Comparative Analysis of the Physical and Chemical Properties of Uzbekistan's Basalts and Ways of Solutions to the Problems of Choice of Raw Processing Directions

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Abstract

This article highlights the common use of petrographic processes in basalt processing. At present, basalt is being processed by liquefaction only. Heat fibers, tiles, cement, fittings, and nets are taken from the basalt. For this reason this article states that the range of products to be purchased is small. And to increase the assortment, it is proved by the fact that basalt basin should not be confined to liquefied processing. Chemical composition of basalt. Depending on the chemical composition of the basalt, the technology of their processing is selected and determined. The article is based on the same principle that the dry method of drying basalt without liquefaction is put forward. Below are the names of products that can be obtained on dry bases processing. This is justified by the fact that it increases the range of basalt products. However, it is advisable to follow two methods of basalt processing in the future. These methods, which are recommended by the authors, have undergone a production trial and received positive assessments; the test report has also been presented.

Keywords: raw materials, dry rock, ore, stocks, basalts, silicate, olive, pyroxene, decomposition, chemical, physical, mechanical, split

1. Introduction

1.1 Introduce the Problem

Currently, basalt products of Uzbekistan are produced mainly by melting. The experience of basalt processing enterprises shows that, in practice, there are practically no standard, established patterns of the influence of any factors on the melting temperature of basalts. It was found that the change in the melting temperature of basalts of different deposits is focused on the chemical and material components of basalts. There are various statements that the processing technology of basalts depends on the chemical composition of the rock. Since basalts have different chemical compositions in different deposits, the technology should also be different. [1].

For example: basalts of the Klyuchevskaya hill and the Hawaiian islands melt at a temperature of 1250 °C - 1400 °C; basalts of the Gavasay deposits at 1300 °C - 1350 °C, Asmansay at 1450 °C, Aydarkul at 1500 °C, Akhangaran at 1200 °C - 1300 °C and Yanovo Valley 1300 °C - 1350 °C, etc. The differences in the melting points of the basalts considered in the five basalt deposits are approximately up to 250 °C.

It is noted that if the melt has a high content of silica (more than 50–51%) or alumina, then it becomes excessively viscous, poorly fills the forms, it is difficult to melt and crystallizes. Oxides of calcium and magnesium, ferrous and oxide iron contribute to lowering the viscosity and improving the crystallization ability of the melts. In the case of a low silica content (between 40 and 50%), basalt melts at a temperature of 1280 °C - 1350 °C, the melt has a low viscosity, which is also bad because it quickly hardens with the formation of a glassy microstructure and cracking upon cooling.

2. Method

By well-known methods, the chemical properties of local basalts were investigated. It was experimentally established that the basalts of the Aydarkul deposit are a rare and finely porphyritic rock with an afyr, allotriomorphic granular structure. They consist, approximately, of an equal number of completely irregular grains of pyroxene and plagioclase. For this reason, the melting point of pyroxene is higher than that of olivine, i.e.
The maximum permissible content of SiO2 in the composition of basalt is experimentally proven is 43.7 ÷ 49.3%, conductivity, the similarity of basalt glass-cast form with quartz glasses is confirmed. According to experts, the high SiO2 content in plagioclase, like pyroxene, contributes to an increase in the melting temperature of basalts, and rocks of the Aydarkulskoye deposit can be attributed to them. The content of basalts (in%): Fe2O3, TiO2, and MgO can also increase the melting temperature. Investigations of the basalts of the Asmansai deposit showed that the composition of the rock includes plagioclase, augite, and secondary minerals: calcite, epidote, zoisite, sphere, chlorite, ore, magnetite, leucoxene, and the structure is hyalopilite and inter-serum. The breed is fine-grained, finely and rarely porphyritic. The presence of augite contributes to the melting of the rock of the Asmansay deposit at temperatures 100 ÷ 200°C lower than that of the Aidarkul basalts, i.e. at temperatures of 1400 ÷ 1450 °C.

In both cases considered, the typical silicate compound formed in the basalt mineral is olivine - (Mg, Fe)2SiO4. The melting point of olivine is in the range of 1200 ÷ 1250 °C. Therefore, manufacturers for the manufacture of basalt fiber materials often use basalts, of which olivine occupies the bulk. An increase in the melting temperature of basalts reduces the casting properties of the melt. An increase in the resistivity of the cast product to external shocks is observed. The content in the composition of basalt MnO2: in the range (0.09 ÷ 0.41)% and FeO in the range (2.6 ÷ 3.9)% Fe2O3 in the range (1.19 ÷ 2.5)% and a low percentage ratio of Al2O3 and TiO2 reduces the conductivity of the basalt casting. Thus, from the point of view of low electrical conductivity, the similarity of basalt glass-cast form with quartz glasses is confirmed.

The maximum permissible SiO2 content in basalt is experimentally proved to be 43.7 ÷ 49.3%, and is recommended as the most optimal option when choosing rock composition [2-4]. With such indicators, the basalts of all three of the considered deposits “Aydarkul”, “Asmansai”, “Akhangaran” and “Gavasai” can be successfully used for the manufacture of heat-insulating fibrous materials (melting temperature of basalts 1350 ÷ 1400 °C).

According to tabular data, it follows that, unlike basalts used for the manufacture of insulators of different potentials, for the manufacture of heat-insulating fibrous materials, basalt rocks will be required, which contain (in%): SiO2 −43 ÷ 47, MgO up to 7, Al2O3 up to 20, CaO up to 10 and (K2O + Na2O) not more than 3.5.

It was established that the content of iron oxides (FeO • Fe2O3) and TiO2 in the composition of basalt does not affect the thermal conductivity of basalt fiber materials. However, it is necessary to take into account the content of MnO2, which determines the viscosity of the jets of liquid basalt that pass through the spinneret device. Basaltes of all three considered deposits possess such properties. Evidence of this is the use of the Aidarkul, Gavasay, and Akhangaran basalts by basalt processing plants. Basaltes of the considered deposits are used exclusively for the manufacture of heat-insulating basalt fiber materials [4-6].

As noted above, an increase in the SiO2 content of basalts by more than 50% contributes to a decrease in viscosity, casting properties of the melt and increases electrical conductivity, but at the same time reduces the hardness and density of the rock itself. The density of the rock decreases, and it becomes more suitable for crushing and grinding.

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The maximum permissible content of SiO2 in the composition of basalt is experimentally proven is 43.7 ÷ 49.3%, and it is recommended as the most optimal option when choosing the composition of the rock [6]. With such indicators, the basalts of all three of the considered deposits “Aydarkul”, “Asmansai”, “Akhangaran” and “Gavasai” can be successfully used for the manufacture of heat-insulating fibrous materials (melting temperature of basalts 1350 ÷ 1400 °C).

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which determines the viscosity of the jets of liquid basalt that pass through the spinneret device. These properties are possessed by basalts of all three considered deposits.

Evidence of this is the use of the Aidarkul, Asmansai, Gavasay, and Akhangaran basalts by basalt processing plants. Basalts of the considered deposits are used exclusively for the manufacture of heat-insulating basalt fiber materials [5]. Table 2 presents data on basalt products that can be produced by heat treatment, i.e., by the petrurgic method, on the basis of melting and by dry processing, without melting.

### Table 1. Comparative regions of the characteristics of the chemical composition of basaltic rocks of different globe

| Component. connection | Klyuchevskoy Hills (Russia) | Hawaiian Islands | Bashkardas - than (Russia) | Yanovoe Valley (Ukraine) | Mikaduxsky (Kazakhstan) | Hawaiat (Uzbekistan) | Asmansay (Uzbekistan) | Aydarkul (Uzbekistan) | Akhangaran (Uzbekistan) |
|-----------------------|-----------------------------|------------------|---------------------------|-------------------------|-------------------------|---------------------|----------------------|----------------------|------------------------|
| SiO2                  | 45.3÷52.4                  | 44.1÷50.3        | 46.7÷51.0                 | 44.2÷50.3               | 44.9÷55.9               | 45.7÷47.05         | 45.7÷53.3            | 43.7÷56.9            | 51.30÷54.9             |
| TiO2                  | 0.62÷0.79                  | 1.4÷3.0          | 0.50÷0.92                 | 1.1÷1.6                 | 0.21÷0.41               | 1.01÷1.05           | 1.18÷1.21            | 1.5÷2.5              | not detected           |
| Al2O3                 | 13.2÷15.3                  | 10.3÷12.9        | 19.2÷20.4                 | 13.2÷15.3              | 17.4÷21.8               | 14.2÷15.7           | 9.2÷10.2             | 8.2÷9.3              | 16.3÷17.2             |
| CaO                   | 6.8÷8.0                    | 8.9÷10.8         | 3.4÷4.5                   | 8.8÷9.0                 | 5.4÷6.2                 | 1.16÷1.39           | 5.6÷8.9              | 4.6÷6.9              | 7.0÷7.2               |
| MgO                   | 8.8÷8.9                    | 6.1÷8.1          | 2.1÷3.7                   | 4.7÷5.1                 | 0.81÷1.6                | 4.8÷5.4             | 1.1÷2.6              | 2.7÷3.8              | 3.2÷4.54              |
| FeO                   | 4.71÷4.75                  | 6.4÷9.5          | 15.6÷18.9                 | 6.6÷7.9                 | 5.2÷11.4                | 1.16÷1.39           | 5.6÷8.9              | 4.6÷6.9              | 7.0÷7.2               |
| Fe2O3                 | 1.8÷3.1                    | 1.2÷1.5          | 12.8÷13.8                 | 2.9÷15.5                | 6.19÷8.96               | 6.9÷7.4             | 2.9÷3.47             | 2.9÷3.0              | 7.2÷9.6               |
| K2O                   | 0.29÷0.86                  | 0.16÷0.46        | 0.81÷0.99                 | 0.55÷0.71               | 0.37÷0.44               | 1.2÷1.4             | 0.21÷0.99            | 0.14÷0.19            | 1.16÷1.72             |
| Na2O                  | 2.0÷2.7                    | 2.1÷2.3          | 4.6÷5.6                   | 2.8÷3.0                 | 1.9÷2.8                 | 2.8÷3.6             | 1.8÷2.6              | 2.8÷3.3              | -                     |
| MgO                   | 0.02÷0.10                   | 0.10÷0.11        | -                         | 0.02÷0.03               | 0.05÷0.07               | -                   | 0.45÷0.73            | -                    | -                     |
| others                | 16.3÷2.1                   | 18.9÷0.66        | 19.0÷0.31                 | 26.95÷0.41              | 7.94÷8.34               | 7.9÷8.3             | 19.03÷0.31           | 26.95÷0.41           | 1.9÷6.8               |

| Melting temp. °C | 1300÷1400 | 1200÷1300 | 1200÷1300 | 1300÷1350 | 1300÷1350 | 1300÷1350 | 1300÷1450 | 1500÷1550 | 1200÷1300 |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|

| Liquidus temperature. °C* | 1250÷1350 | 1150÷1250 | 1350÷1350 | 1250÷1350 | 1250÷1350 | 1250÷1350 | 1250÷1350 | 1250÷1350 | 1250÷1350 |

### Table 2. Comparative characteristics of the chemical composition of basaltic rocks of different regions of the globe

| The main components of the chemical components of basalts | Boundary criteria of physiochemical properties and composition of basalts | the content of chemical components,%, mass Operating temperature, °C | Basalt products, °C | The content of chemical components,%, mass | Dielectric constant ε (8.55x10^-12, k/m^3/N) |
|--------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------------------------|---------------------|------------------------------------------|---------------------------------------------|
| SiO2: 50.3÷60.0                                         | 42.7÷47.3                                                              | 43.7÷49.3                                                          | 4.34                |
| TiO2: 0.63÷1.5                                         | 0.5÷1.5                                                                | 0.8÷1.0                                                            | 86.0                |
| Al2O3: 10.2÷15.0                                       | 14.2÷20.2                                                              | 8.7÷13                                                             | 10.5÷12.0           |
| CaO: 8.4÷13.0                                         | 7.2÷8.4                                                                | 9.4÷12.0                                                           | 3.0                 |
| MgO: 2.7÷4.0                                          | 3.7÷6.0                                                                 | 5.7÷11.6                                                           | 3.2                 |
| FeO: 1.6÷2.9                                          | 2.6÷4.0                                                                | 5.6÷8.9                                                            | 16.0                |
| Fe2O3: 1.19÷2.1                                       | 3.1÷6.3                                                                | 2.9÷3.47                                                           | 11.6                |
| K2O: 0.3÷0.99                                         | 0.2÷0.49                                                               | 0.14÷0.99                                                          | 16.0                |
| Na2O: 1.8÷2.6                                         | 1.30÷2.0                                                               | 1.1÷2.0                                                            | 1.0                 |
| MnO2: 0.09÷0.11                                       | 0.45÷0.73                                                              | 5.48                                                                | -                   |
| P2O5: 6.39                                            | 12.40                                                                  | -                                                                   | -                   |
| Others: 100                                            | 100                                                                    | -                                                                   | -                   |
| Melt. point °C                                        | 1300÷1400 °C                                                          | 1450÷1550 °C                                                       | -                   |
| Melt. point °C                                        | 1300÷1400 °C                                                          | 1450÷1550 °C                                                       | -                   |

**Table 2. Comparative characteristics of the chemical composition of basaltic rocks of different regions of the globe**

- Acid-resistant tiles, refractory and building materials, portland cement
- Heat-insulating basalt wood, building materials, treatment belts and insulation tiles, Portland cement
- Support-higher insulators of different potentials, alkali resistant tiles, fittings, metal substitutes

**Bazalts**
- Aidarkul, Hawaiasi, Asmansai and Akhangaran
- Hawaiasi, Aidarkul, Asmansai
- Asmansai, Aidarkul and Asmansay
As noted above, an increase of more than 50% in the composition of basalts of SiO₂ contributes to a decrease in viscosity, casting properties of the melt and increases electrical conductivity, but at the same time reduces the hardness and density of the rock itself. The density of the rock decreases, and it becomes more suitable for crushing and grinding. The considered basalts from four deposits have a high SiO₂ content in the Aydarkul rocks, in which the SiO₂ content reaches up to 60% and TiO₂ up to 2.5%. It was experimentally revealed that basalts with such a SiO₂ content are difficult to melt and are easily crushed and milled. [7].

3. Results

Thus, it was found that the main factors on which the basalt melting temperature depends are: the percentage of olivine, pyroxene, and plagioclase in the rock, the mineralogical composition of the basalt rock, and the chemical properties of the rock. Basalts that are difficult to melt and require additional heat resources to melt them; also, for such basalts, the SiO₂ content reaches more than 50% are considered to be pipe melting.

The results of theoretical and experimental studies using samples of the considered basalt deposits: Aydarkul, Asmansay, Gavasay and Akhangaran found that all local basalts cannot be processed by heat treatment, that is, by melting. Because, with an increase in the content of basalts, the amount of SiO₂ rock becomes less solid and dense. Such basaltic rocks should be processed by crushing and grinding, excluding melting.

This technical solution allows you to open a new direction for the processing of basalts. This direction is based on dry processing of basalts, which allows you to organize production without the use of the melting method. This technical solution allows the production of new basalt products, which increases the product range and expands the use of basalt products. Such basalt products can be: acid-base resistant tiles, various bricks operating in aggressive environments, refractory bricks for various purposes, Portland cement, etc. This technical solution allows you to open a new direction for the processing of basalts. This direction is based on dry processing of basalts, which allows you to organize production without the use of the melting method. This technical solution allows the production of new basalt products, which increases the product range and expands the use of basalt products.

The two types of basalt products processing directions that we proposed in this article in a single technological chain allow us to further increase the company's labor productivity, minimize technological and energy costs, and increase the product range.

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