

## Optimization of hydrocarbon fuels combustion variable composition in thermal power plants

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**Abstract.** It is known that associated petroleum gas and refinery waste can be used as fuel in thermal power plants. However, random changes in the composition of such fuels cause instability of the combustion process. This article explores the burning of hydrocarbon fuel in the case of long continuous change of its specific heat of combustion. The results of analysis were used to develop a technique of optimizing the combustion process, ensuring complete combustion of the fuel and its minimum flow.

### 1. Introduction

It is known [1] that the optimization of the associated petroleum gas (APG below) and wastes of petrochemical plants combustion [2,3] having an unstable structure, that a complex problem. This is due to the fact that changes in the composition and the specific heat of fuel combustion have a random character. This causes instability of the thermal regime of power plants, such as boilers and other devices [4].

The aim of this work – is development of a technique to optimize APG combustion in the boilers in a case of long continuous changes in the specific heat of combustion.

It is assumed that initially the specific heat of combustion of fuel is constant, burning - optimal, that is, the fuel burns completely, and the flow rate of fuel is minimal for a given thermal power production. At some point, the specific heat of combustion of fuel begins to continuously increase or decrease. The dependence of the specific heat of combustion of fuel on the time is represented by a series of small steps. This approach results in [5] can be used.

### 2. Physical justification of technique

Reducing the output temperature of the coolant at a constant flow of fuel and air means that the reduction of the specific heat of combustion of fuel was began. Since, there was an excess of air is necessary to begin increasing the fuel flow rate, gradually increasing the rate of change. For example, during the first minute of 1% relative to the initial value, the second minute - 2% of the third minute - 3%, etc. The amount of completely burning fuels and emissions of heat increases, which compensates for heat losses due to the decrease of the specific heat of combustion of fuel. When the rate of increase in the fuel flow exceeds the rate of decrease in the specific heat of combustion, growth of output coolant temperature begins. Eventually the outlet temperature of the coolant reaches the initial value. At this point, a complete combustion and optimum stoichiometric air / fuel ratio is achieved. A further



increase in fuel flow results in its unburnt [6] and does not change the coolant temperature at the outlet of heat exchanger. It is necessary to stop the fuel flow increase. Because of the continuing decrease in the specific heat of the combustion temperature of the coolant at the outlet of the heat exchanger will start gradually decreasing. As soon as the coolant temperature decrease to a predetermined reference value you need to start again increase the fuel flow. The increase in fuel flow compensates for the reduced rate of heat release. As a result, the coolant temperature is increased again to the initial value. This correction process of the fuel flow periodically repeated during the entire time of reducing the specific heat of combustion of fuel.

If during the period of constant fuel and air flow output value of the coolant temperature does not drop to the reference value, then reduction of the specific heat of combustion completed, and disappeared reason for the decrease in temperature of the coolant at the outlet of the heat exchanger. However, in the future permanence of the coolant temperature at the outlet of the heat exchanger does not provide unambiguous information on the combustion process. This result corresponds to a constant calorific value and the case where it begins to rise.

Increased specific heat of combustion at constant flow of fuel and air leads to incomplete combustion of fuel due to a shortage of air. The increase in heat generation due to the increase of the specific heat of combustion is compensated by its (fuel) underburning, i.e. heat generation and the resulting cooled heat remain constant. As a result, the coolant temperature at the outlet of the heat exchanger is not changed.

It is necessary to reduce the fuel flow to a certain reference value relative the initial value. In the case of constant specific heat of combustion of fuel and constant air flow there is an excess air ( $\alpha > 1$ ). This leads to a decrease in the coolant temperature at the outlet of heat exchanger. In this case, it is necessary return to the previous value of the fuel flow by restoring the optimal combustion process. This control process optimal combustion process it is necessary repeated periodically.

In the second case, after the reduction the fuel flow with increasing calorific value at constant air flow rate of heat increase due to the increase of the specific heat of combustion is compensated by its underburning. The temperature of the coolant at the outlet of the heat exchanger is not changed.

To eliminate the growing underburning it is necessary to start reduction fuel flow, gradually increasing the rate of change. Air flow rate is not changed. Over time, the rate of reduction the fuel flow exceeds the rate of increase of the specific heat of combustion. As a result, the coolant temperature at the outlet of the heat exchanger is reduced because of an excess of air caused by the reduction in the fuel flow [6]. When the temperature of the coolant at the outlet of the heat exchanger drops to a predetermined reference value, it is necessary to stop the reduction of fuel consumption.

Because of the continuing increase in the specific heat of the combustion temperature of the coolant at the outlet of the heat exchanger will rise to the initial value. After that re-appear underburning of fuel and it is necessary to reduce fuel flow rate again, without changing the air flow rate. Further, the periods of constant and reduces fuel consumption follow each other at all times of increase the specific heat.

If during the constant flow of fuel and air temperature at the outlet of the heat exchanger does not reach the initial value, the increase of the specific heat of combustion of fuel is completed. By inertia outlet temperature of the coolant rises to an initial value and remains constant. This means that the specific heat of the combustion was stabilized. Combustion process is stoichiometric.

### 3. Conclusion

So, the method of optimizing the combustion of APG and other fuels to the long continually changing specific heat of combustion is developed. Her summary of the following:

1. In the case of long continuous decrease of the specific heat of combustion of fuel at a predetermined reference value, it is necessary to start an increase the fuel flow, gradually increasing the rate of change, without changing the air flow rate. If you exceed the rate of increase in fuel consumption over the rate of reducing the specific heat of combustion is the initial value of the coolant temperature, stabilize the fuel flow, and when the temperature of the coolant at the outlet of the heat

exchanger stops declining, while remaining within the accuracy of measurement, complete the optimization of combustion process.

2. The increase in the specific heat of combustion of fuel is determined by periodic control reducing of the fuel flow. When you fixate a long continuous increase of the specific heat of combustion of fuel at a predetermined reference value, it is necessary start to reduce fuel flow rate, gradually increasing the rate of change, without changing the air flow rate. When the temperature of the coolant at the outlet of the heat exchanger is reduced because of an excess of air it is necessary to stop to reduce fuel consumption. If the coolant temperature at the outlet of the heat exchanger reaches the initial value it is necessary to begin to lower fuel flow again. If the coolant temperature does not reach the initial value it is necessary to complete the optimization process.

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