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METHOD FOR REDUCING THE HEAT CARRIER FLOW RATE FOR SMELTING BASALT

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Abstract:
This article discusses ways to reduce energy consumption in smelting and basalt casting processes. Also proposed are methods for reducing the melting time, increasing the efficiency of the furnace, reducing the gas consumption and reducing the operating costs of basalt processing.

Keywords: Basalt, electric arc melting, energy carrier, superthin fibre, filler, heat value, sound permeability, moisture resistance.

This article presents the main results of the improved smelting process with the introduction of energy-saving mixtures of the gas-air environment that make production and processing of basalt very profitable.

The problems of energy saving, protection of the environment and reduction of metal consumption have given the construction industry a number of urgent tasks, among them the creation of new insulating and structural materials. Such materials include basalt fibres and products of them in the form of cotton wool, mats, plates, shells, rovings, tissues, nets and plastics with a number of unique properties: minimum heat and sound conductivity, ecological cleanliness, fire resistance, Acids, alkalis, moisture resistance and durability [1].

Basalt fiber has great potential to become the next generation of material. The total annual average growth in the global market for basalt fibres is projected to be 13.1 per cent over the period 2015 - 2020, due to successful experiences and growing applications in infrastructure projects, the automotive industry and construction.

Modern scientific achievements, combined with engineering ideas, supported by economic analysis and forecasting, make it possible to make fuller use of Uzbekistan's natural wealth. Thus, the Republic owns solid mountain ranges of Tien Shan and the Pamir, in the interior of which are stored millions of cubic cubic meters of basalt - raw materials on a silicon basis in a mixture with aluminium oxides, magnesium, calcium, boron and other metals and minerals.

Geological studies have shown that basalt is a very common product in nature, particularly in Uzbekistan in the form of thousands of cubic kilometres of rock. As a product of tectonic movements, basalt has absorbed many rarely earth metals, including SiO_2 silicon. The natural colour of the basalt varies according to its content.

The processing of natural basalt is traditionally considered to be quite complex, costly and costly.
The basalt fibre consists of a single-component melt of raw material (basalt) and is superior to other fibres in terms of thermal stability, heat and sound insulation properties, vibration resistance and durability. Basalt fibres and basalt fibre-based composites have potential advantages for application in various fields [2].

The high resistance of basalt fibres to high temperatures, acids and especially alkalis is well known. This opens up great prospects for the use of basalt fibres in construction: Reinforcing material for concrete and concrete pavements;

- corrosive and chemical resistant basalt-plastics fittings, profiles, pipes with a strength 2.5 times that of alloyed steels;
- Non-combustible and flammable composites for nuclear and thermal power plants, refineries and chemical plants, firewalls (flame-retardant structures) of high-rise buildings and other responsible industrial facilities, Where the occurrence and spread of fires is prohibited;
- Chemical and wear-resistant coatings, composite materials;
- filters for industrial and household effluent filters, industrial flue filters and dust filters
- dc materials for the automotive industry.

Techno-economic analysis shows that basalt fibres and materials based on them have the preferred price-quality ratio compared to glass fibres. The use of basalt fibres has a special perspective in these industries.

Mankind learned to industrialize (melt) basalt in the 1950s and in the Republic of Uzbekistan in the 1990s. Lithium basalt has an even lower coefficient of friction and the highest degree of wear resistance - 1600 2900 units. comparable to corundum only. However, the use of basalt products has not been widely used (2-3 enterprises have been built producing super-thin and short fibres used for insulation of pipes heat lines, gas pipelines, roof covers and the like).

The problem of promoting basalt as a finished product is not about its properties, but about the cost of fibrous forming devices and furnaces, for example, one set of an installation costs more than $400,000.

In turn, products from basalt are needed by the Republic of Uzbekistan, neighbouring States as well as countries of South-East Asia, Europe and the Americas. They solve many of the problems of the construction automobile, gas, oil, chemical and other industries.

Basalt fibre production is based on four main stages:

- resist pre-processing of basalt spruce (crushing, washing, drying);
- Melting of the basalt crumb in the melting furnace to produce a continuous fibre in the form of a complex filament;
- Moulding of continuous fibres;
- Fibre weaving into fabric or other forms of finished products, depending on the scope of further application

The effect of new technologies is achieved by the modernization of known technologies. Thus, when producing super-thin fibres only four to five years ago, use was made of devices for the preliminary formation of monothreads and their subsequent splitting. Hut later used a slit basalt spill. All these installations were worth considerable sums, due to the inclusion of various devices of expensive metals (one filler cost 6250-360 thousand units). Today the technology of superthin fibers formation in vortex "twisted" flow has been created, wherein splitting basalt is done immediately, and there are no expensive working elements. The device is so reliable in operation that it does not require a high qualification of service personnel.

The strategy is aimed at creating small production units producing a limited range of basalt products, with the introduction of systems with a limited number of operations. This makes it possible to simplify and shorten the line considerably, to save energy and capital.

Therefore, it is necessary to make full use of basalt and to do this it is necessary to change the technology of obtaining it, excluding from the processes expensive working organs, for example, platinum fillers, create separate processes, in which the economically feasible design options must be justified.

In solving the problems and goals, we have investigated materials and structures of basalt spill devices, options of the melting process and formation of the finished product from it.

Modern technologies for changing the state of basalt from solid to liquid use electroarc melting or burning natural gas in a mixture with air. In both cases, the melting process and the subsequent casting of basalt is quite energy-intensive and therefore expensive.

As practice shows, electric arc smelting is very effective for the process of maintaining basalt in a liquid state in the spill processes in the form, say for instantaneous increase of energy potential of molten mass, and it is not efficiently used in the furnace.

The unit cost of electric arc smelting is 20-30% higher than in processes using natural gas in a mixture with air. If energy (including air) is counted as a tool in basalt processing technology, its share in the production capital stock is 55-70%, and the efficiency ratio of the capital stock is 40-45%[3].

It follows that in order to solve the problems of wide-scale development of experience with basalt as a raw material for construction, engineering and local industry, it is necessary to find ways of reducing energy consumption in the processes of smelting and casting basalt products.

In our publications on basalt processing processes and devices, we have shown that it is possible to replace raw fillers with markedly cheap ones based on alloyed steels, proposed to build small predinations directly at the sites of basalt extraction and fragmentation in order to exclude costly transport, customs and other expenses, to organize production of a reduced range of products, for example, to produce slate, or ruberoid, or tiles, etc. However, our proposals are not sufficiently convincing in the light of the role of energy in basalt melting processes, Let’s say we rationalized them, but didn’t bring them to the level of optimum. Therefore, the challenge of energy conservation may be both urgent and urgent, given the issues we have resolved.

It is known that in order to increase the efficiency of the flame of the gas being burned, oxygen is added to it, and the temperature of the flare is raised to 2500-30000C. This is why air is fed into smelters. But air contains only 19-20% oxygen, the rest nitrogen, and other impurities.

In order to determine the influence of the concentration of oxygen in the air on the intensity of the basalt melting process, we used a method comprising elements for controlling the flow of air into the combustible gas and a device for increasing the concentration of oxygen in the air. Using the elements of the control of the air supply to the burn gas flow, we determined the need for the air flow of the burnt gas before its complete combustion, and we obtained oxygen concentrations one at a time, for example during the combustion of 1 m3 of gas and the "calorific value" of the mixture. Furthermore, a given volume of pure oxygen was added to the resultant rational volume of air and the "calorific value" of the gaseous air medium [3] was measured.

Practice requires specific information about the possibilities of the smelter, so our proposed "calorific value" is not the classical definition of the heat emitted (kcal/h), but the operation of the gas-air mixture in converting, For example, 1 kg solid to liquid basalt for a certain time (hour).

For example, when a gas is burned with a minimum supply of air sufficient to sustain the flame, the time needed to melt 1 kg of basalt has practically gone to infinity (heat the sample for 24 hours and no change). The air was added to a volume of 0.7 m3 by 1 m3 of gas, the melting time was 4.8 hours, with a volume of 1.3 m3 of air per 1 m3 of gas, the melting time was reduced to 1.3 hours, 2.0 m3 of air per 1 m3 of gas, and the melting time was 0.75 hours. Increasing the volume of air to 3 m3 leads to unstable gas combustion, loss of flame and dangerous operation.

Oxygen was added to the air flow, taking into account that 1 m3 of gas is burned in the oven for 10 minutes. The experiment continued with an air flow of 1.3 m3 to 1 m3 of gas. They increased the oxygen concentration to 26% in the air, gave a melting time of 0.88 hours, and at concentration of oxygen in the air up to 35%, the melting time decreased to 0.45 hours.

Reduction in melting time means an increase in the efficiency of the kiln, a decrease in gas consumption, and therefore a reduction in operating costs for basalt processing.

To the above we add that in experiments we used electrochemical decomposition of water into gases (hydrogen and oxygen) which are themselves a beautiful combustible mixture. The machine is authorized for serial production and operation by the Uzbek Centre for Standardization and Metrology (TU Uz 64.15364937-01-96), has three degrees of protection and is practically safe in use. The capacity of the gas mixture apparatus is 0.5 l/h, the power consumption is up to 4 kW/h, the water consumption is up to 1 l/h. If necessary, you can order a more efficient machine. Finally, the gases obtained in the apparatus may replace the energy potential of the electric arc welding in the moulds.

Economic calculations show that the improvement of the smelting process with the introduction of energy-saving mixtures of the gaseous air makes the production of basalt highly profitable.

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