водненных песчаниках и могут использоваться для определения мест отбора нагретых вод в разные периоды времени.

Результаты исследований позволяют, обосновано подойти к определению эксплуатационных запасов нагретых вод и возможности их отбора при конкретизации геотехнологической схемы, которая предполагает закачку воды через систему нескольких скважин, с синхронизацией годового графика температур и периодов сжигания угольного пласта.

ЛИТЕРАТУРА

1. На рынке энергетического угля ожидается увеличение спроса и цен [Электронный ресурс] / И. Марьяненко // Электронный журнал энергосервисной компании «Экологические системы». – 2011. – №11. – Режим доступа к журн.: http://www.esco.co.ua/journal/2011_11/art164.htm. – Название с экрана.

2. Батурина И.М. Горное дело и окружающая среда. Геодинамика недр: Учебное пособие для вузов / Батурина И.М., Петухов И.М., Батурин А.С. – М: Издательство Московского государственного горного университета, 2009. –120 с.

3. Теория и практика термохимической технологии добычи и переработки угля: Монография / [под. ред. О.В. Колоколова].- Днепропетровск: НГА Украины, 2000. – 281 с.

4. Садовенко И.А. Численное исследование теплового поля вокруг подземного газогенератора / И.А. Садовенко, Д.В. Рудаков, А.В. Инкин // Збірник наукових праць НГУ. – 2012. – № 39. – С. 11-20.

5. Рудаков Д.В. Моделирование теплопереноса в водоносном горизонте при аккумуляции и отборе тепловой энергии / Д.В. Рудаков, И.А. Садовенко, А.В. Инкин // Науковий вісник НГУ. – 2012. – № 1. – С. 40-45.

6. Гончаров С.А. Термодинамика: Учебник / Гончаров С.А. – М: Издательство Московского государственного горного университета, 2002. – 440 с.

7. Геология месторождений угля и горючих сланцев СССР. Т. 1. Угольные бассейны и месторождения юга Европейской части СССР / [Лагутина В.В., Левенштейн М.Л., Попов В.С. и др.]; под ред. И.А. Кузнецова. – М.: Госгеолтехиздат, 1963. – 210 с.

УДК 621.347

ИССЛЕДОВАНИЕ ФИЗИКО-МЕХАНИЧЕСКИХ СВОЙСТВ ДЛЯ СИСТЕМЫ TI-FE-C В РЕЖИМЕ СВС-ПРОЦЕССА

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Аннотация. Рассмотрен механизм спекания порошков титана, углерода и стали ШХ15. Рассмотрены основные закономерности, при которых происходит СВС-процесс. Показано, что характерной особенностью СВС-процесса является наличие двух

продуктов реакции - тугоплавкого соединения и окиси металла-восстановителя. Структура такого материала зависит от многих факторов растворимости, отношение удельного веса, размера реакционной массы, давления газа.

Ключевые слова: спекание, пористость, СВС, структура.

RESEARCH OF PHYSICAL AND MECHANICAL PROPERTIES FOFSYSTEM Ti-FE-C MODE SHS PROCESSES

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Abstract. The mechanism of sintered of powders of titan, carbon and steel of BBS15 is considered. Considered basic conformities to law, there is a SHS- process at that. It is shown that the characteristic feature of SHS- process is a presence of two products of reaction - refractory connection and oxide of metal-repairer. The structure of such material depends on many factors of solubility, relation of specific gravity, size of reactionary mass, pressure of gas.

Keywords: sintering, porosity, SHS, structure.

1. Introduction. Environmental protection, introduction of resource and energy saving technologies is determining backbone for modern society. In light of the limited energy resources of Ukraine the problem of energy saving is particularly relevant. Finding solution implemented in several ways. First, the study and introduction of new, innovative energy saving technologies of powder metallurgy, self-propagating high-temperature synthesis (SHS), ion-plasma, laser deposition of films, use of nanomaterials as raw materials and others. Another important reserve of increasing efficiency is the use of wastes of humanity, including wastes of engineering complex. Important role in solving this problem is improving the quality and reliability of parts and structures by improving the properties of structural materials. In Lutsk National Technical University researches are conducted to improve technologies of bearing waste production and obtaining details of construction and tribological purpose with using powdered metal steel BBS 15(ball bearing steel).

2. Experimental

2.1 *Starting Materials*

For preparation of blend for realization of sintering in the mode of SHS-process in quality of initial components powder was used to titan of brand PTS -1(GOST 5657-69), carbon (soot is TU 14-7-24-80) and powder of steel of BBS15, got (obtained) from grinding sludge for technology of LNTU. The calculation of components of initial mixture (blend) for the synthesis of the system of titan-carbon-BBS15 was conducted with taking into account of quantity and stoichiometrical coefficients of initial components, cleanness and bulk closeness (fill density**)** of initial blend on methodology. Powder of steel of BBS15 undertakes in such quantity that allows fully to bind titan and carbon in chemically neutral connections.

2.2 *Synthesis a mixture of powders*

For samples received in the method of furnace sintering, were used mixtures with the same interest rate and weight content of initial components. Mixing of powders of initial reagents is carried out in ball mill, which is a horizontally placed rotatory cylinder with a set of steel balls with a diameter of 20 mm in the middle. Mixing continues for eight hours until formation of an homogeneous mass. Pressing of the initial charge is carried out by using of the hydraulic press of model PSU 500 (maximum pressure 500 MPa). Press-moulds are made of steel 20XH9T. The obtained samples from the first version were sintered for two hours in a furnace of a model SHO55-754 at the temperature 1750 K under liquid gate. Argon was used as a substance that prevents the formation of oxidative environment. The samples from the second version were obtained by using the method SHS in a laboratory reactor, which was made in Lutsk National Technical University. The synthesis is carried out at temperatures interval of 557 -1677 K.

2.3 *Metallographic research*

Metallographic study was held with a microscope MMP-4. Metallographic test specimens were prepared in accordance with a standard test procedure. Having an aim to get a clear picture (correct image) of grains' borders specimens were etched with 4% H_2SO_4. The plane porosity of a sample, which equals 30%, was fixed with the help of PHOTOM program. Microstructure of samples sintered with a SHS method shows that they are sintered better due to multiple reconstruction of lattice. Polymorphic transformations lead to the intensification of synthesis process as the result of which both components iron and titanium undergo multiple phase changes and their lattices are rebuilt. Thus, natural polymorphic transformations as the result of lattice reconstruction ensure a SHS activity and creating of intermetallics. They also appear in a role of an aid in diffusion process. In the Figure 1 the structure is presented with enlargement 600 (before and after etching).

In the Figure 2 the structure is furnace method. It is seen: dark areas - martensite, light areas – intermetallide of iron.

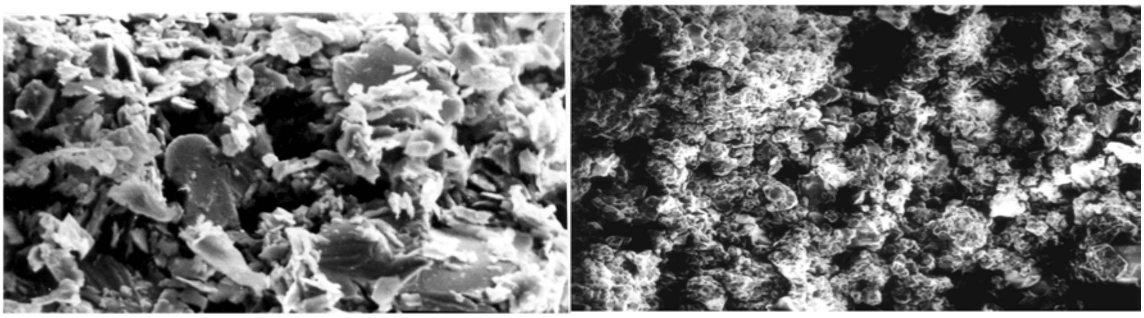

Figure 1 - The specimen structure sintered with a SHS method or with a help of oven sintering (before and after etching) 600 is presented

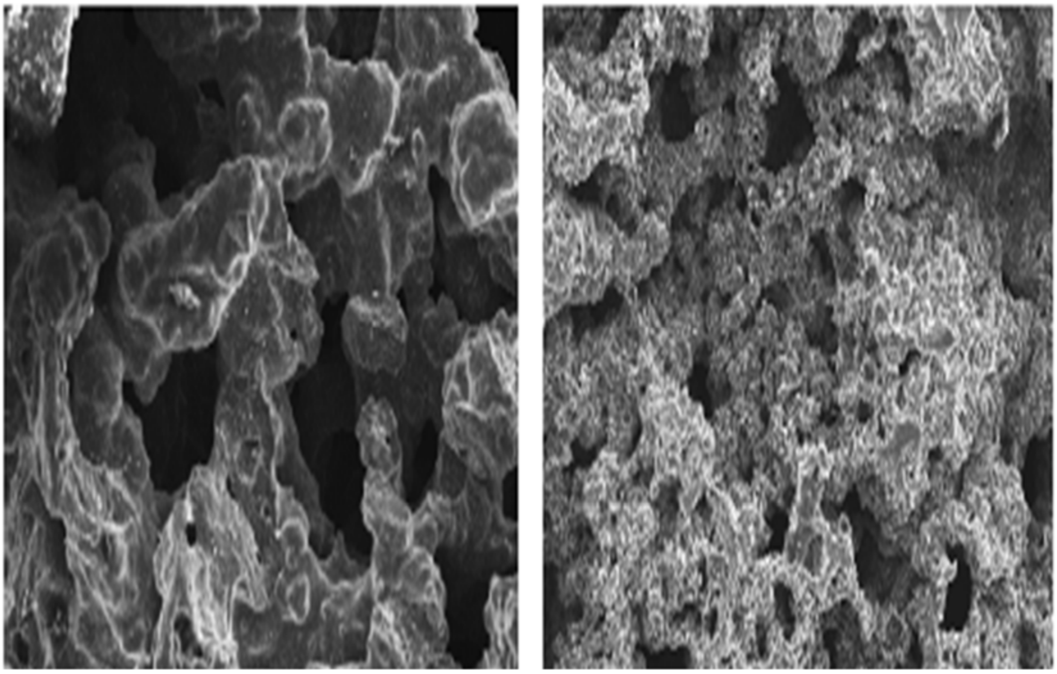

Figure 2 - The specimen structure sintered with a furnace method (before and after etching) 600 is presented

2.4 *Determination of dynamic hardness*

After sintering of samples, was carried out comparative analysis with the following parameters: the structure of samples was studied, their hardness and compressive strength were determined. The hardness of the samples was defined by means of the dynamic hardness tester TD 42 M according to three parameters: HRC – hardness by Rockwell, HB – hardness by Brunnel, HV – hardness by Vickers. The certificate limit of permissible divergence equals ± 3..5%.

3. Results and Discussion

The results of determination of the samples' hardness got by means of furnace sintering are given in Table 1, and the results of determination of the samples' hardness got by means of SHS are represented in Table 2. In the tables 1, 2 № 1 means determination of hardness 0,9R, № 2 means – 0,5 R, № 3 means – within the sample. The hardness and deformation limits at static loading were defined as mechanical characteristics of the samples. The tensile-testing machine MI-40КU with automatic recording of the deformation diagram was used for the tests. As an example the deformation diagram at the sample's compression sintered by means of SHS is represented.

Table 1 - Hardness of samples after furnace sintering

№	HRC	HB	HV
0,9R	18	100	99
0,5 R	38	180	173
within the sample	63	381	421

Table 2 - Hardness of samples after SHS processing

№	HRC	HB	HV
0,9R	20	101	101
0,5 R	43.2	187	187
within the sample	63.9	385	446

As a result, the tests found that the maximum stress at the time of the destruction of Q_{max} 70 MPa at a relative deformation of E_{max}-0,0375 for samples after sintering furnace. For samples obtained by SHS process Q_{max} = 106 MPa at E_{max} =0.038. The results show that the strength of the material obtained by SHS is 1,5 times higher than for samples obtained by sintering furnace. Deformation characteristics do not depend on the method, sintering. Investigation of structure damage done by microscope type MS-29, shows that for SHS samples observed brittle fracture (there are surface cracks on the free end of the sample). Figure 3 is showing pictures for the destruction of the sample issintered by SHS and figure 4 the sample is sintered by furnace sintering. Insamples sintered using sintering furnace under static compression, there are deep cracks that lead to their destruction.

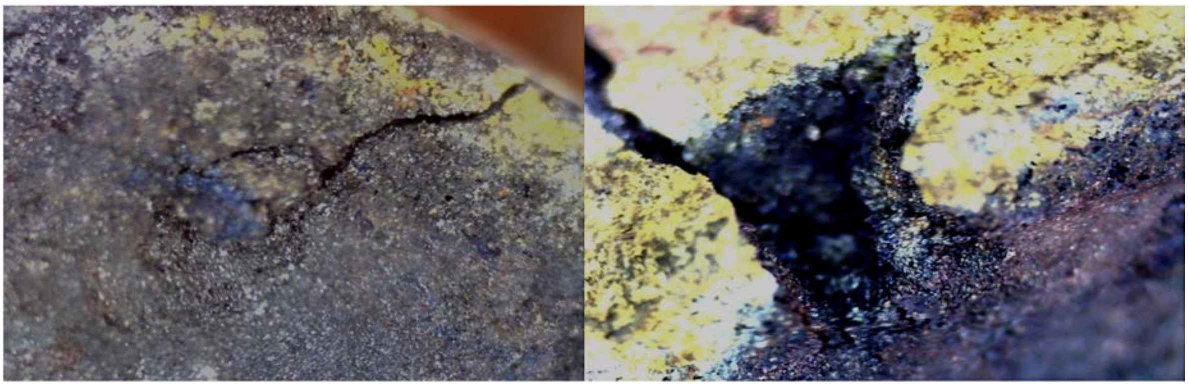

Figure 3 - Photos of character of destruction of samples which were got by the method of SHS.

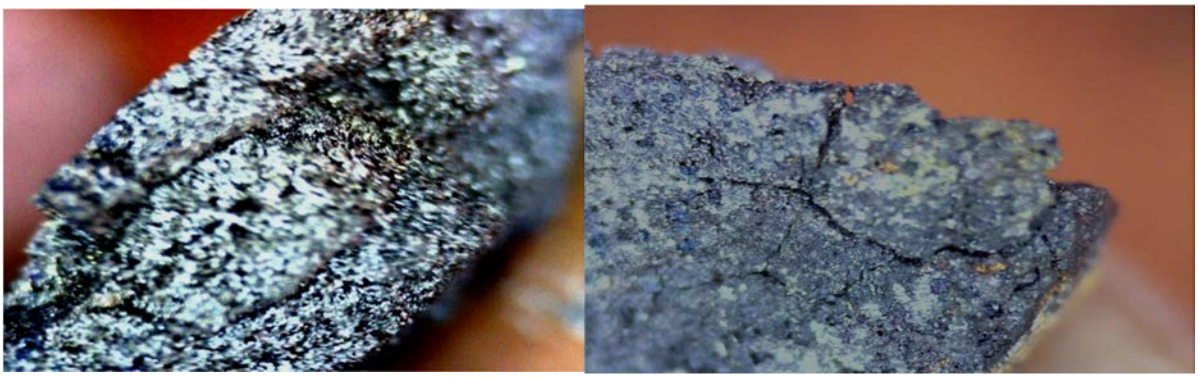

Figure 4 - Photos of character of destruction of samples which were sintered by the method of sintering.

Conclusions. Comparing analysis of physical and mechanical properties of the material with the similar chemical content, that was got by the method of furnace sintering and method of SHS process denotes:

- porosity of samples doesn't depend upon the method of sintering;
- method of sintering doesn't influence on the deformation characteristics and firmness of the material;
- the strength of samples which were got by the method of SHS is higher (1.5 times) than the strength of samples which were got by the method of furnace sintering by means of strengthening of relations between the elements of SHS sintering. Thus it is proved that to get materials of constructional purposes one should use reducing wastes of machine-building production decreasing energy consumption by SHS process.

REFERENCES

1. Merzanov A.G. SHS-powders and their technological processing Russian Academy of Sciences. Institute structural macrokinetics and materials science problems. - Chernogolovka: *ISMAN'S publishing house*, 2000.-117 pages.
2. Merzanov A.G. Self-extending high-temperature synthesis in chemistry and technology of refractory connections VHO, 1999. - t. XXIV. No. 3. - Page 223-227.
3. Bobovich B.B. Processing of production wastes and consumption Interment Engineering, 2000. - 496 pages.
4. Dorofeev Ju.G. Constructional powder materials and products M: Metallurgy, 1986. - 144p.
5. Rud' V. D., Gal'chuk T, N., Povstjanoj O. Ju. A method of receipt of metallic powder is from slime wastes of bearing production Ukraine Patent no 63558 A МПК 7 B22F9/04. 15.01.04