УДК 621.998.77

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NEW POROUS PENETRATING MATERIAL

In this research, the basis of composite components for the mixture of porous material is industrial waste from engineering production, which is metal oxides and metal powders. The possibility of the practical use of these materials for filtration of liquids was approved with providing of the entire complex of properties and the required characteristics, necessary for service life. Submitted components and the technology of producing make the created material economically feasible for usage in comparison with known materials in consequence of energy-efficient technologies and technical waste utilization.
***Keywords*: SHS, saponite, batch, filtration, metallographic analysis.**

Objective. The most common process in many industrial productions is filtration of liquids. Filter materials in service may be subjected to mechanical and chemical impact, which reduces its service life, and in some cases require periodic replacement. When using developed materials, there are a number of operational requirements, the main ones are mechanical strength and capacity for multiple chemical regeneration. Recovery of filter capacity of penetrating materials during thermal regeneration requires high thermal stability (at least 200 °C). Concerning chemical regeneration, the stability of the filter to inorganic acids is very important. There are a number of materials for filtration, the most distributed and lasting are ceramic filter materials [1]. The disadvantage of ceramic materials in spite of their long service life is energy-intensive production technology.

At present, the preliminary results of the study found that one of the promising methods for ceramic materials is self-propagating high temperature synthesis (SHS). The purpose of SHS-process is not temperature and combustion wave velocity control, but to obtain the microstructure of the final product. Porous moving materials received by SHS has the following advantages: high mechanical strength, chemical resistance, highly economical method of manufacture.

The analysis of researches. The research of penetrating porous blocks of catalytic converters obtained by SHS, introduced in work [5], showed that the use of these materials for filter cleaning of gas has several advan-

tages over MRP obtained by traditional methods in terms of manufacturing technology and by the performance properties. However, the contents of the main components that are part of the filter element is expensive. The design of the rest of this filter narrows the scope of its application, which leads to an increase in the cost of its maintenance and replacement.

The use of industrial waste for production of filtering elements significantly reduces their cost, increases durability and allows to recover filtering properties. In [4], the production technology of filter cleaning for technical liquids and gas mixtures based on iron dross of 18H2N4MA steel is submitted. Test result shows high filtering properties of the given material in order to lower cost compared to traditional materials and high technical performance characteristics.

Despite the significant achievements in this area the work to improve DPM continues. The scientists of the KPV and TM departments of Lutsk NTU have been working on creating of a filter material, which is based on cheap natural materials combined with industrial waste.

Introduction. Great importance for obtaining of quality products has selection of batch of materials. In this research, the basis of composite components for the mixture of porous material is industrial waste from engineering production, which is metal oxides and metal powders. The following materials were taken as initial: steel slag 18H2N4MA, alumina powder TU (48-5-22-87), a natural mineral - saponite from Tashkivsky deposits and pore creator - carbamide. The main uses of saponite minerals associated with the versatility and efficiency of these minerals in various industries. For example, in the chemical industry saponite clays are used as adsorbents. Raw bentonite is used in wastewater treatment in light industry. Taking into account the high sorption and valuable physical - chemical properties it is possible the application of saponite as safe and low-cost sorbents for the purification of solvents in the chemical treatment. The using of saponite filtering solvents will improve the quality of cleaning solvent, increase the environmental safety of the process and reduce the amount of sludge waste [2].

Receiving of material by SHS is held by the scheme:

- mxing of powders of initial reagents according to the stoichiometric calculation of the relevant equations of reaction;
- drying of the initial batch of reagents in conditions of protected environment;
- pressing of the initial batch of reagents in cylindrical timber of different diameter and height with variations of the density of the material of the samples obtained by changing the pressing value;

- SHS process in laboratory unit, obtaining samples of functional materials;

- analysis of the structural characteristics.

Mixing of the powders of initial reagents were performed in ball mills, which is a horizontal rotating cylinder containing a set of steel balls with a diameter of 20 mm. Mixing continued for eight hours until homogeneous mass formation. The next step is pressing of the initial batch through a hydraulic press (model PSU 500). Formation of the samples was carried out in different proportions, i.e. (30% Al_2O_3, 30% Fe_3O_4, 30% powder saponite clay, 10% pore-carbamide; 25% Al_2O_3, 35% Fe_3O_4, 30% saponite clay powder, 10% pore-carbamide etc.).

Fig. 1. Experimental prototypes in different proportions

The process of sintering was carried out in a laboratory reactor, which was developed in Lutsk NTU. While burning happens in a simpler and the

most important steady state, the points of the front move with constant speed. When steady state loses its stability, unstable regimes of the front may occur [3]:

- pulsating combustion;
- localization of the combustion in the centers, moving by wave trajectory (spin waves);
- chaotic movement of combustion.

Combustion wave is not spread by the batch in the case of strong heat loss to the environment (small diameters of batch samples, low adiabatic temperatures of interaction of reagents) [4]. The process of wave propagation is characterized by:

1. The boundary of extinction (relationship between the parameters of the system, separating the two situations: propagation of wave and no burning on any terms of initiation).
2. The boundary of instability (the relationship between system parameters that separate regimes stationary and unstable combustion).
3. The speed of propagation of the combustion front.
4. The maximum temperature and rate of heating of matter in wave of stationary combustion.
5. In unstable processes – pulsation frequency, speed of fire in a spiral trajectory, adiabatic effect value, etc.
6. The depth of chemical conversion of initial reagents in end products (completeness of burning).
7. Dependence of not complete afterburning from the relative density of the sample.
8. Dependence of not complete afterburning from the size of the metal particles.

The last statement tested in a series of experiments. There were several series of studies of powders, which particles have dimensions of 100-200 microns, 50-100 microns, 50-80 microns. The study on cracking samples found that piece of particle size of 100-200 microns. 50-100 microns. characterized by not complete afterburning. Blanks with a particle size of 50-80 microns have high density. Therefore, as the optimal size for further studies used particles of 50-80 microns.

Front of burning spread the specimen to the opposite side of initiating a spiral. Electrical signals from thermocouples recorded by sensors (thermocouples) connected to a computer via an analog-digital converter. The test specimen obtained by SHS shown in Figure 2.

Fig. 2. New penetrating porous ceramics obtained by SHS

Samples for metallographic studies were prepared by the standard method [4]. Thin sections of samples studied by microscope (MMP-4 model) with increasing rate: x 400. In order to obtain a clear picture of grain grinding boundaries they were etched with 4% H2SO4. Plane porosity was determined from the micrograph of thin sections using Smart-eye software. The determined porosity is 15-20%. The volumetric porosity was determined by gravimetric method for the geometric parameters of the samples. The structure of the obtained material is shown in Figure 3.

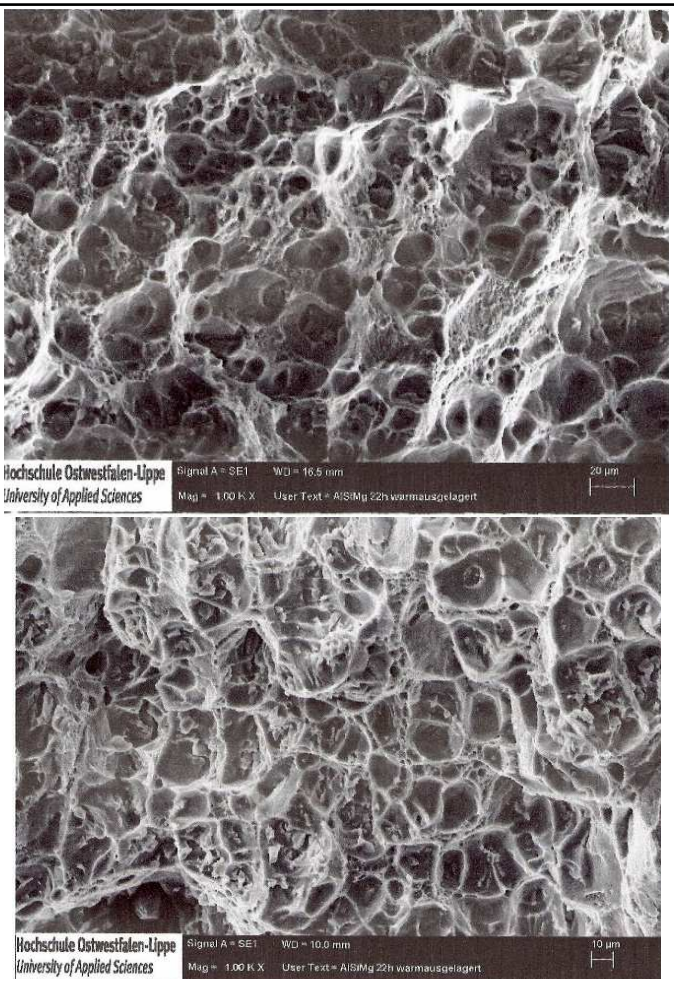

Fig. 3. Microstructure of the penetrating porous material

The results of the analysis of published data shows there is only a general idea of the mechanisms of formation of porous structures of SHS materials. In specific cases, for obtaining of porous materials with a certain penetrating, pore sizes, chemical and mechanical stability the conducting of experimental researches to determine the temperature regimes, cooling rate and machining is required.

Conclusion. Experimental studies have shown that the submitted porous material from waste forging-stamping production can be recommended for filtration of liquids with providing of the entire complex of properties and the required characteristics to make the lifetime of the material economically more appropriate for use in comparison with known materials in consequence of energy-efficient technologies and technical waste utilization.

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НОВІ ПОРИСТІ ПРОНИКАЮЧІ МАТЕРІАЛИ

У статті досліджені основи композиційних компонентів для суміші пористого матеріалу промислових відходів від машинобудівного виробництва, такі як оксиди металів і металевих порошків. Можливість практичного використання цих матеріалів для фільтрації рідин була затверджена з наданням всього комплексу властивостей і необхідних характеристик, необхідних для служби. Представлені компоненти і технологія виробництва роблять матеріал економічно доцільним для використання в порівнянні з відомими матеріалами в результаті енергозберігаючих технологій та використання технічної відходів.

***Ключові слова*: СВС, сапоніт партія, фільтрація, металографічний аналіз.**

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НОВЫЕ ПОРИСТЫЕ ПРОНИКАЮЩИЕ МАТЕРИАЛЫ

В статье исследованы основы композиционных компонентов для смеси пористого материала промышленных отходов от машиностроительного производства, такие как оксиды металлов и металлических порошков. Возможность практического использования этих материалов для фильтрации жидкостей была утверждена с предоставлением всего комплекса свойств и требуемых характеристик, необходимых для службы.
Представленные компоненты и технология производства делают созданного материала экономически целесообразно для использования в сравнении с известными материалами в результате энергосберегающих технологий и использования технической отходов.
***Ключевые слова*: СВС, сапонит партия, фильтрация, металлографический анализ.**
