ХИМИЧЕСКИЕ ТЕХНОЛОГИИ

МРНТИ 61.01.91

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SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS OF HIGH POROUS CERAMICS BASED ON NATURAL AND TECHNOGENIC RAW MATERIALS

Аннотация. В статье представлены результаты по подбору состава и механохимической обработке (МХО) шихтовых смесей на основе кварца и техногенного сырья (зола – унос, отходы производства автоклавного газобетона) для получения в режиме СВ-синтеза высокотемпературных теплоизоляторов. Предварительная механохимическая обработка компонентов шихты проводилась в присутствии различных углеродсодержащих модификаторов. Установлено оптимальное соотношение компонентов шихтовой смеси и условий МХО для получения СВ-синтезом мезопористого материала с низкой теплопроводностью (0,185±0,228 В/мК) и высоких показателях прочности (до 96 МПа).Данный материал относится к категории огнеупорных систем. Использование отходов различных производств в составе шихты может быть достаточно эффективным при получении тепловых изоляторов.

Ключевые слова: СВС-теплоизоляторы, обработка шихты, механохимическая обработка, кварц, золоунос, газобетон.

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Түйіндеме. Жоғары температуралық жылу оқшаклағыштар ӨЖ-синтез режимінде алу үшін кварц және техногенді (күл, автоклавты өндірістің газобетон қалдығы) негізіндегі шихталық қоспалардың механохимиялық өңдеу (МХӨ) және құрамды таңдау бойынша нәтижелері осы мақалады көрсетілген. Шихта компонеттерін алдын ала механохимиялық өңдеу әр түрлі көміртек құрамды модификаторлар қатысын да жүргізілді. Жоғары беріктік (96 МПА дейін) және төмен жылу өткізгіш (0,185±0,228 В/мК) көрсеткішті мезокеуекті материалды ӨЖ-синтезбен алу үшін МХӨ шарты және компоненттердің шихталық құрамының тиімді қатынасы анықталды. Бұл материал от•атөзімді жүйелер категориясына жатады. Әртүрлі өндіріс қалдықтарын шихта құрамында пайдалану жылуоқшаулағыштар алу кезінде айтарлықтай тиімді болуы мүмкін.

Түйінді сөздер: ӨЖС-жылуоқшаулағыштар, механохимиялық өңдеу, кварц, күл, газобетон.

Abstract. The article presents the result of the selection of the composition and mechanic-chemical treatment (MChT) charge mixtures based on quartz and technogenic (flu cinder, waste of the production of autoclaved aerated concrete) for obtaining self-propagating high-temperature synthesis of high heat insulator. A preliminary mechanic-chemical treatment of components of the charge was held in the presence of various carbon-containing modifiers. The optimal ratio of the components of the charge mixture and conditions of MChT were established for receiving of mesoporous material with low thermal conductivity ((0,185±0,228 V/mK) and high strength (96 MPa) by the SV-mode synthesis. The given material is classified as refractory systems. The use of the waste of various productions, composed in the charge can be quite effective in obtaining thermal insulators.

Key words: Self-propagating high-temperature synthesis thermal insulators, charge treatment, mechanic-chemical treatment, quartz, flu cinder, aerated concrete.

Introduction

For high-temperature thermal isolation the microporous materials on the basis of alluminates and calcium silicate were made by different methods. Fire-resistant mullite heat-insulating boards are quite common [1]. They used for thermal isolation of hot-air-units for blast furnaces, thermal, heating, vertical-sectional, cylindrical and other types of furnaces, soaking pits, heat insulation of ingot head and iron casting and steel and other objects.

The corundum light-weighted products which were obtained by combination of burning addition and chemical pore formation methods have higher factors on fire resistance in comparison with siliceous [2]. An introduction of porous filler material is one of widely applicable methods in industry for imparting to the materials the porous structure. The expanded vermiculite is used as filler material [3, 4], which has low conductivity (0,04-0,12 W/м·K) and highly melting temperature (1240-1430 ^{0}C).

Self-propagating high-temperature synthesis (SHS) is one of most effective methods for creation of high-temperature heat insulators and products on its basis. Particularly, on the basis of SHS technologies the number of multicomponent of refractory composites is developed, that providing the synthesis of mullite structures in combustion wave at formation of fire resistant thermal protection coatings [5, 6]. At temperatures of 1400-1800 ^{0}C in combustion wave the synthesis of new oxide-ceramic structures of mullite type – $3Al_2O_3$ $2SiO_2$; Al_2O_3 SiO_2 is occurred with melting temperature 1820 ^{0}C and more complex high melting compounds such as $2Al_2O_3$ 3SiC, $5Al_2O_3$ $3TiB_2$.

In work [7] the aluminosilicate fire resistant and heat-insulating SHS materials are considered, aluminum and silicon dioxide are the main components of charge, but the corundum, silicon and mullite are the products of SHS-synthesis. The product composition, is formed as the result of synthesis in combustion wave, besides of oxides of high-melting metals can contain the carbides, borides, nitrides, silicides of metals which also belongs to category of high-heat resistance compounds and as consequence improves the physico-chemical, mechanical and working properties of synthesized aluminum silicate materials. Much attention is paid to the corundum –carbide silicone ceramics which is obtained by SHS-synthesis, and combines the properties of corundum and silicon carbide, i.e has strong chemical resistance, resistance to abrasion action, mechanical stability and high fire resistance as well. With the help of SHS method the obtaining of composite materials on the basis of silicon carbide according to reactions, is passing in mixtures of silicon oxide, carbon and metallic aluminium is possible. As initial materials the aluminum powder, quartz sand and soot are used. With the help of thermodynamic analysis it was found that adiabatic temperature of combustion in system Al-SiO_2-C is 1900-2000 ^{0}C. As the part of the study it has been established that phase composition of the material is presented by corundum (α-Al_2O_3) and silicon carbide (SiC), also there are small impurities of mullite and silicon.

At production of high – temperature heat-insulators the key attention is paid to the study of SHS-synthesis process is aiming for obtaining of porous microheterogenetic mixtures of various composition. In work [8] the interaction of mechanisms of local combustion regime and formation of anisotropic macrostructure of interaction products in obtaining of alloy on the basis of Al2O3 was shown. The systems $CaO-SiO_2-Al_2O_3$ for synthesis in SHS regime are of great interest, because they allows to obtain composites that containing the wollastonite, anorthite and helenite. These structural elements provide strength enhancement and thermal resistance of material.

Oxide compounds, including SiO_2, Al_2O_3, CaO, and also Fe_2O_3, MgO, Na_2O and K_2O are the basis of many industrial wastes. The wastes of certain industries are characterized by specified ratio of oxides and in accordance with composition can be used also for synthesis and production of constructional and building materials [9, 10]. For example, the wastes of thermal station (ash-slags, fly ash) represent an advanced raw material for producing of various valuable products, in particular for construction sector, because in their composition there are alumino-silica-calcium compounds. During production there is up to 20 % of wastes is formed. The development of utilization technology for these wastes is the actual economical and ecological task for many industrial regions. They could be used for charge mixtures when producing different materials, including high-temperature heat-insulators, in regime of technological combustion (i.e SHS-synthesis). Mechanochemical treatment is the effective method for preparation of technogenic wastes when using them as full-value raw material at production of composite systems of different assignment [11, 12].

This article presents the results on research of used mineral and industrial raw material, mixture selection and mechanochemical treatment of charge mixtures for production of porous ceramics in SHS regime for high temperature thermal insulators.

1. Materials and investigation methods

Experimental works were carried out with using of quartz sand of Kuskudsky minefield with quartz content – 81,3 %, moreover it has 18,7 % of microcline $K(Si_3Al)O_8$, as well as different elements, which saturating the surface and dissolved in particle volume. In accordance with the spectral analysis results, it contain from 0,1 to 1,0 % of iron magnesium, calcium, natrium which can act as active centers in the process of mechanochemical surface modification. From technogenic wastes as raw components for SHS-charge the fly ash from thermal station – 2 of Almaty city is used as well as wastes of autoclave aerated concrete of LLP «Concrete-Products» of Almaty city which is leading producer of aerated concrete in Kazakhstan. In composition of fly ash there is four phases: the main – X-ray amorphous, quartz and mullite are in equal amount but in small amount the magnetite is presented.

X-ray amorphous phase is generally consists of full microspheres on the basis of silicon dioxide and carbon in the form of soot. Phase composition of aerated concrete is presented: by tobermorite $Ca_5(OH)_2Si_6O16{\cdot}4H_2O$ – 34 %, quartz – SiO_2 – 36,6 %, calcite $CaCO_3$ – 25,9 % and microcline KAlSi3O8 – 3,5 %. Tobermorite- hydrous silicate calcium is formed at reaction of cement with water and plays an important role in the process of concrete producing. Tobermorite forms the crystals of needle structure, which providing the concrete strength.

The mechanochemical treatment of powders was carried out in centrifugal planetary mill «Pulverizet 5» the producer is – FRITSCH with volume of working chamber is 500 mm^3, the rotation rate of platform is 400 round/min, acceleration motion of grinding balls is 40 g, energy power consumption is 1,5 kW/h. At mechanochemical treatment the time for blending and modified mixtures in the form of activated carbon and polystyrene $[\text{-}C_8H_8]n$ are verified.

The choice of carbon and polymer on its basis as modifier was stipulated by the fact that the carbon is surface –active agent during blending of various minerals and effective reducer, particularly the silicon and its oxides. As was shown previously [13], at mechanochemical treatment the polystyrene together with quartz is destroyed till carbon and polymerized at the surface of crushed particles, providing at that the high activity in the process of technological combustion.

The aluminium with brand PA4 was used as reducing material at SHS process. After mechanochemical treatment the mixtures of powders with reducing material were compressed into cylindrical specimemens with diameter 20 mm and with high 20-25 mm during introduction of binding material in quantity of 5 %. The samples were formed at laboratory press with brand «Carver» with a force of 10 tons. SH-synthesis of samples was carried out in muffle furnace with predetermined temperature ~ 900 ^{0}C. The sample temperature was measured during SH-synthesis by pyrometric thermometer with brand «Raytek Raynger 3i» and thermographs of combustion models were build.

After mechanochemical treatment the powder materials were subjected to dispersion, poured density, structural analysis and changes of morphological features of particles with powder composition. The obtained samples as the result of SHS were investigated on density, thermal conductivity, compression strength and phase composition of synthesis products.

2. Results and discussion

As the result of blending the quartz sand in planetary centrifugal mill from 5 to 30 min with ratio of powder mass (Mp) and mass ball (Mb) Mp/Mb = ¼, the poured density of the powder is changing not monotonically (table 1). In initial condition the poured density of quartz powder is 1,25 g/cm^3, and as a consequence of blending its value is decreasing. The minimum values were fixed after 20 minutes of mechanochemical treatment, and it is a reflexion of modification in proportion of particles with different size in quartz powder, and therefore the changing of its packing density. This characteristic is the first clear factor both as structural (dimensional) and morphological changes of powder at mechanochemical treatment.

Table 1

Poured density of quartz powder after mechanochemical treatment

Material, Modificator	Poured density, g/cm^3			
	Activation time, minutes			
	5	10	20	30
SiO_2	1,130	1,100	1,00	1,082
SiO_2 + 5 % C	1,090	0,910	0,88	1,050
SiO_2 + 5 %$[-C_8H_8]n$	1,115	1,070	1,060	1,100

The using of modifying agent during mechanochemical treatment of quartz enhances the strengthening of particle dispergation, this is reflected in a decrease of values of packed density of powder. The changes of this factor largely are observed after 20 minutes of quartz processing with carbon. It is connected both with increasing of powder dispersity and with the presence of carbonic element in powder composition. The using of polystyrene at mechanochemical treatment of quartz increases the packing density of obtained powder composition. During process of materials processing, in mill, except particle breakage the saturation and redistribution of defects by volume of powder particles is occurred. The result is a change of crystallite size of deformed particles.

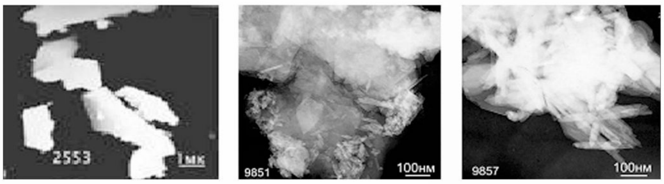
In table 2 there are results on crystallite measurement depending on processing environment of quartz: the time of mechanochemical treatment and introduction of 5 % of modifier into treatable powder. In accordance with presented results the crystallite size in a volume of milled particles is decreased in the course of treatment time. At quartz processing without modificator during 20 minutes the minimum size of crystallites is fixed. Further increase of processing time leads to the increase of crystallite size. Crystallite size reflects the accumulation of defects, their redistribution in crystal volume, storage and annihilation and as the result of which the growth of crystalline blocks is occurred again. When using the modifying additives the crystallite size is decreased significantly, especially while processing with polystyrene, it means that mechanochemical treatment leads to the sizable storage of defects, but intensive diffusion of elements of destroyed modificator is providing the strengthening of defects and excludes their following fusion it means the crystallite size.

Table 2

Dimensional changes of crystallite particles of quartz powder after mechano-chemical treatment

Material, modificator	Crystallite size, L, C			
	The time of mechanochemical treatment, minutes			
	5	10	20	30
SiO_2	2750	2510	1300	1940
SiO_2 + 5 %C	1320	1070	950	820
SiO_2 + 5 %$[-C_8H_8]n$	870	450	380	340

The activity of modified powders is also depends on morphological features of mechanically treated particles. The electron microscopic studies of particle morphology in depending of mechanochemical regimes and used modifiers have shown that as the result of mechanochemical treatment the breakage of quartz is occurred but a deep destruction of surface layer of quartz sand particles with formation of nonosized structural elements of needle form (figure 1 a, b).

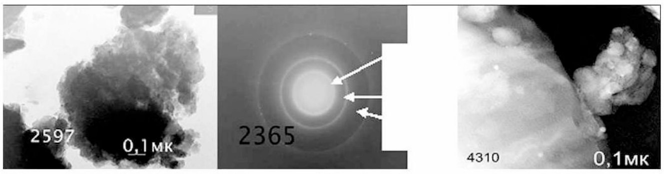


a b c

Figure 1. Electron micrographs of quartz before (a) and after mechanochemical treatment during 10 (b) and 20 minutes (c)

Mechanochemical treatment of quartz in the presence of carbon leads to the carbonization of surface layer of particles. The surface of quartz particles becomes loose – amorphized (figure 2a). Carbonization of the surface is confirmed by results of electron microdiffraction from particle surface (figure 2b). At cooperative processing of quartz with polystyrene there is a destruction of quartz particle and destruction of polystyrene molecules for polyyne and aromatic components is occurred. In this case the change of active surface structure of quartz is occurred with the participation of polycyclic aromatic molecules at simultaneous participation of polyine connections, that corresponding to the known views concerning soot formation in depending on used raw materials [14]. In dependence of quantity of used modificator (from 3 to 10 %), during the time of mechanical effect the structural films are formed, they strongly sewed with particle surface and capsulating it (figures 2c).

Thus, in the process of mechanochemical treatment of quartz with organic compounds the complex multi-stage process of formation of new carbonaceous structures at the surface of particle is occurred, which can be considered according to [15], as a result of grafting to radical centers ($\equiv Si^{\bullet}$ и $\equiv SiO^{\bullet}$), arising at the surface of group split of destroyed organic compounds. The degree and form of «carbonization» of quartz surface is specified by used modifier.



a b c

Figure 2. Electron micrographs and electron diffraction of quartz is dispersed in planetary centrifugal mill in the presence of: a, b – 5 % of carbon and polystyrene (c) during 20 minutes

The quartz is presented in composition of technogeneous wastes which were used in work. At mechanochemical treatment of fly ash and aerated concrete with quartz component, and also with amorphous silicate component of these materials the analogical structural and morphological changes will be happened. In case of aerated concrete the large share of phase composition is presented also by tobermorite. At mechanical effect on aerated concrete in treatment process in planetary centrifugal mill the destruction of tobermorite with dehydration, quartz and calcite is occurred. As the result the phase ratio consisting of milled aerated concrete is changed with decreasing of tobermorite and increasing of quartz and calcite (table 3). Annealing at 900 oC leads to full decomposition of tobermorite with the formation of wollastonite, helenite and other compounds.

Thus, after mechanochemical treatment and thermal action the full transformation of composition of gas-concrete sample is occurred. Wollastonite and quartz are become the basic phases. After mechonochemical treatment of aerated concrete, in consequence of structure destruction of tobermorite, the powder density is increased (figure 3). Cooperative processing of aerated concrete with quartz in the ratio 50/50 is also promote to certain rice of poured density as the result of fine fraction formation and rice of packing density of powder.

The using of different modifying agents reduces the poured density. Most of all it decreases at using of polystyrene. With increase of mechanochemical treatment time the destruction of tobermorite in aerated concrete is occurred gradually, destruction of polystyrene

Table 3

Phase composition of aerated concrete samples before and after mechanochemical treatment and after annealing at 900 ^{0}C

Material	Phases, %							
	Tobermorite	SiO_2	$CaCO_3$	Microcline	Albite	Wollastonite	Helinite	$Ca_2(SiO_4)$
AC*	34,0	36,6	25,9	3,5				
AC, MCT** 5 min	29,3	42,6	27,0	1,1				
AC, MCT, 20 min	24,8	48,1	23,6	2,9	0,5			
AC, annealing 900 ^{0}C		26,2	1,7	2,5		46,5	10,2	12,9
AC, MCT 20 min, annealing 900 ^{0}C		37,0		2,8		45,8	8,1	6,2

**AC – aerated concrete,*

***MCT- mechanochemical treatment.*

and the formation of new bounds which is reflected in external dependence of index of treatment time. When using carbon as the modifier, this dependence is linear. The obtained results clearly reflect not only dispersity alteration during powders breakage, structure destruction, but also the modification, i.e. the change of particle surface when treated them with various carbonaceous organic compounds – modifying agents.

As in fly ash there is some quantity of unburnt coal, so at mechanochemical treatment of fly ash the modification of oxide particles by own carbon is occurred. The poured density of fly ash in initial condition is 0,82 g/cm^3. As the result of mechanochemical treatment of fly ash during 20 minutes the decrease of poured density to 0,74 g/cm^3, but for mixing of it with quartz (in the ratio 50-50) after mechanochemical treatment the poured density of powder is 0,95 g/cm^3.

The obtained results testify that silicate which containing the mineral and technogeneous systems is providing the major modification of structure and as the consequence the activity of obtained mixtures, that can be seen in thermokinetic characteristics of SHS process on the basis of such systems. According results of structural changes at mechanochemial treatment of quartz, aerated concrete and fly ash the optimal time for processing of these materials is 20 minutes. All subsequent investigations on mechanochemical treatment in this work were carried out in this time mode.

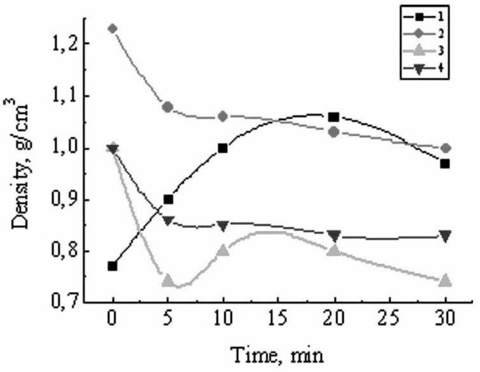


Figure 3. The alteration of poured density of aerated concrete powder (1) and и mixtures quartz + aerated concrete (2) without modifying agents in the presence of 5 % polystyrene (3) carbon (4) and in dependence of mechanochemical treatment

Thermographs of combustion on the basis of quartz and fly ash after mechanochemical treatment have shown (figure 4) that induction period of the sample on the basis of fly ash is considerable larger, but the maximum combustion temperature is higher for 200 ^{0}C using of mixture quartz + fly ash смеси (50/50) consisting of charge is providing the sharp decrease of induction period and high combustion temperature. This result from increasing of activity of mineral constituent's mixtures, and activation of carbon which is included in fly ash composition. Activation of carbon is caused by not only dispergation, but in consequence of milled quartz, as abrasive material and as the result of emission of electrons flow, are arising during failure of quartz particles [16, 17]. The activated carbon which is presented in SHS-mixture initiates the sparking of sample and participates in silicon dioxide recovery.

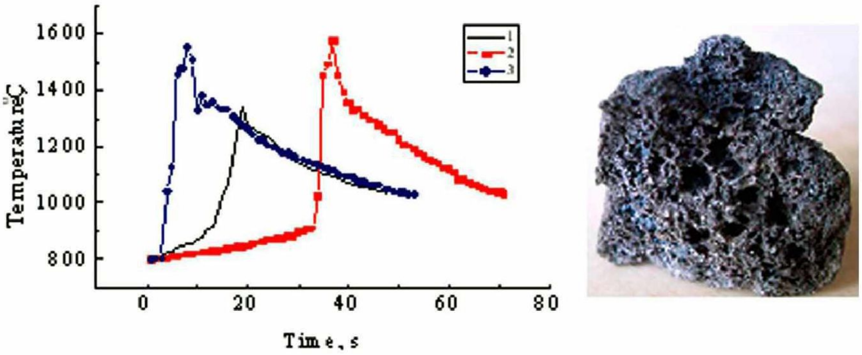


Figure 4 – Thermographs of combustion systems on the basis of quartz (1), fly ash (2) and mixture quartz + fly ash (3) after 20 minutes of mechanochemical treatment. Fracture surface of SHS samples, are obtained from charge of quartz + fly ash

The combustion of such system with fly ash is independent from time of mechanochemical treatment, is occurred also at high temperature ~ 1600 ^{0}C (figure 4). Phase composition of combustion products in these cases is presented by large amount of corundum, moreover there is y-Al_2O_3 also. The aluminum and quartz are almost completely realized in combustion reactions. The sample is obtained with the help of fly ash and quartz the quantity of silicon is increased and aluminum nitride is formed. In accordance with results of semiquantative X-ray phase analysis, the synthesized samples consisting of corundum Al_2O_3 – 64,0 %, y-Al_2O_3 – 8,2 %, Si – 18,4 %, SiO_2 – 1,2 %, Al –1,2 %, $FeAl_3Si_2$ – 2,7 %, AlN-4,3 %.

By phase composition the samples corresponding to the materials with high fire resistance. But their resistance was no more than 4 MPa, which indicates about formation of large amount of gaseous phase, is loosening the sample during synthesis. Variations in the ratio of quartz and fly ash consisting of charge have increased the strength of synthesized samples to 10 MPa. The obtained SHS- samples are characterized by porous structure, their density is 1,173 g/cm^3. Thus, the using of fly ash in conjunction with quartz consisting of charge mixture can be effective sufficiently for obtaining of porous and sufficiently steady heat –insulating material, which will be shown letter at complex analysis for synthesized systems.

The using of aerated concrete as component for charge mixture leads to substantial delay in development of combustion processes and decrease of combustion temperature in consequence of decomposition of terbomorite in heating process (figure 5). If more content of aerated concrete in mixture, so the speed and temperature of combustion is lower. The increase of processing time during mechanochemical treatment is also decrease the combustion temperature to 1100 ^{0}C.

The modified systems at mechanochemical treatment by carbon and polystyrene are activating the process and raising the combustion temperature. Figure 6 shows the thermographs of combustion of systems (50 % quartz +50 % aerated concrete), are modified by carbon and polystyrene at mechanochemical treatment.

For the system, which is modified by carbon the induction period of striking is increased sharply and thermokinetic characteristics of SHS process are increased. The

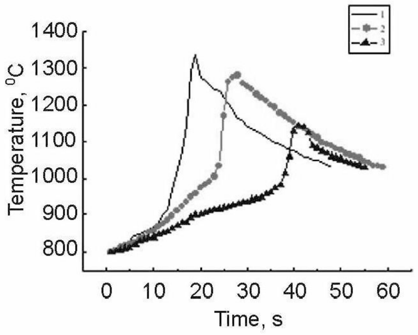


Figure 5. Thermographs of combustion systems with activated quartz (1) and activated mixture of quartz + aerated concrete in the ratio of 80/20(2) и 50/50 (3) mechano-chemical treatment during 20minutes

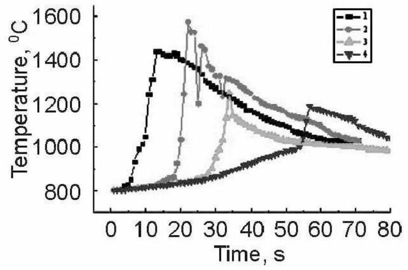


Figure 6. Termographs of combustion of the systems (50 % quartz + 50 % aerated concrete), are modified by carbon (1, 2) and polystyrene (3, 4) at mechanochemical treatment during 10 (1, 3) and 20 (2, 4) minutes

maximum combustion temperature is increased up to 1400 ^{0}C. For the system which is modified by polystyrene, the increase of temperature and kinetics process is not so important. The prolonged synthesis process at the temperature is not below than 1050 ^{0}C is a specific factor for these samples.

Stability factors are the result of synthesis samples with aerated concrete, is determining the applied significance of charge proportioning and regimes of mechanochemical treatment with different modifying agents. When using the polystyrene as modifying agent with increase of mechanochemical treatment time, the stability of SHS samples, containing aerated concrete is increased from 19 to 48 MPa (figure 7).

When using the carbon at charge modifying the sample strength is sharply decreased and in time of mechanochemical treatment falls from 12 to 2 MPa. The appropriate level of sample strength is conditioned by their porosity (figure 8). The samples which are modified by carbon have the loose structure. The samples which are modified by polystyrene have the fine porous structure with tight partitions. This fact indicates the application perspectiveness of such materials for obtaining of heat – insulating systems.

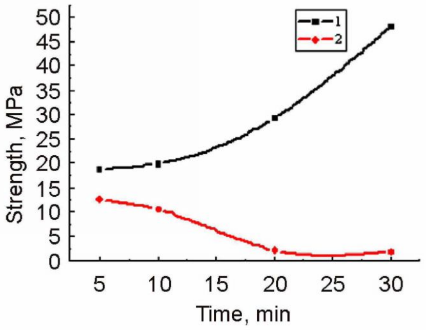


Figure 7. The stability independence of SHS samples on charge with (50 % of quartz + 50 % of aerated concrete) are modified by polystyrene (1) and coal in dependence of mechanochemical treatment time

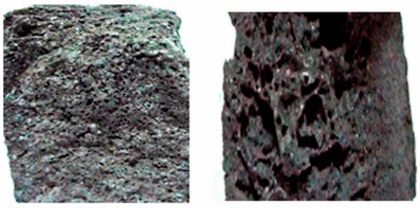

a b

Figure 8. External appearance and breakage after testing on compression of SHS samples, are obtained at charge with aerated concrete, is modified by polystyrene (a), coal (b)

Furthermore, the strength enhancement from time of mechanochemical treatment in connected with formation of different aluminosilicates, as well as with formation of aluminum nitride, providing the strength and heat resistance of obtained composite. Results of semi-quantitative analysis showed that the sample contains the following phases: 49,1 % Al_2O_3; 19,3 % Si; 14,9 % SiO_2; 6,1 % AlN; 4,5 % $FeAl_3Si_2$; 4,0 % $NaAlSi_3O_8$; 0,4 % $FeSi_2$; 1,7 % $KAlSi_3O_8$.

For SHS samples, which are synthesized on charge mixtures at different combination of used mineral and technogenic raw materials and conditions for its processing at mechanochemical treatment, the complex investigation of strength and thermophysical properties of samples (table 4) was carried out.

The synthesized samples have shown that thermal conduction coefficient is changing within limits from 0,552 to 0,185 W/m·K and correlates with density variation (it means porosity) of SHS-samples. Due to sufficient low values of thermal conduction coefficient, these samples are heat-insulators. When using the polystyrene as modifying agents, so the synthesized samples are differs by low-porous structure, which provides to them sufficient high rates of density.

Table 4

Measuring data of density (ρ), strength (σ), thermal conductivity (λ) SHS-samples, are synthesized on the basis of systems with the components of technogenic raw materials after mechano-chemical treatment during 20 minutes

Charge mixture	σ, MPa	ρ, g/cm³	λ, W/мK
80%SiO_2+20%FA*	10,5	1,173	0,309
50%SiO_2+50%FA	4,0	1,09	0,229
80%SiO_2+80%FA	3,3	0,973	0,359
FA	2,8	0,895	0,418
80%SiO_2+20%AC**	80,8	1,77	0,552
50%SiO_2+50%AC	47,04	1,47	0,397
(80%SiO_2+20%AC)+5%C***	23	1,51	0,212
(80%SiO_2+20%AC)+5% PS****	96	1,67	0,185
(50%SiO_2+50%AC)+5%C	3,2	1,37	0,346
(50%SiO_2+50%AC)+5%PS	30	1,72	0,228

*FA – fly ash, **AC - aerated concrete , ***C - carbon, ****PS-polystyrene

The presence of polystyrene plays an important role in formation of structure and phase composition of obtained material. Apparently, it's fulfill the role of mould in mixture of powders, around of which the directionally structural changes, providing the obtaining of ordered structure in synthesized sample is occurred, this is determining the strength enhancement of material. At the same time the modifying agent is a carrier of necessary for synthesis components and sources of gaseous state in synthesis products, providing the formation of fine porous structure of different level. The Combination of these two factors should be effective during material obtaining of certain specific structure and as a consequence of properties. First off all is it expressed in strength improvement at sufficient density.

Conclusion

Thus, the using of wastes of different productions in composition of charge mixture and realization of mechanochemcial treatment of charge mixtures can be quite effective in getting of SHS thermal insulators. As can be seen from the obtained results, the favorable factor for synthesis process is the content of aerated concrete in charge and modifying of it by polystyrene. From obtained results it can be seen that at optimal ratio of components of charge mixture the synthesized material shows a sufficiently low thermal conductivity (from 0.185 to 0.228 W/mK), is characterized by a porous structure at high rate of strength (30 to 96 MPa). Furthermore, in accordance with X-ray phase analysis such material consists of essentially from aluminum oxide and also contains aluminum nitride, i.e. refers to a category of refractory systems

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