

Scottish International Conference on Multidisciplinary Research and Innovation – SICMRI 2026

INFLUENCE OF HEAT TREATMENT PARAMETERS OF SERPENTINITE ON ITS PROCESSABILITY INTO MAGNESIUM-CONTAINING MATERIALS

B.B. Bekchanov, M.S. Djandullayeva, A.U. Erkayev, Z. Atkhamova

Tashkent Institute of Chemical Technology. Tashkent, Uzbekistan

Serpentine is a promising and economically accessible raw material for producing magnesium oxides and salts, which are widely used in various sectors of the chemical industry.

Currently, a significant number of technologies have been developed for processing serpentine raw materials. Despite differences in the process flowsheets, most of them are based on two key processes: acid leaching (using sulfuric, hydrochloric, and nitric acids) and thermal activation (sintering) [1–5].

In this study, serpentine from the Karakalpakstan deposit was used as the starting material. It has the following chemical composition (wt.%): MgO – 35.0; SiO₂ – 46.4; Fe₂O₃ – 9.12; Al₂O₃ – 3.94; CaO – 0.17; Cr₂O₃ – 0.40; NiO – 0.25; MnO – 0.13; SO₃ – 0.14.

The aim of this study is to determine the effect of heat treatment temperature on the physical and mechanical properties of serpentine and assess its suitability for subsequent processing into magnesium-containing materials.

Serpentine samples were heat treated at temperatures of 100, 200, 400, 600, and 800°C for 30 minutes. Property changes were assessed using the Vickers method (HV20) and the Mohs scale.



Fig. 1. Serpentine processed at different temperatures, °C:
1-100; 2-200; 3-400; 4-600; 5-800.

Figure 1 shows serpentine samples after heat treatment at various temperatures. It was found that with increasing temperature, significant changes in the color and structure of the material are observed.

In the initial stages (100–200°C), visual changes are virtually absent. At 400°C, a darkening of the samples is observed, which may be due to the onset of dehydration and phase transformations. At 600°C, the changes become more pronounced, indicating the development of crystalline structure breakdown processes. Maximum changes are observed at 800°C, where significant transformation of the mineral phase occurs, accompanied by a color change to a brown hue.

The results of the study of the physical and mechanical properties of serpentine are presented in Table 1.

Scottish International Conference on Multidisciplinary Research and Innovation – SICMRI 2026

Table 1.

Studies of physical changes in serpentinite at different temperatures

The number of samples matches Fig. 1	hardness	Original samples			Термообработанные образцы		
		according to Vickers	according to Mohs	indicator of structural change	according to Vickers	according to Mohs	indicator of structural change
1	H V20	243.8	3	131.49	2476 .9	9	1335. 97
2	H V20	2482	9	1338.7 2	2816 .7	8.5	1519. 25
3	H V20	780.9	6	421.19	1043 .5	7	563.8 0
4	H V20	1644.9	8.5	887.21	1896 .5	8.5	1022. 92
5	H V20	2809.3	8.5	1515.2 6	2338 .7	9	1261. 43

Analysis of the obtained data revealed that heat treatment has a significant effect on the material's hardness. Specifically, at 800°C, the average Vickers hardness increases from 1592.18 to 2114.82 HV, indicating structural strengthening.

Simultaneously, the calculated structural change index increases from 858.78 to 1140.68. This parameter reflects the degree of structural change in the material and may be related to thermally induced phase transformations.

Thus, increasing the heat treatment temperature leads to significant changes in the structure and mechanical properties of serpentinite, confirming the effectiveness of thermal activation as a raw material preparation step for further chemical processing.

List of references

1. Пат. 2285666 Российская Федерация, МПК С 01 F 5/06. Способ комплексной переработки магниисиликатосодержащего сырья / Григорович М. М., Менькин Л. И. № 2005122952/15, заявл. 20.07.2005; опубл. 20.10.2006, Бюл. № 29. 6 с.
2. Габдуллин А. Н., Калиниченко И. И., Печерских Е. Г., Семенищев В. С. Получение высокодисперсного кремнезема методом азотнокислотной переработки serpentinita // Ученые записки Таврического национального университета им. В. И. Вернадского. Серия: Биология, химия. 2011. Т. 24, № 3. С. 44–47.
3. Б.Б. Бекчанов, М.С. Джандуллаева, А.У. Эркаев, Б.Т. Кошанова / Разработка технологии получения солей магния расщеплением serpentinita серной кислотой. //

**Scottish International Conference on Multidisciplinary Research and
Innovation – SICMRI 2026**

4. Пат. 2368654 Российская Федерация, МПК C10M 177/00. Способ получения противоизносного состава из серпентинита и состав на его основе / Гужев Олег Павлович, Волков Дмитрий Георгиевич // Опубликовано: 27.09.2009 Бюл. № 27.

5. Умиров Ф. Э., Файзуллаев Н. И., Усанбаев Н. Х., Музаффаров А. М., Умиров У. Ф., Пирназаров Ф. Г. Минералогическая и технологическая оценка сапонитов месторождения Учтут в Республике Узбекистан // Международный журнал контроля и автоматизации. 2020. Т. 13, № 4. С. 230–236.