for defining the activation energy leads to some significant errors, because the precise definition of the values dα/dt is complicated. Thus, there are different approximate solutions of Arrhenius equation for obtaining more accurate results. When applying these methods the calculation of the value dα/dt is not required. One of these methods, used in this work is Starink method:

$$ln\left[\frac{\beta}{T^{1,92}}\right] = Const - 1,0008\frac{E}{RT},$$

β – heating rate;

Const – constant.

To obtain the activation energy applying this method it is necessary to find temperatures of samples at fixed conversion level. Thus, constructing a dependence diagram of $\ln(\beta/T^{1,92})$ on 1/T the value of the activation energy can be obtained by the slope of the approximation curve.

The experimental results are shown in Figure 1. This diagram shows that there isn't any drying stage in the considered process, because the amount of water in anthracite is very low. The combustion process starts at the temperature about 400 °C at any heating rate, but the final temperature depends on the heating rate and varies from 700 to 1300 °C.

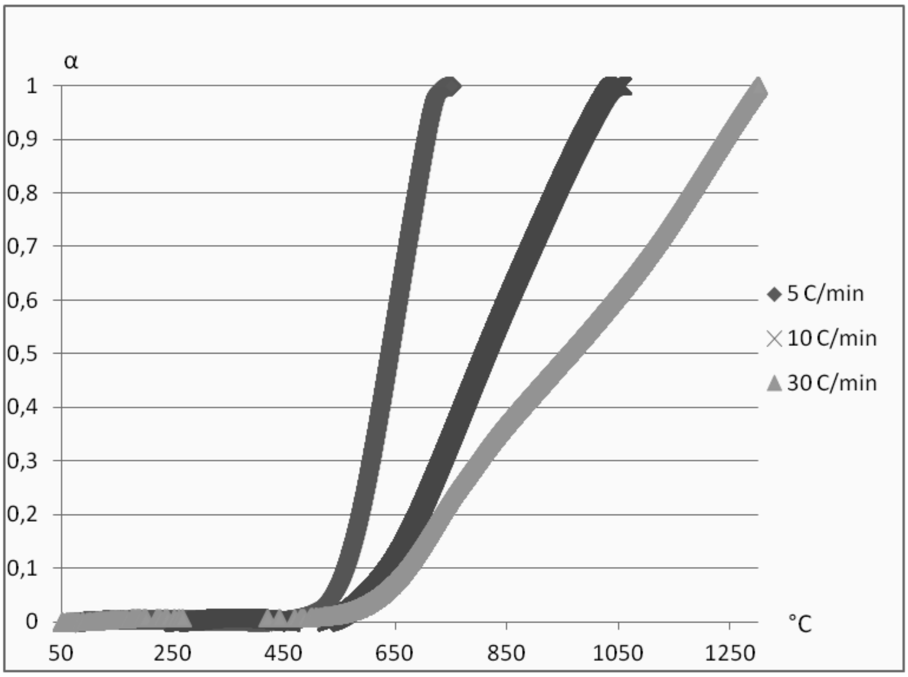


Fig. 1. Dependence of conversion on temperature

Dependence of reaction speed on temperature is shown in Figure 2. This diagram shows that the maximum of reaction speed has the temperature about 600-700 °C. With the increase of heating rate the curve stretches and there is the second maximum of the reaction speed at the temperature about 1200 °C, which is a clear evidence of several parallel reactions by anthracite combustion.

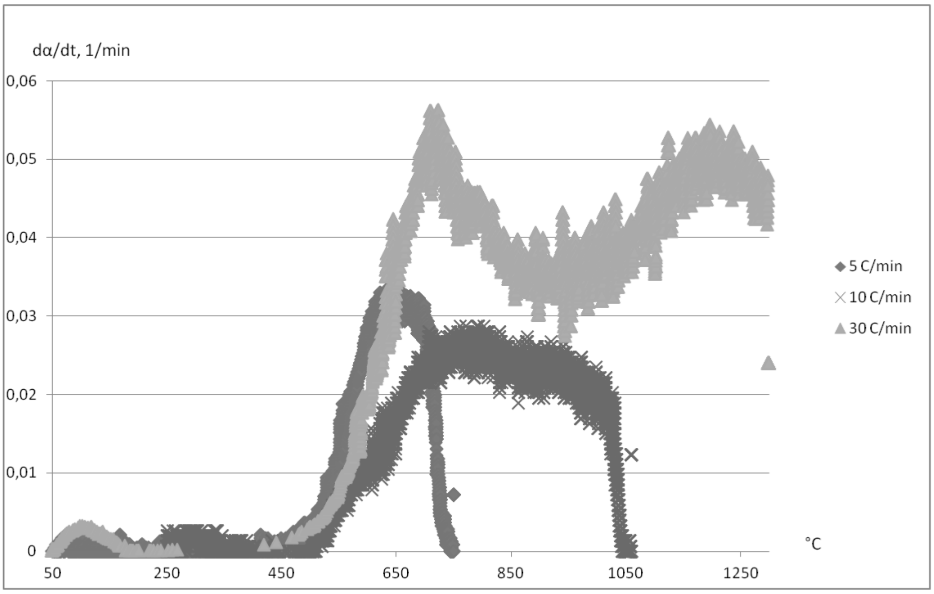

Fig. 2. Dependence of reaction speed on temperature

Dependence of the activation energy on conversion level is shown in Figure 3. As we can see in this figure the activation energy decreases abruptly with the increase of conversion level and varies from 17 to 86 kJ/mol. This dependence is well expressed by the approximation equation:

$$E=-97{,}037\cdot\alpha^3+283{,}62\,\alpha^2-281{,}08\,\alpha+111{,}61,\ \text{kJ/mol}.$$

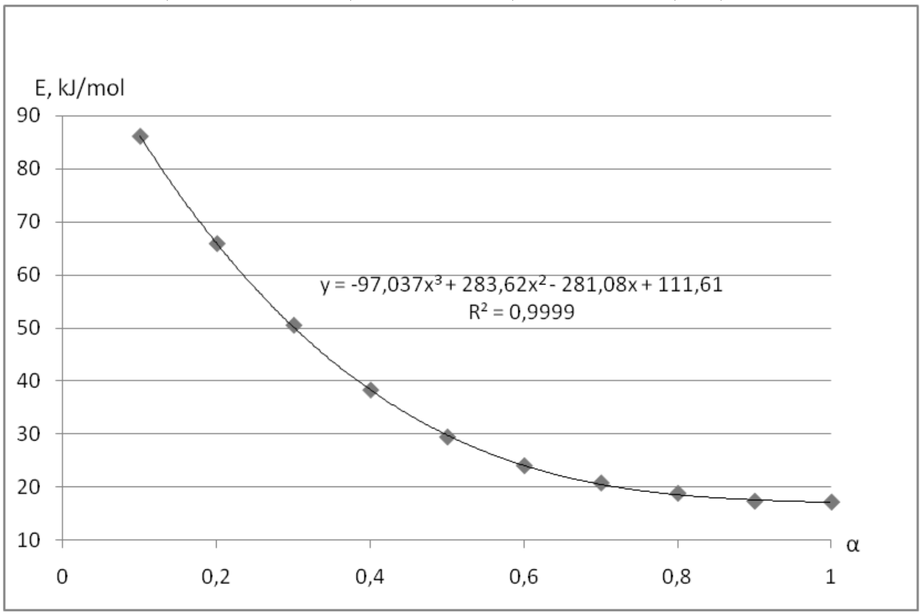

Fig. 3. Dependence of activation energy on conversion.

**Conclusion**

As a result of experimental study the values of activation energy were obtained for anthracite combustion in air. The values of the activation energy are within the range from 17 to 86 kJ/mol and decrease sharply with the increase of the conversion level. The results also have shown that anthracite combustion process is a complex process consisting of several parallel reactions, making the definition of other kinetic parameters very problematic. To overcome this difficulty it is necessary to continue the further experimental research of coal combustion. The results can be useful for modeling the combustion processes for anthracite and other types of coal.

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## LIFE CYCLE OF NUCLEAR POWER PLANTS

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Nuclear power plants like any living creature has a life cycle, which includes several stages, as choosing the location for building, designing, the process of building, running and shutting down of NPP.

The first stage includes safety precautions for the environment. The chosen location has to satisfy several conditions, such as

- Nuclear power plant should be built only where the ground cannot be used in agriculture.
- Near the chosen place, there should be the source of water, as nuclear power plant requires great amounts of water for cooling.
- The ground is to be solid enough to withstand the building such huge construction, and so on.

The second stage is designing of nuclear power plant, which includes the designing the power of reactors.

The designing consists of several steps:

The first step is completion of product requirements document, the next step is calculation of project power, the amount of reactors and so on. Then, the company makes technical drawing of NPP, which includes all components of planning project.

After that, the government should confirm the plan and then the next stage starts.