FIBROUS MATERIALS ON THE BASE OF BASALTIC GLASSES

Shchekina T.I., Gramenitskiy E.N., Batanova A.M. (Geol. Dep., MSU),
Putlyaev V.I. (Dep.Sci. of materials, MSU), **Rusakov V.S., Kotelnikova A.A.** (Phys. Dep., MSU), **Knot'ko A.V.** (Chem. Dep., MSU), **Kotelnikov A.R.** (IEM RAS), **Zemtsov A.N.** (IIET RAS)

tishchek@geol.msu.ru; fax: (095) 932-88-89, tel.: (095) 939-20-40

Key words: basaltic fibrous materials, valence state of iron, hydrolithic stability

The collection of basaltic fibres produced on the main Russian and foreign plants has been studied. The samples are from Lianizovo plant (Moscow), Sudogda plant (Vladimir region) – made by vertical air-jet dispergation, Dmitrov plant (near Moscow) - the dispergation of initial fibres, Rockwool and Paroc companies (centrifugal dispergation). For the comparison the glasswool from Fliederer (Chudovo, Leningrad region and also natural volcanic basaltic fibres from Kulauea (Hawaii) and Tolbachic (Kamchatka penn.) volcanoes were studied.

Basaltic fibres have been studied by the optical, scanning and transparent electron microscopy, Mössbauer spectroscopy, X-ray diffraction analysis, thermogravimetry and with the use of microbeam analysis. The fibres matter states have been studied during the dry annealing (at 400-1000 ^{0}C). The hydrolytic stability of the fibres has been estimated. The differences found in the composition and the properties of the fibrous materials produced by different technologies open the way to determine the optimum composition of raw material, fibres parameters important for longer working life period. Also the testing procedures are discussed.

The effectiveness of fibre diameter's measurements based on scanning electron microscopy is shown. The diameters distribution type is connected with fibre formation mechanism. In a majority of samples the string of beads structures are found. They are formed by the oval droplets up to 10 microns in diameter being put on the micron diameter thread. The familiar formations but made out of binding substance are found in foreign fibres.

The special study of refraction indexes of the fibre glass had shown that the calculation based on the gross chemical composition cannot properly predict the refraction index and the petrochemical characteristics, proposed by P.Nigglie, should also be taken into account.

The basaltic fibres are composed from the rather homogeneous (at the 1 micron level) glass. The possible submicron heterogeneities are connected with the Fe^{2+}/Fe^{3+} distribution. Both Fe atoms are the modificators of the silica-oxygen net, are the rather mobile elements open to oxidation and crystallization. The difference in the Fe valent state is connected both with the petrochemisty of the raw material and the basalt melts processing technology. The fibres of the Russian plants, where the natural basalt is used without collecting the charge, is more acidic as compared with the foreign companies products, made form the specially burden preparation. The Russian-made fibres contains more Fe^{3+}, has smaller diameter with larger diameter dispersion and thus larger ratio of an "inhaling fibres".

The presence of the Fe^{2+} outside of the silicon-oxygen net makes the fibres unstable for the oxidation and crystallization at the high (higher than 300 ^{0}C) temperatures. The crystallization of pyroxenic and ferritic phases and the rise in the oxidation degree is caused by the high temperature treatment, and finally it leads to the mechanical destruction of the fibre.

During the manufacturing process the ratio of Fe^{3+} increases (up to 20%). The content of Fe^{3+} ions in foreign fibres is sufficiently lower (up to 10-45%) as compared with Russian raw material and fibres. The decrease in Fe^{2+} ratio is considered to be responsible for changes of physical properties of the melt during the production process stages.

The exposure to the water vapor and different solutions support the slow destruction of the fibres. The 3-5 months period is sufficient for the leaching of the 2/3 of the fibre mass in the case it is located in the water milleau at the 90 ^{o}C temperature. It can be used as the estimation of the material working life duration. The important role is played by the different inhomogeneities of the subsurface glass layer formed at the cooling stage. These inhomogeneities are observed by the microscopy technique. The hydrolysis rate for the Russian fibres produced by the air-jet dispergation is lower as compared with the fibres produced by the centrifugal dispergation. It is connected with the different surface geometry of the reaction zone at the starting stage of the reaction. The Russian-made fibres are more stable against the leaching effect of the aggressive environment. Some recommendations are discussed concerning the charge moisture preparations, the increase of the fibre's diameters and the testing protocols. The charge mixture preparation of the Russian raw basalts with the purpose to decrease the $SiO_2+Al_2O_3$ ratio should be specially studied because the expected amendment of melt parameters could contradict with intensive oxidation of the fibre's material. The latter could launch the formation of microheterogeneities which presence is critical for the fibres stability in aggressive environment.

This research work was supported by the Moscow government grant № 1.1.145 of the 2002 and Moscow State University inter-disciplinary grant for 2002 and 2003.

Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(22)'2004
Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2004
URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2004/informbul-1_2004/term-45e.pdf
Published on July, 1, 2004