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Energy-metallurgical complex based on the spray–emulsion reactor

This article describes how to use the energy from the secondary metallurgical unit of spray-type emulsion. The physical heat is used in the recovery boiler and steam is drawn into the steam turbine. Then it is fed, through the condenser and heat exchanger into the central heating unit for the use of thermal energy for various purposes. The rest of heat after gas treatment is applied to the gas turbine unit, where the generator produces electricity that is used in oxygen units. Oxygen compressor located on the shaft of the gas turbine is fed into the SER-type metallurgical reactor. Use of oxygen in the steel unit allows you to get rid of the nitrogen in the flue gases and gas-cleaning system to simplify and improve the environment by eliminating nitrogen oxides.

The most effective option is recovery of chemical energy in the gas reformer to produce energy or synthesis gas. In this case, you can get completely smoke-free process, because exhaust gases (smoke) by passing these gases through the bars with the red-hot coke and steam injection gas is converted in high or even in synthesis gas that is suitable for clean motor fuel, for example, dimethyl ether.

Keywords: *energy-metallurgical complex, spray-emulsion reactor, desulphurization, catalytic synthesis, heat utilization.*

The basis of the energy-metallurgical complex is self-organizing spray-emulsion metallurgical reactor (SER) [1 - 3], the mechanism of its operating is represented as follows (Figure 1).

Fine ore charge, consisting of a mixture of metal oxides and solid wastes, is effectively dispersed in the reaction chamber 6. It leads to creation of gas suspension with a volume fraction of gas 0.99. Due to the critical effect, used two-phase fluid flow is generated in aerodynamically lockable connective channel 7 and in combination with feedback on gas content (by changing the conditions of chemical reactions). Therefore, it is possible to create stationary conditions of oscillatory regime (self-organizing oscillating reactor). Creation of the high potential for pressure and total isolation from the atmosphere of the process in the oscillating reactor 6 allows you to push products through all the reactions, This reactor is a major technological device of energy utilization without the use of induced-draft fan. It also uses the results of research work directed on expansion of reaction gases, that have not been yet implemented in any of the known and operating metallurgical units.

The second important feature of SER is the aggregate supply in the lower columns of refining sump 9 prepared in the first reactor (reactor-oscillator) of the working mixture. In this case, the reduction reaction of iron and post-combustion reactions of solid and gaseous fuels

$(FeO) + C_{sp} = [Fe] + CO$
$(FeO) + CO = [Fe] + CO_2$,
$C_{sp} + 0{,}5O_2 = CO$
$CO + 0{,}5O_2 = CO_2$
$C_{sp} + CO_2 = 2CO$

occur within the foam layer of high gas-slag-metal emulsion. Thus, in this SER aggregate, the conditions of deeper use of the energy source of fuel are depended on the possibility of burning it in an enclosed space and pushing it through all components of the unit and heat-utilizing devices using pressure generated by the reactor-oscillator 6. The scheme of secondary energy use for the above-discussed SER metallurgical unit is shown on figure 2. The main components of this scheme are the following:

– boiler-heat exchanger 4, steam turbine 5;

– boilers-heat exchanger, a group of cyclones 9, gas turbine 10, drying of raw materials 14, waste low potential energy 15 and 16;

– reformer flue gases 17, catalytic synthesis 18 and then the engine fuel.

First of all, it should be noted that the steel itself 1 represents a substantially boiler. Instead of refractory masonry cooling of the scull is used and the unit is held on the frame of the twisted-cooled tubes (figure 3), which utilized thermal energy supplied to the central heating unit 3 as a tank with water having temperature of 95°C.

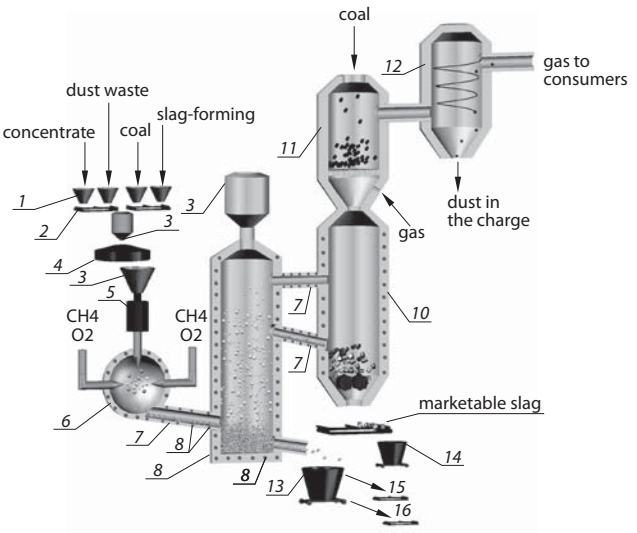

Fig. 1. Self-organizing spray-emulsion reactor – SER
1 **– feed bin;** ***2*** **– feeders;** *3* **–** ***dispensers;*** ***4*** **– mixer;** ***5*** **– screw feeder;** ***6*** **– SER;** ***7*** **– connecting channels;** ***8*** **– cooling system scull;** ***9*** **– refining sump;** ***10*** **– slag granulator;** ***11*** **– fluidized-bed apparatus;** ***12*** **– cyclone;** ***13*** **– receiving ladle or induction furnace;** ***14*** **– hopper for receiving commodity slag;** ***15*** **– special line for casting;** ***16*** **– bottler.**

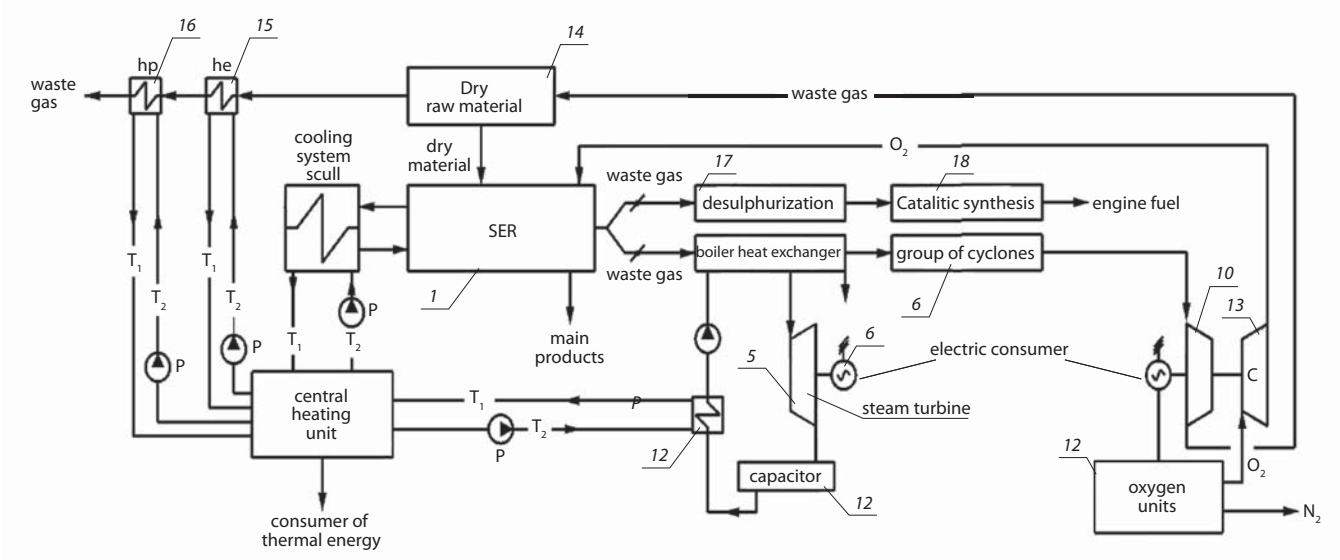

Fig. 2. Variants of energy-metallurgical complex on the basis of SER reactor hp – heat pump; he – heat exchanger; P – pump; C – compressor; T1, T2 – flow and return highway.

The energy of the exhaust gases can be used in the following areas.The physical heat is used in boiler heat exchanger 4, then the steam is drawn to the steam turbine 5, where the generator 6 is installed. The physical heat is fed through the capacitor 7 and heat exchanger 8 to a central heating unit 3 for the use of thermal energy for various purposes. The temperature at this stage is reduced from 1650 to 800°C. The rest of the heat after the gas treatment in cyclones 9 is served in gas turbine power unit 10, where the generator 11 produces electricity used in oxygen units 12. Oxygen compressor 13, located on the shaft of the gas turbine 10 is fed into a steel unit 1.

Use of oxygen in the steel unit allows you to get rid of the nitrogen in the flue gases and gas-cleaning system to simplify and improve the environment by eliminating nitrogen oxides. Product nitrogen, in turn, is used for technological purposes. The temperature of gases in a gas turbine is reduced from 800°C to 200°C-300°C. Gas is fed into the drying unit 14 where its temperature can be lowered to 50°C using a heat exchanger 15; it is also used for production of commercial water. The final step is a heat pump that uses heat exchanger 16 with low-potential heat from 50°C to 20°C.

Thus, due to increased pressure in order to complete the closure process in a processing unit and in the considered technological chain of heat-utilizing devices, almost all physical temperature of heat capacity of combustion products decreases from 1650°C to 20°C and their chemical potential is used in various heat-utilizing devices.

If all the heat used for heating of metal and slag is considered as a useful but used (in principle, it can be disposed of, and also heat the cooling of metal and slag) in this scheme, the use of energy initial fuel, charge materials and chemical reactions can be achieved 90%.

The most effective option is the chemical regeneration of energy in the gas reformer 17 to produce energy or synthesis gas. In this case, you can get completely smoke-free process, because the exhaust gases (smoke) by passing them through the bars with the red-hot coke and steam injection gas is converted into high or even in synthesis gas is suitable for clean motor fuel, for example, dimethyl ether. The temperature of the combustion products is reduced, for example, 1650°C to 700-800°C, then there is a natural heat is converted into chemical energy with more caloric gas. Thus, at this stage all physical and chemical energy used by all smoke.

It is interesting, if there is combination of the SER reactor with steam boilers and electric heat or boilers beyond the scope of this scheme. In this case, eliminating of the need in construction of gas purification and boiler waste heat is occurred and waste gases are added in SER reactor to the main pulverized coal. At the same time, plant ash contains 8-12% (sometimes more) of iron oxides in a convenient notation for the magnetic modification of enrichment. Ashes obtained in this fraction contain more than 50% of iron oxide and can be used as raw material for production of iron in the SER unit.

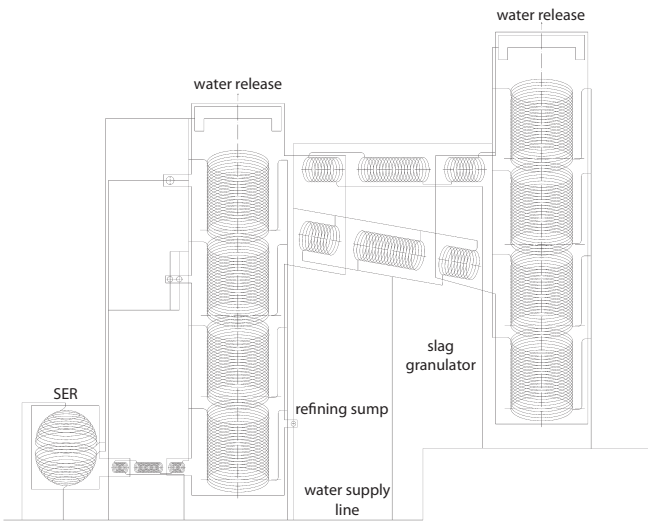

Fig. 3. System for scull cooling in SER reactor

Thus, using the above ideas and principles, we have created a well-managed, eco-friendly and, in fact, a universal steel (and under certain supplements, even energy-metallurgical) unit with a specific volume 10-15 times smaller than those known in the world, and with considerable decrease of energy (approximately by 1.5 times) and capital expenses (2 – 3 times).

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