Calcium Sulphate Dihydrate as a Product of Complex Processing of Serpentinite

VADIM V. VELINSKIY and GENNADIY M. GUSEV

Trofimuk United Institute of Geology, Geophysics and Mineralogy, Siberian Branch of the Russian Academy of Sciences,
Pr. Akademika Koptyuga 3, Novosibirsk 630090 (Russia)

E-mail: ofiolit@uiggm.nsc.ru

(Received February 12, 2002; in revised form April 8, 2002)

Abstract

The investigation of gypsum (calcium sulphate dihydrate), obtained in course of serpentinite processing, is performed. It is shown that the product is characterized by high ecological purity and meets the demands of the All-Union State Standard (GOST) to the 1st-rate gypsum. The gypsum binder made of the gypsum obtained from serpentinite corresponds to rapidly and normally hardening grades G-2–G-4 of medium grinding grade. The properties and quality of this material allow using it in various branches of industry and medicine.

A principally new scheme of waste-free processing of serpentinite and serpentinite tailings of the production of asbestos is developed at the United Institute of Geology, Geophysics and Mineralogy [1]. According to the proposed scheme, one of the products of this technology can be calcium sulphate dihydrate (gypsum) $CaSO_4 \cdot 2H_2O$.

Thus obtained gypsum is a weakly cemented powder of white or slightly yellowish colour. Its chemical composition is shown in Table 1. The gypsum is rather pure; calcium carbonate ($CaCO_3$) admixture was formed during obtaining the product as a result of interaction between calcium oxide and carbon dioxide of water. Other admixtures are represented mainly by sodium chloride, one of the final components of the technology.

Chemical analysis of the samples under investigation was performed with elevated accuracy in agreement with the requirements of mineral raw classification for analytical examinations in geological establishments [2]. Determination of oxides was performed according to the schemes of full silicate analysis using gravimetric, spectrophotometric, and atomic absorption analysis methods. The square mean deviation in determining separate components

TABLE 1
Chemical and phase composition of gypsum

Component	Content, % mass
CaO of gypsum	31.25
SO_3	44.65
H_2O of gypsum	20.09
CaO of calcium cabronate	1.68
CO_2	1.32
Na_2O	0.66
K_2O	0.11
SiO_2	n/d*
Al_2O_3	»
Fe_2O_3	»
MgO	0.16
Total	99.82
$CaSO_4 \cdot 2H_2O$	96.00
$CaCO_3$	3.00
Other	1.00
Total	100.00

*Not detected.

did not exceed the permissible level in agreement with the recommendations of NSAM. The quality of the analysis of separate components was monitored with the help of standard samples of composition (SSC) throughout the whole analytical process in accordance with [3]. The reproducibility of the analysis of each component was within the permissible error of its determination.

The performed investigations indicate that the resulting gypsum can be referred to the industrial raw material, which follows from the data shown in Table 2, presenting for comparison the data for theoretical gypsum and the 1st-rate gypsum [4]. It also follows from Table 2 that the product obtained belongs to the 1st-rate gypsum and according to the All-Union State Standard (GOST) can be used both in cement industry and in the production of gypsum binders, including those for ceramic industry, for the production of decorative and broadening cement [5–8]. Because of ecologi-

TABLE 2

Chemcial composition of gypsum $CaSO_4 \cdot 2H_2O$

Sample	Content, % mass				Content of $CaSO_4 \cdot 2H_2O$, %
	CaO	SO_3	H_2O	Other	
Gypsum, theoretical	32.56	46.51	20.93	No	100
Product of serpentinite processing	31.25	44.65	20.09	4.01	96.0
The 1st-rate gypsum	30.93	44.18	19.89	5.00	≥95.0

TABLE 3

Ecological characterization of gypsum obtained from serpentinite

Component	Content in gypsum		MPC [9]	
	%	mg/kg	mg/m^3	mg/kg
Na_2O	0.56	5.6	4	not standardized
K_2O	0.11	1.1	4	»
SiO_2 unbound	n/d*	n/d	6	»
MgO	0.16	1.6	10	»
Al_2O_3	n/d	n/d	6	»
Fe_2O_3	0.001	0.01	4	»
P_2O_5	n/d	n/d	no data	»
Be	»	»	0.001	50
V	»	»	0.1	100
Co	»	»	no data	100
Mn	»	»	0.3	1000
Ni	»	»	no data	100
Pb	»	»	0.01	50
Cr	»	»	no data	100
Cu	0.0001	0.001	»	100
Mo	0.002	0.02	»	5
Zn	n/d	n/d	»	100
As	»	»	0.5	300
Sr	0.01	0.1	no data	
Zr	0.007	0.07	»	1
Hg	n/d	n/d	0.01	no data
B	0.003	0.03	6	

*Not detected.

TABLE 4

Chemical composition of the gypsum binder

Sample	Content, % mass				Content of $CaSO_4 \cdot 2H_2O$, %
	CaO	SO_3	H_2O	Other	
$CaSO_4 \cdot 2H_2O$, theoretical	38.62	55.17	6.21	No	100.0
Gypsum binder from serpentinite	37.08	52.98	5.96	3.98	96.02

cal purity of the resulting product (Table 3), it may be widely used in medicine: surgery, stomatology, *etc.*

Preliminary investigation was performed in order to test whether the gypsum can be used as a binder. The basis for this application is thermal dehydration of calcium sulphate dihydrate. The initial sample was preliminarily ground till fineness characterized by the 3.6 % residue at the sieve No. 02. The data on the quality of the obtained gypsum binder are shown in Table 4.

The product of thermal dehydration is a white (sometimes slightly yellowish) powder with light refraction factors N_g = 1.556 and N_p = 1.55. Derivatogram (thermal analysis curve) of the substance suggests that its composition corresponds to β-$CaSO_4 \cdot 0.5H_2O$, *i. e.* to the gypsum binder. It should be noted that no aggregation of agglomeration occurs during dehydration of the initial sample; no additional grinding is required; the residue on sieve No. 02 is 3.2–3.4 %. Technical characterization of the product, performed according to the requirements of the State Standard No. 23789–79, showed that, depending on thermal treatment mode, gypsum binders corresponding to G-2–G-4 grades can be obtained. The strength of samples after hardening for 2 h is, kg/cm: for bending, 15.0–22.0; for compression, 21.1–41.0.

Thus, gypsum obtained by complex processing of serpentinite (calcium sulphate dihydrate) is characterized by high chemical and ecological purity and meets the requirements of the State Standard No. 4013–82 to the 1st-rate gypsum. The obtained product can be used in different branches of industry and in medicine.

The gypsum binder obtained from this gypsum meets the requirements of the State Standard No. 125–79 for rapidly and normally hardening grades (G-2–G-4) of medium grinding.

REFERENCES

1 V. V. Velinskiy, G. M. Gusev, Pat. 2097322 Russian Federation, 1997.
2 Metodicheskiye znacheniya NSAM, No. 11, VIMS, Moscow, 1975.
3 OST–41–08–262–86. Upravleniye kachestvom analiticheskoy raboty, Moscow, 1986.
4 GOST 4013–82, Kamen' gipsovy i gipsoangidritovy dlya proizvodstva vyazhushchikh materialov.
5 Stroitel'nye materialy: Spravochnik, Stroyizdat, Moscow, 1989.
6 Yu. D. Natsievskiy, V. P. Kholyekko, V. V. Begletsov, Spravochnik po stroitel'nym materialam i izdeliyam, Burevestnik, Kiev, 1989.
7 GOST 23789–79. Vyazhushchiye gipsovye, Metody ispytaniy.
8 GOST 125–79. Vyazhushchiye gipsovye. Technical Specifications.
9 Predel'no dopustimye kontsentratsii khimicheskikh veshchestv v okruzhayushchey srede: Spravochnik, in G. P. Bespyamyatovskiy, Yu. M. Krotov (Eds.), Khimiya, Moscow, 1985.