The analysis of efficiency of a power technological complex on processing of low-quality coals

S.A.Semenov, L.F. Gutchinskiy, I.O. Slobodchikov

Article is devoted research of plants of thermooxidizing pyrolysis of coals with reference to systems preliminary preparation of fuel power stations, and also technical and economic optimisation of regime parametres of power technological processings of Kansko-Achinsk coals with manufacture to the consumer pure the energy carrier by means of developed mathematical model of plants of pyrolysis.

Keywords: **mathematical model, kansko-Achinsk coal, power technological processing, optimisation**

1. INTRODUCTION

For research of plants of pyrolysis low-quality coals authors develop mathematical model of plants of pyrolysis (MOPP). It includes calculation blocks of heat-transfer properties of initial substances and pyrolysis products, the block of processing of experimental data, and also blocks of calculation of power and economic indicators. In MOPP calculation of basic elements of the technological scheme is provided: the block of fuel preparation, the reactor of pyrolysis, the boiler, the block of processing of products of pyrolysis, the steam-turbine plant, etc. All blocks MOPP are realised in the MathCAD.

By means of MOPP by authors technologies of thermooxidizing pyrolysis in system preliminary preparation of fuel of a Thermal power plant (PFTP) and as a part of a power technological complex (PTC) are investigated. As the device for realisation of process of pyrolysis the autothermal reactor of cyclonic type (processing temperature - 700-900^{O}C is accepted; productivity on initial fuel – $100 \cdot 10^3$ kg/h).

2. RESEARCH OF EFFICIENCY OF THERMOOXIDIZING PYROLYSIS

2.1. Application of thermooxidizing pyrolysis in system preliminary preparation of fuel

Calculations of installation PFTP were spent with use of the equations of regress received as a result of processing of experimental data of thermooxidizing pyrolysis of Kansko-Achinsk coals (KAC) [1].

Exits of products of pyrolysis are functions of temperature level of process (1-3). Dependence of an exit of gaseous products of pyrolysis is function of the expense of air in a reactor (4).

Exits of products of pyrolysis – Fig.1:

$$G_{ПК} = -806{,}406 \cdot t_П^2 + 4{,}76 \cdot t_П - 3{,}73 \cdot 10^{-3}, \quad (1)$$

$$G_Г = 2531{,}77 \cdot t_П^2 - 7{,}32 \cdot t_П + 6{,}16 \cdot 10^{-3}, \quad (2)$$

$$G_{СМ} = 353{,}33 \cdot t_П^2 - 0{,}59 \cdot t_П + 2{,}18 \cdot 10^{-4}. \quad (3)$$

where $G_{ПК}$, $G_Г$, $G_{СМ}$ – leaving the reactor of pyrolysis accordingly quantity of semicoke, pitch and gas, kg (м^3) / kg d.c. (d.c. - dry coal); $t_п$ – temperature at which pyrolysis, was spent.

Exit of gaseous products of pyrolysis –Fig.2:

$$V_Г = 4.417 \cdot 10^4 \cdot V_B^{1.066 \cdot 10^{-5}} - 4{,}416 \cdot 10^4 \quad (4)$$

where $V_Г$ – exit of gaseous products of pyrolysis, м^3/kg d.c.; V_B – expense of air in a reactor, м^3/kg d.c.

With application MOPP reactor of pyrolysis characteristics are calculated, and also power efficiency of application of pyrolysis in system Preliminary preparation of fuel is estimated. The plant Efficiency was defined taking into account efficiency of manufacture brought from the outside of the electric power and has made about 31 %. Despite decrease in power overall performance PFTP in comparison with direct burning of coal, application of the given technology allows to get essential enough advantages: operational and ecological characteristics of boilers improve, reliability of their work raises, decrease in capital and operational expenses is observed.

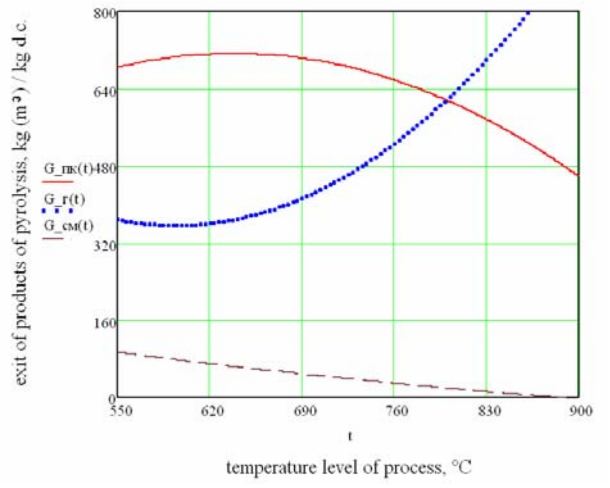

Fig. 1. Dependence of an exit of products of pyrolysis on temperature level of process

2.2. Integrated technical and economic optimization of regime parameters of head process of power technological processing of Kansko-Achinsk coals

With reference to PTC, releasing to consumers pure energy carriers and chemical production, complex optimisation of regime parametres of process of thermooxidizing pyrolysis of brown kansko-Achinsk coals was spent. The estimation of efficiency PTC was spent taking into account identical power and effect at the consumer.

Complex optimisation of regime parametres (temperature of process of thermooxidizing pyrolysis KAC, temperature of a warming up of the firm heat-carrier) is carried out by goal-function minimisation in which quality the resulted expenses of the system consisting from power technological block are chosen, condensing plant with direct burning of Kansko-Achinsk coals and coke chemical plant on which stone Kuznetsk coals with manufactured the gas, pitch and crude benzene. Thus conditions should be observed.

$$\left(\frac{\partial З сист}{\partial t_{TT}}\right) t_n = 0; \left(\frac{\partial З сист}{\partial t_n}\right) t_{TT} = 0; \qquad (5)$$

Where Зсист - a variable part of the resulted expenses in system.

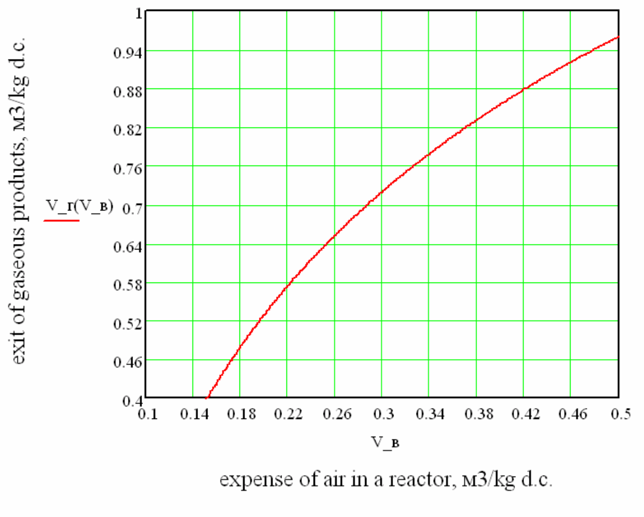

Fig. 2. Dependence of an exit of gaseous products of pyrolysis is function of the expense of air in a reactor

At change of regime parametres the assortment of production received on power technological plant over a wide range changes, expenses of the electric power, thermal energy and auxiliary materials for own needs power technological plant, and, as result, manufacture to consumers of electric energy, gas and valuable chemical products over a wide range changes. Necessity of maintenance of identical power and industrial effect in any compared variant calls introduction of closing power installations and chemical manufactures the consumer. As closing power installation the power station with direct burning of the brown Kansko-Achinsk coals, closing chemical manufacture - coke chemical plant.

Expenses in system at identical power effect and level of manufacture of target production taking into account maintenance of set reliability of power supply and maintenance of nature protection actions will be expressed by a dependence

$$З_{сист} = З_{ЭТБ} + З_{КЭС} + З_{КХЗ} + З_{рез} \ , \qquad (6)$$

Where $З_{ЭТБ}$ - the resulted expenses for manufacture of electric energy and chemical products in power technological plant, rbl./year;

$\Delta З_{КЭС}$ - the resulted expenses for development of the set quantity of the electric power for the power station burning Kansko-Achinsk coal, rbl./year $\Delta З_{КХЗ}$ - expenses for manufacture of gas and chemical production for coke chemical plant taking into account consumer properties of products, rbl./year;; $\Delta З_{рез}$ - expenses in reserve power installations, rbl./year.

Approximation of experimental and settlement data has allowed to receive dependences of the resulted expenses in system from regime parametres:

From temperature of a warming up of the firm heat-carrier - a Fig. 3

$$for\ t_n = 700\,^0C\ \ З_{cucm} = -1{,}82 \cdot 10^{-6} \cdot t_{TT}^2 + +3{,}478 \cdot t_{TT} + 39{,}457; \quad (7)$$

$$for\ t_n = 750\,^0C\ \ З_{cucm} = -8{,}794 \cdot 10^{-6} \cdot t_{TT}^2 + +0{,}018 \cdot t_{TT} + 30{,}998; \quad (8)$$

$$for\ t_n = 800\,^0C\ З_{cucm} = -1{,}115 \cdot 10^{-5} \cdot t_{TT}^2 + +0{,}024 \cdot t_{TT} + 25{,}128; \quad (9)$$

$$for\ t_n = 850\,^0C\ \ З_{cucm} = 6{,}21 \cdot 10^{-8} \cdot t_{TT}^3 - 2{,}176 \cdot 10^{-4} \cdot t_{TT}^2 + 0{,}255 \cdot t_{TT} - 63{,}042; \quad (10)$$

From temperature level of process of pyrolysis – a Fig. 4:

$$for\ t_{TT} = 950\,^0C\ З_{cucm} = 1{,}078 \cdot 10^{-4} \cdot t_n^2 - 0{,}202 \cdot t_n + 129{,}556; \quad (11)$$

$$for\ t_{TT} = 1000\,^0C\ \ З_{cucm} = 7{,}719 \cdot 10^{-5} \cdot t_n^2 - 0{,}150 \cdot t_n + 108{,}512; \quad (12)$$

$$for\ t_{TT} = 1050\,^0C\ З_{cucm} = 7{,}531 \cdot 10^{-5} \cdot t_n^2 - 0{,}145 \cdot t_n + 105{,}848; \quad (13)$$

The analysis of dependences (7) - (13) has shown, that change of temperature level of process of pyrolysis influences size of the resulted expenses in system, than temperature of the firm heat-carrier more strongly. In the set interval of temperatures of process of oxidising pyrolysis t_n = 700-850°C the minimum of the resulted expenses in system is necessary on a mode with parametres t_n =850°C and t_{TT} =950°C. Increase of size $З_{сист}$ at increase in temperature of a warming up of the heat-carrier is called by increase in expenses at the power technological block, connected with necessity of decrease of thermal losses. Decrease in the resulted expenses of system at increase of temperature level of process of pyrolysis speaks that manufacture of target chemical products from the power technological block raises, more economic in comparison with a coke chemical plant. At temperature reduction, the coke chemical plant should increase manufacture of gas, pitch and crude benzene to compensate insufficient manufacture of chemical production.. The cost price of these products above, than at the products made from a power technological complex. It leads to increase of the resulted expenses in system.

The regime Parameters received by technical and economic optimisation will well be coordinated with the results of the thermodynamic optimisation received under earlier developed recommendations. [2]

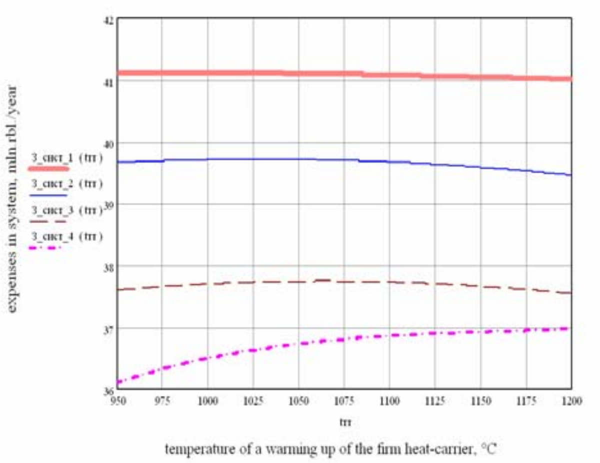

Fig. 3. Dependence of the resulted expenses in system from temperature of a warming up of the firm heat-carrier t_{TT}

3. THE CONCLUSION

By means of mathematical model of installations of pyrolysis developed by authors the analysis of efficiency of application of technology of thermooxidizing pyrolysis of bad quality coals in system of **preliminary preparation of fuel power stations** is carried out, and also technical and economic optimisation of regime parametres of the given process in structure of power technological block is spent. Reactor characteristics are calculated and power efficiency of application of pyrolysis in system of **preliminary preparation of fuel** is estimated. The installation Efficiency has appeared low and has made about 31 %, but not looking at decrease in power overall performance PFTP in comparison with direct burning of coal, application of the given technology allows to get essential enough advantages: operational and ecological characteristics boilers improve, reliability of their work raises, decrease in capital and operational expenses is observed. At research power technological block authors receive dependences of the resulted expenses in the system consisting from power technological block , power plant with direct burning of Kansko-Achinsk coals and chemical coke factory, from such regime parametres as temperature level of process of pyrolysis, and also temperature of a warming up of the firm heat-carrier.

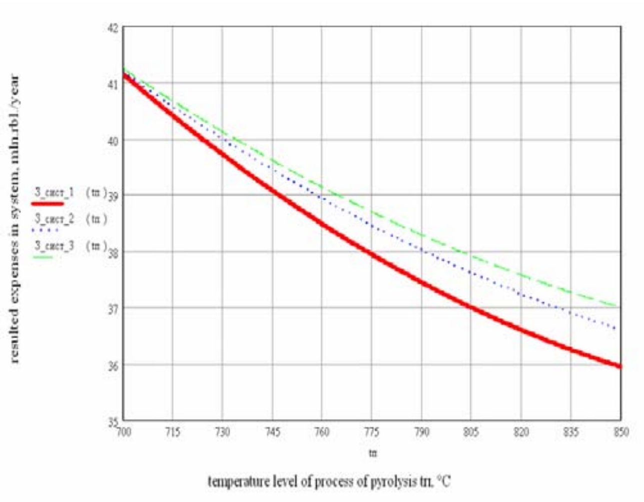

Fig. 4. Dependence of the resulted expenses in system from temperature level of process of pyrolysis $t_п$

4. THE LITERATURE

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5. DATA ON AUTHORS

Semenov Sergey - Dr.Sci.Tech., the professor managing chair «Industrial power system», «Bratsk state university».

Gutchinskiy Leonid - The senior teacher of chair «Industrial power system», «Bratsk state university».

Slobodchikov Ilya – The post-graduate student of chair «Industrial power system»,«Bratsk state university».