Research Group

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in field of mineral resources, metallurgy and chemical industry

Review of market of glass fibre and glass fibre products in Russia and CIS countries

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Internet: www.infomine.ru
e-mail: info@infomine.ru

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Introduction

The report is devoted to analysis of glass fibre and glass fibre products market in the CIS for promotional support of the customer.

Modern level of technological development owes demand for new materials with special properties. Among such new synthetic materials is glass fibre. Glass fibre materials has a number of valuable properties: inflammability, resistance to corrosion and biological action, rather high strength and relatively low density, in combination with excellent optic and electro-, heat- and sound-insulating properties. The materials find growing application in various branches industry.

The investigation includes the following main sections: technology of production; kinds of products and requirements, imposed on glass fibre and glass fibre products; production of glass fibre by CIS enterprises and their current standing; analysis of foreign trade operations; determination of consumers of glass fibre in various industrial end-uses.

Methodologically, the investigation is desk study. We considered and analyzed all available information sources, first of all, data official state bodies: Rosstat (Federal Service of State Statistics of Russia), Federal Customs Service of Russia, Inter-State Committee on Statistics of CIS countries, Customs Committee of Ukraine, Customs Service of Belarus, official Russian domestic railage statistic of JSC RZhD (former Ministry of Railway Transport of Russia), sectoral (industrial) and regional press, reports of companies, data from web-sites of company-producers, as well as information from InfoMine database and scientific-research literature.

1. Technology of production of glass fibre and resources used

1.1. Technology of production of glass fibre and glass fibre products

Glass fibre (glass fibre) is artificial fibre, formed from molten inorganic glass. The following types of glass fibre are distinguished: continuous glass fibre – complex glass filaments 20 km long (and more), 3-50 microns in diameter of a filament, and staple glass fibre – 1-50 cm long, 0.1-20 microns in diameter.

In Russia, 2 technologies of production of glass fibre are used: one-stage and two-stage.

The two-stage method (the most widespread) includes 1) stage of charge preparation, glass cooking, obtaining glass balls or small bars, and 2) stage of fusing the balls (bars) in fusing crucible and drawing fibre.

The second stage includes the following operations:

1. Preparing and feeding the balls/bars into the crucible.
2. Fusing and preparing glass mass for forming.
3. Obtaining rough fibre.
4. Forming fibre.
5. Cooling fibre.
6. Oiling fibres and joining them into filament.
7. Winding filament.

More modern and progressing **one-stage** methods provides for drawing fibres from glass mass, arriving directly from glass-cooking furnace (fed by charge directly)that excludes operation of obtaining balls/bars that, in turn, decreases power consumption practically in two times. Instead, operation of distribution of glass flow in the furnace by distinct die feeders.

Fibre oiling provides hydrophobization of fibre surface, decreasing its surface energy, friction coefficient from 0.7 to 0.3, and increasing tensile strength by 20-30%. The surface properties of glass fibre and its capillary structure determine low hygroscopy of the fibres (0/2%) and increased one for cloths (0.3-4%).

In the course of production of fibre for nonwoven materials, operations of joining fibres into filament and fibre reception are modernized depending on kind and designation of the product.

The one-stage method is applied by JSC «Saint-Gobain Vetrotex Glass fibre», JSC «Steklonit», LLC «URSA Serpukhov» and LLC «Saint-Gobain Isover Egor'evsk».

The most modern technology of production of glass fibre – so-called S-process – is applied in USA. The method provides for drawing fibres from feeders with 2000 and 4000 orifices, at rate of 750m/sec. Annual productivity of the facilities is 1080-1440 kg at 2000 orifices and 2160-2460 kg at 4000 orifices. Unfortunately, this technology is included in list of hi-tech technologies, exports of which is restricted considerably in USA, and Russian producers can not buy the technology (owing to the prohibition on its sale to Russia). For comparison, corresponding facilities, applied at Russian enterprises, have 800 orifices in die plates maximum, and rate of drawing is 10-100 m/sec.

From continuous glass fibre, obtained by die forming of thin mono-filaments of molten glass melt, twisted complex filaments are produced, as well as one-direction strips and cords (by joining 10-60 complex filaments. Complex glass filaments differs by glass composition, average fibre diameter (3-15 micrometers and more), quantity of simple filaments (50-800), twisting way.

From the twisted filament, cloth, nets, strips are produced at looms. Glass cloths differ by kind of netting and density (quantity of filaments per 1 cm). The cloth width ranges 500-1200 mm, thickness – 0.-17-25 mm, mass of 1 m2 – 25-5000 g. Depending of thickness, netting density and kind of surface treatment, glass cloths may demonstrate high transparency (translucence coefficient up to 64%), high sound absorption coefficient (up to 90% at frequency 500-2000 GHz), high reflection coefficient (up to 80%).

Staple glass fibre is formed by breaking molten glass flow (after die) by air, steam, hot gases or other methods, as well as by cutting complex filaments. It is used for manufacture of glass wool, glass fibre mats, plates. Glass fibre mats are commonly bounded (strengthened) by resins or mechanically.

1.2. Resources, used in production of glass fibre

1.2.1. *Composition of resources*

In production of glass fibre, common resources, applied in glass production, are used.

Resource for production of glass and glass fibre are subdivided into *main* and *auxiliary*. Glass fibre properties are determined by composition and properties of fibre-forming glass, used for its production. Several types of the glass (in glass composition) are distinguished (Table 1) .

Table 1. Typical composition of the main fibre-forming glasses, mass %

Components of glass	Grade of glass				
	A	C	E	S	Quartz
	High-alkaline	Chemically-resistant	Electric-insulation	High-strength	
SiO_2	70.5	64	53	64.2	99.95
Al_2O_3	3.1	5.5	15	24.8	-
Fe_2O_3	0.2	1	0.1	0.21	-
CaO	8.7	12	17	0.01	-
MgO	3.1	2	4	10.27	-
Na_2O	12	9.5	0.3	0.27	-
B_2O_3	-	2	10	0.01	-
BaO	-	2	-	0.2	-
Other	2.4	2	0.6	0.03	0.05

A-glass is also named “lime-sodium”, C-glass – sodium-boron-silicate, E-glass – aluminium-boron-silicate, S-glass – magnesian-alumino-silicate.

The main resources are presented by glass-forming oxides:

– SiO_2 is introduced in form of quartz sand, sandstone, quartzite or vein quartz;

– CaO and MgO is fed in form of dolomite, limestone, chalk, marble;

– Al_2O_3 arrives as pegmatite, feldspar, feldspar concentrate, nepheline, technical alumina;

– Na_2O and K_2O is fed as soda ash, potash, synthetic and natural sodium sulfate, sodium and potassium nitrates;

– In synthesis of alkali-free glasses, containing increased amount of boron oxide, artificial boric acid or natural calcium borate ($CaO \cdot B_2O_3 \cdot 2H_2O$) and asharite ($2MgO \cdot B_2O_3 \cdot H_2O$) are used;

– In synthesis of alkali-free glasses, containing increased amount of Al_2O_3, most often pure alumina or, much rarely, natural kaolin $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ are used.

In production of heat-insulation and acoustic items of building designation on the base of silicate melts, various industrial wastes are widely used: metallurgical slags, ash from power-generating plants, wastes of ceramic and silicate productions, natural rocks. Blast furnace slags are one of the main resource for production of mineral wool.

The auxiliary materials are presented by pigments, silencers (fluorite, oxides of tin and zirconium, talc). Lighteners, de-colorants, coking accelerators; their shares in charge are very small.

In addition, one of the main kind of resources is *broken glass*, share of which ranges 15-40%.

Depending on composition of glass, characteristics of glass fibre ranges considerably that determines end-use of the product.

The most important characteristics of glass fibre are presented in Table 2.

Table 2. Some properties of glass fibre

Parameter	Grade initial glass				
	A	**C**	**E**	**S**	**Quartz**
Density, kg/m^3	2500	2490	2540	2480	2210
Tensile strength (at 22^{o}C), GPa	3	3	3,5	4,6	6
Tensile elasticity modulus at растяжении (at 22^{o}C), GPa	74	69	72	86	75
Coefficient of linear extension, β, (β·10^{-6}); K^{-1}	8,6	7,2	5	5,6	0,55
Coefficient of heat conductivity, W/(m· K)	-	-	10,4	-	14,2
Specific heat, kJ/(kg x K)	-	0,89	0,83	0,74	0,9
Volumetric electric resistance (at 22^{o}C), Ом·m	10 ^{15}	-	10 ^{17}	10 ^{18}	10 ^{21}
Softening temperature, ^{o}C	730	750	840	-	1670
Dielectric constant (at 22^{o}C and frequency 1 MHz)	6,9	7	6,3	5,1	4,2

Fibres of A-glass are resistant to alkalis, but less resistant to water compared with fibres of E-glass. C-glass fibres are more chemically-resistant compared with A-glass. S-glass fibres are the most strong (high-strength) and demonstrate increased heat resistance. Quartz glass, composed of SiO_2 (above 99%), are used in production of heat-stable fibres, keeping their properties up to 700^{o}C.

Glass fibre are used as structural, electr0-, sound- and heat-insulation materials, in manufacture of filtering materials, glass fibre plastic, glass paper, etc. As rule, A-glass is processed into staple fibres and used in form of mats and plates for sound-

and thermo-insulation. Clothes of C-glass are applied in chemical industry for filtering acidic and alkaline solutions, for cleaning air and hot gases. Clothes of A-glass and E-glass are used in production of glass-textolite. High-strength S-glass fibre is used in manufacture of compounds for aircraft building and apparatus production. Quartz fibres are high-temperature dielectric and heat-stable materials. So-called high-lead and high-boron fibres are used as protectors from X-ray and radioactive radiation. Optical (light-transparent) glass fibres are used in manufacture of light guides and fibre glass cables.

1.2.2. *Characteristics of deposits of quartz sand in Russia*

State Balance of glass resources reserves in Russia, as of 01.01.2004, includes 81 deposit of quartz sands; balance demonstrated reserves of quartz sands are 597 mln tonnes.

Of the total glass resources reserves, distributed fund includes 38 deposits of quartz sands, including 28 being mined deposits with total balance demonstrated reserves of 185 mln tonnes (33.4% of total Russian reserves). Residual 10 deposits are being prepared for exploitation. Reserves of other 43 deposits of glass sands, being in State Reserve, are 204.2 mln tonnes (34.2% of Russian reserves).

Deposits of glass resources are distrubuted irregularly over the Russian territory. The bulk of reserves of quartz sands (41.6% of Russian reserves) belongs to Siberian Federal District, whereas share of the District in Russian reserves of quartz sands in exploited deposits is only 0.6%. At the same time, 98% of the exploited reserves (in being exploited deposits) of glass quartz sands of Russia belong to Central, Northwestern, Privolzhsky and Southern Federal Districts. Ural, East-Siberian and Far Eastern Federal Districts are poor in the reserves of quartz glass sands. For instance, in the Urals, no one distributed or mined deposit of quartz sands is available.

The greatest mined deposits of quartz sands in Russia are presented in Table 3.

Table 3. The greatest mined Russian deposits of quartz sands

Deposit	Region	Contents of SiO_2 and harmful impurities, %	Company-operator
Velikodvorskoe II	Ryazan' region	SiO_2– 97.9 – 99.1 Fe_2O_3 – 0.07 – 0.24	PJSC «Tumsky GOK»
Kingisepp	Leningrad region	SiO_2– 93.2 Fe_2O_3 – 0.18 Al_2O_3 – 0.28	LLC «Fosforit-Portstroi»
Chulkovskoe	Moscow region	SiO_2 – 90.1 – 99.17 Fe_2O_3 – 0.05	PJSC «Quartz sands»
Muraevnya	Ryazan' region	SiO_2 – 95.0 – 98.0 Fe_2O_3 – 0.1 – 0.8	JSC «GOK «Muraevnya»
Elshanskoe	Volgograd region	SiO_2– 96.8 – 98.6 Fe_2O_3 – 0.07 – 0.35	PJSC «Kamyshin container glass plant»
Tashlinskoe	Ul'yanovsk region	SiO_2– 98.5 – 99.88 Fe_2O_3 – 0.02 – 0.2 Al_2O_3 – 0.23 – 0.83	JSC «Quartz»
Kozlovskoe	Bryansk region	SiO_2– 93.9 – 98.9 Fe_2O_3 – 0.11 – 0.55 Al_2O_3 – 0.62 – 1.85	JSC «Quartzite»
Blagodarnenskoe	Stavropol' krai	SiO_2 –99.0 Fe_2O_3 – 0.08	LLC «Agropromenergo»
Priluzhskoe	Leningrad region	SiO_2 – 94.5 Fe_2O_3 – 0.23	LLC «Kingisepp GOK»
Maloiliktinskoe	Irkutsk region	data are not available	LLC PTK «Baikal-Lena»
Snezhet'skoe	Bryansk region	SiO_2– 96.74 – 97.68	JSC «Litii»

Deposit	Region	Contents of SiO_2 and harmful impurities, %	Company-operator
		Fe_2O_3 – 0.17 – 0.23 Al_2O_3 – 1.19 – 1.69	
Ostrov Zolotoi	Tatarstan	SiO_2– 97.1 Fe_2O_3 – 0.33	JSC «Zolotoi Ostrov»
Nebolchinsky	Novgorod region	SiO_2– 97.0 – 99.0 Fe_2O_3 – 0.07 – 0.3 Al_2O_3 – 0.29 – 0.5	JSC «Nebolchinsky kar'eroupravlenie»
Spasskoe	Stavropol' krai	SiO_2– 95.3 – 99.4 Fe_2O_3 – 0.06 – 0.36 Al_2O_3 – 0.05 – 2.29	LLC «Agropromenergo», FGUP «Sevkavgeologiya»
Krapivnenskoe	Novgorod region	SiO_2– 98.3 Fe_2O_3 – 0.16 Al_2O_3 – 0.79	PJSC «Russian mining company»
Krasny Oktyabr'	Vladimir region	SiO_2– 95.0 – 98.6 Fe_2O_3 – 0.16 – 1.09 Al_2O_3 – 0.1 – 3.25	JSC «Kovrov glass plant «Krasny Oktyabr'»
Berezichskoe	Kaluga region	SiO_2– 96.1 – 97.8 Fe_2O_3 – 0.12 – 0.22 Al_2O_3 – 1.17 – 1.9	JSC «Berezichsky glass plant»
Antonovskoe	Amursky region	SiO_2– 83.9 Fe_2O_3 – 0.5 Al_2O_3 – 11.4	JSC «Raichikhinsky glass plant «Dal'stek»

Source: State Balance of mineral resources of Russia. Glass resources, 2005

Volume of mining glass quartz sands in Russia increased by 20.6% for the latest 6 years up to 3.04 mln tonnes in 2004. The greatest Russian producers of quartz sand for glass industry are *JSC «Quartz»* and *JSC «Ramensky GOK»*, which together yield above 60% of total production in Russia (Table 4). 4 more producers of glass sands produce annually above 100 kt the product each. Besides, in small volumes, glass sands are mined by some enterprise-producers of molding (foundry) materials.

Table 4. Mining and production of glass sands by Russian enterprises

Company	Region	Volume of mining, kt					
		1999	2000	2001	2002	2003	2004
JSC «Quartz»	Ul'yanovsk region						
JSC «Ramensky GOK»	Moscow region						
LLC «Fosforit-Portstroi»	Leningrad region						
LLC «Agropromenergo»	Stavropol krai						
JSC GOK «Muraevnya»	Ryazan' region						

Company	Region	Volume of mining, kt					
		1999	2000	2001	2002	2003	2004
LLC «Firm «Mechta»	Tver' region						
JSC «Nebolchinsky Kar'eroupravlrnie»	Novgorod region						
PJSC «Kamyshin container glass plant»	Volgograd region						
PJSC «Quartzite»	Bryansk region						
JSC «Pokrovsky glass plant»	Vologda region						
JSC «Litii»	Bryansk region						
Other enterprises	-						
Total for enterprises	-						

Source: Rosstat, Russian domestic railage statistics, data of the companies, estimate of «InfoMine»

In Russia, by now, only 4 enterprises are capable to conduct concentration of glass sands: JSC «Ramensky GOK», JSC «Quartz», JSC «GOK «Muraevnya» and JSC «Dal'stek», which exploit, respectively, Eganovskoe, Tashlinskoe, Muraevnya and Antonovskoe deposits. In addition, pilot facility of concentration of glass sands was commissioned at Kingisepp deposit. Other enterprises supply quartz sands to glass plants without preliminary treating and concentration.

Resources provision of producers of glass fibre with quartz sands is presented in Table 5.

Table 5. Mining enterprises, supplying quartz sands to producers of glass fibre

Producer of glass fibre	Mining company
JSC «Saint-Gobain Vetrotex Glass fibre»	JSC «Ramensky GOK» (Moscow region)
JSC «Steklonit»	JSC «Quartz» (Ul'yanovsk region)
JSC «Stupino plant of glass fibre plastic»	JSC «Ramensky GOK» (Moscow region)
JSC «Tver'glass fibre plastic»	LLC «Firm «Mechta» (Tver' region)
JSC «Makhachkala plant Glass fibre»	JSC «Millerovsky GOK» (Rostov region)

JSC «Novgorod plant of glass fibre»	JSC «Nebolchinsky kar'eroupravlenie» PJSC «Russian mining company» (Novgorod region)
JSC «Astrakhan' glass fibre»	JSC «GOK «Muraevnya» (Ryazan' region)
JSC «Sudogda glass fibre»	JSC «Kovrov glass plant «Krasny Oktyabr'» (Vladimir region)

Source: «InfoMine» on the basis of data of Russian domestic railage statistics