InfoMine research group

Union of Independent Experts in the Field of Mineral Resources, Metallurgy and Chemical Industry in the CIS

Natural Fine-Graded Calcium Carbonate (GCC, chalk, microcalcite) Market Research in the CIS

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

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ANNOTATION

The actual report is devoted to research of current situation in the market of natural fine-graded calcium carbonate (GCC) in the CIS and its development outlook. The Report consists of eight Sections, contains 214 pages, including 83 tables, 39 figures and 2 supplements.

The Report's First Section presents brief features of GCC World market. It gives assessment for output volume of this production, provides prices for chalk commodities in the World market.

The second chapter of the report is devoted to analysis of raw-material base for GCC manufacture in Russia, Ukraine, Kazakhstan and Byelorussia. This Section provides data in regard of balance stocks of chalk and marble, regional structure of resources location and characteristics of raw materials at certain deposits as well.

The Third chapter considers technological schemes of GCC manufacture being applied at present time, provides description and contact information with leading suppliers of equipment for manufacture of fine-graded products.

The Fourth chapter provides statistics over volumes of GCC output in the CIS countries and current condition of enterprises manufacturers, including information about time of existence of the enterprise, sources of the raw materials, applied production technologies, characteristics of manufacturing production and target markets. The Third Chapter further includes information in regard of existing projects on organization of GCC manufacture in the CIS countries.

The Fifth chapter of the report is devoted the analysis of GCC foreign trade operations by the CIS countries. It brings data on volumes of deliveries of this product, estimates regional structure of foreign trade operations, provides information in regard of directions and volumes of deliveries by leading exporters and importers of fine-graded chalk and a microcalcite.

The Sixth chapter of the report provides GCC price analysis. This section gives average prices of the Russian manufacturers of chalk; GCC of various marks factory gate prices at the enterprises. This section also analyses export-import prices for GCC.

The Seventh chapter is devoted to assumption of GCC consumption in Russia. It provides balance of "manufacture-consumption", evaluates regional and branch structure of consumption. The section also gives current state and prospects of development of key consuming branches.

The final, the Eighth Chapter of the Report, presents forecast for GCC output in Russia, as well as outlook for fine-graded chalk and microcalcite consumption until 2015.

Appendix 1 provides contact information from key producers of GCC in the CIS countries.

Appendix 2 includes technological flow sheet and equipment specification for engineering of process line to produce fine-graded chalk with capacity of 10 ton per hour Lamel-777 (Byelorussia).

This work is a "desk" study. As sources of information, we used data from Rosstat, Federal customs service of Russian Federation, Federal customs service of Russian Federation, official statistics of domestic railway transportation of Russian Federation, Goskomstat of Ukraine, the CIS countries (production indicators), State Customs Committee of Ukraine (data on foreign trade operations), Agencies for statistics in Republic of Kazakhstan (РК). In addition, we attracted data from industrial and regional press, annual and quarterly accounts of emitters of securities, Internet sites of enterprises, and information databases of enterprises, database of Infomine. Because cargo transportation motor transport is not subject to the obligatory statistical account in Russia, the present report presents data in regard of transportations just by railway.

INTRODUCTION

Natural Fine-Graded Calcium Carbonate (GCC – ground calcium carbonate, $CaCO_3$) proved to be carbonate-filling agent for manufacturing of various composite materials administered to composite mixes with the aim of lowering their cost and granting them certain performance properties.

In general, one could get fine-graded carbonate-filling agent from three main sources:

1. Development of chalk pit of ***sedimentary*** origin with further milling, purification and possible hydrophobization (GCC-chalk);
2. Exploitation of calcite open-cast mines of ***metamorphic*** origin with milling, purification and possible hydrophobization (GCC-microcalcite)
3. Artificial extraction by means of chemical sedimentation (Precipitated Calcium Carbonate - PCC).

Recently, ShengdaTech Inc. (China) company developed some method of extraction of NPCC – nano-precipitated calcium carbonate – from limestone. The new product finds application in polyethylene utilization.

Thus, GCC is natural calcium carbonate, and PCC with NPCC are synthetic products.

There are three facies used as initial raw materials in manufacture of natural carbonate fillers (GCC) – chalk, limestone and marble.

The *chalk* corresponds to loosely coherent sedimentary strata of biogene origin. *Limestone* is a more condensed against chalk rock. *Marble* is a product of natural recrystallization of chalk or limestone been exposed to high pressures and temperature.

It is the **chalk** that is most widely being applied in manufacture of GCC. It is due, first, to predominance of the Cretaceous period sediments in geological structure of earth crust. A powerful cretaceous belt stretches through the entire European continent, including the north of France, southern part of England, Poland; it passes through Ukraine, Russia and runs to Asia – Syria and Libyan Desert. Chalk stocks are almost unlimited in many European countries, countries of former CIS and in Russia.

Distinctive feature of this natural material lies with easiness in its extraction and treatment at rather low costs. Extraction and processing of chalk does not cause serious ecological infringements.

The chalks as raw materials for manufacture of GCC boast its advantages and suffer disadvantages. Advantages are – lower cost of excavation against other raw materials, and comparative looseness (on a scale of Moosa – 1). Later makes fillers, prepared with sedimentary chalk much more suitable from the point of view of wear of equipment, therefore technologists from many enterprises prefer this kind of fillers. This raw material also is rather "pure". The contentof calcium carbonate in chalk reaches 96-99 %; the impurities are clay, glauconite, and ferrous oxides. Content of non-carbonate rocks is insignificant, but they considerably complicate technology of extraction of high-quality cretaceous powder. As imperfection, it is worth mentioning comparatively low whiteness (up to 87 %) against carbonates of metamorphic origin. However, this imperfection is cured with optical brighteners or titan dioxide (TiO_2).

The most popular method of fine-graded chalk manufacture includes rough crushing of initial raw material, magnetic separation, wet powdering, fine crushing in jet disintegrators, collection of suspension with dispergator addition (sodium triphosphate or sodium triphosphate with carbonic sodium mixture are used as dispergator), enrichment in hydrocyclones with intermediate gathering of suspension, secondary thin crushing in jet disintegrators and spray drying.

Limestone and marble possess definitely expressed crystal structure. Limestone is the most widespread sedimentary rock containing up to 95 % of $CaCO_3$. Carbonate share of limestone also includes dolomite $CaMg(CO_3)_2$, $FeCO_3$ and $MnCO_3$ (below 1 %), non-carbonate impurities presented by clay aluminosilicates and silica minerals (opal, chalcedony, quartz) and in small amounts oxides, hydroxides and sulfides Fe, $Ca_3(PO_4)_2$, $CaSO_4$, organic substance. Thus, limestones are considered the most "polluted raw materials".

Industrial fillers based on marble are characterized by very high whiteness. For manufacturing fine-graded filler, marble is subject to micronization (mechanical, jet and ultrasonic crushing is used).

The main property, which defines field of application of fine-graded product, is ***granulometry*** – a set of numerical parameters and graphic histograms of particle distribution.

The basic figure in granulometry is average size of particles (d50) of core share of filler. Important parameter is also top limit of particles size (d90, d97), showing so-called "tail" – the size of the particles exceeding average level. In case the parameter significantly exceeds the average size, the raw materials practically is unsuitable for use since even a small contentof large particles against great bulk leads to decrease in properties of production and wear of equipment. The bottom limit of the size of particles is not obligatory and consequently many manufacturers do not specify it.

For characterizing of carbonate fillers with average size of particles above 100 micron, they often use such parameter as ***sieve residue***, showing percentage of particles of the set size, which has remained on a sieve after sifting.

Depending on field of application, great importance is attached to such characteristic of a product, as ***whiteness*** – quantity of light beams in percentage, reflected from substance. So, for example in the plastic industry, this parameter plays large role in manufacture of white window profile, and is less important in manufacture of colored lining boards or laminated window sills. Whiteness plays very important role, when chalk is used in manufacture of paintwork materials. Whiteness most often depends on chemical cleanliness of filler.

The greatest whiteness among natural versions of calcite (up to 99.8-99.9 %) belongs to colorless and transparent Icelandic spar. Whiteness decreases mainly due to presence of ferrous oxides infiltrated with soil and underground waters through cracks between blocks and crystals of calcite. Marble whiteness at commercial deposits is in limits of 94-96 %; 98 % in separate blocks is rare. Whiteness of chalk usually makes no more than 84-86 %. Higher whiteness belongs to marble and chalk in droughty areas and at deep position.

Other physical properties of fine-graded product - ***humidity, dispersancy, hygroscopicity, hardness***, – are differently important in production depending on type of production being manufactured.

Cleared from extraneous impurity, calcium carbonate is widely used in construction. Crack fillers, various hermetic, glues and dry building mixes – all of them contain calcium carbonate in significant amounts. Besides, this product makes some 20% of the painting pigment used in manufacture of paints.

Manufacturers of plastic mass are also one of key consumers of calcium carbonate as well. Used as filler and dyer, calcium carbonate is required in manufacture of polyvinylchloride (PVC), polyester fibers (crymplen, lavsan, etc.), and polyolefin.

Paper industry applies GCC as bleach, filler (replacing expensive fibers and dyes with it), and as deoxidant too.

In addition, calcium carbonate is major component in manufacture of rubber, coagulants for water treating, household chemical goods production – means for cleaning sanitary equipment, footwear creams, etc.

$CaCO_3$ finds application in manufacture of goods for personal hygiene (for example, toothpaste), and in food industry. However, volumes of consumption of this raw material in these branches are insignificant. Moreover, even more specific and less capacious are such fields of application of calcium carbonate, as manufacture of pharmaceutical powder mixes for tabletation or manufacture of mixed fodders, as well as manufacture of chemical reactants.

The property complicating application of carbonate filler, chalk in particular, is its ability of aggregation at insignificant humidifying because of big "connectivity" of particles. It leads to chocking-up and caking in bunkers, to difficulty of transportation and use. For elimination of this phenomenon, chalk is subject to superficial processing – hydrofobization that means coating of particles' surface with surface-active substances giving chalk resistance to water and causing good flowability.

As a whole, volumes of consumption of carbonate fillers are tens of times less than extraction and use of carbonate raw materials for manufacture of cement, lime, break stone, etc. So, in 2009, manufacture of carbonate fillers in Russia consumed below 450,000 ton of chalk and 400,000 ton of marble while just extraction of chalk reached some 30 million ton.

1. GCC World Market Brief Appraisal

Development of rubber goods and electro technical branches, polymer goods, paintwork and other industries needs increase in output of high quality fillers, including chalk in the first place. Annual consumption of chalk in lump, crashed and milled form in developed countries stands for some 170 million ton. USA and Canada produce over eight million ton of milled marketable chalk, in Europe – over 15 million ton. Key World producers of milled marketable chalk are USA, China, France, England, Belgium and Russian Federation.

Leading exporters of milled chalk are France, Denmark and Germany. Importers are Germany, Belgium and Netherlands. Some European countries, such as Germany, import chalk for milling and subsequent export of fine-graded product, which costs much higher.

Experts assume that since 2001, GCC (produced from chalk, marble and limestone) World market capacity was increasing 7 per cent a year and reached 80 million ton in 2008 (including produced from chalk – near half). From which not less than 60 million ton has been used in manufacture of paper, plastic mass and paints. The main growth in producing GCC capacities falls upon makers of fine-graded chalk for paper industry.

Some 70 per cent of GCC production is the share of 10 largest companies, including Omya of Swiss (30%) and French Imerys (10-15%). However, the dominating share of these transnational companies in resent years had reduced due to increase in volumes of GCC output just by enterprises of paper industry directly, primarily in China.

In Western Europe and North America, companies which extract and process raw materials on their own (such as OMYA and Imerys), are the main manufacturers of GCC. At the same time in Asia, primarily in China and Japan, manufacture of GCC is carried out directly by industrial divisions of pulp-and-paper industrial integrated plans that buy the raw material at mining companies.

GCC main consumers are pulp-and-paper industry enterprises as well as manufacturers of plastic mass and polymers. Pulp-and-paper industry now accounts for some 40% of GCC consumption. Besides, this branch is the largest consumer of chemically precipitated calcium carbonate (PCC).

In addition, significant volume of GCC (some 20% of world consumption) goes to manufacture of polymers and plastic mass.

The basic growth in demand for GCC is observed in Asia due to dynamic acceleration in Chinese market. In Europe and North America growth in consumption of fine-graded carbonate fillers resulted from increase in manufacture of penetrable polymeric materials.

Fine-graded chalk prices remain almost flat since 2001 when two leading manufacturers of this product OMYA and Imerys increased its prices by 6%-8%. However, chemically precipitated chalk (PCC) (Table 1) prices had grown during two last years.

Table 1: Fine-graded Chalk World Prices in 2006-2010

Country	Kind of Product	Terms of Delivery	Price, £/ton		
			2006-2007	2008-2009	1 half of 2010
GB	Hydrophobizated GCC (chalk)	ex-works	30-52 £	30-52 £	-
	Hydrophobizated fine-graded GCC (chalk)	ex-works	80-103 £	80-103 £	80-103 £
	High brightness GCC for paper-and-pulp enterprises (1.5 micron)	ex-works	-	170-180 £	-
	Hydrophobizated PCC (without coating)	ex-works	300-390 £	320-420 £	320-480 £
	Hydrophobizated PCC (coated)	ex-works	300-417 £	320-450 £	350-550 £
USA	GCC 5-7 μ	FOB USA	110-160 $	110-160 $	-
	GCC 2-0.5 μ	FOB USA	140-290 $	140-290 $	-
	GCC 0,4-1 μ	FOB USA	250-270 $	250-270 $	-
	Ultra fine-graded with reinforced surface PCC (0,02-0,36 μ)	FOB USA	375-750 $	375-750 $	-

Source: Industrial Minerals

According to experts' assessment, GCC volume of production in the World would be expanding 2%-4% per annum and reach 90 million ton by 2015.

2. Reserves and Deposits of the Raw Materials for Production of GCC in the CIS Countries

Chalk resources distribution over the territory of former USSR is highly irregular: some 48-50 % of high quality chalk rich with calcium carbonate and magnesium as well as minimum rate of harmful impurities centers in Russia; some 32-33 % in Ukraine and a bit over 12 % in Byelorussia. There are small deposits by resources in Kazakhstan, in Lithuania and Georgia.

2.1. Russia

Chalk resources in Russia are being registered in several releases of the State balance of minerals resources. Release under name of "Chalk" now lists 117 deposits of a chalk with total category A+B+C_1 balance reserves making 1,140.3 million ton and category C_2 – 305 million ton. Two more chalk deposits for soda production and rubber manufacture with total category A+B+C1 reserves at 115.7 million ton and C_2 categories at 26.7 million ton are accounted in the balance sheet of "Carbonate raw materials for chemical industry". One more deposit with A+B+C_1 category resources at volume of 19.3 million ton and C_2 category at 1.1 million ton is listed in the balance sheet of "Carbonate raw materials for sugar and pulp-and-paper industry". All 18 deposits of a chalk with resources of A+B+C_1 category at volume of 3,318.8 million ton and C_2category at 1,066.8 million ton are accounted in the balance sheet of "Cement raw materials".

Geography of chalk deposits in the territory of Russian Federation is extremely irregular. Over half of all chalk resources - 65.4 % - are concentrated in Central Federal District (Table 2) of which 40.4 % of balance stocks are located in Belgorod Region

Table 2: Geography of Chalk Balance Reserves in Russia

Federal district, Subject of the Federation	Number of deposits	Balance Resources, 000 ton			C_2
		A+B	A+B+C_1		
			Total	% to resources in Russia	
Central	**53**	**184565**	**745394**	**65.37**	**251015**
Kaluga Region	1	1184	2446	0.21	-
Briansk Region	11	32380	82754	7.26	3411
Orel Region	1	6928	11599	1.02	-
Kursk Region	10	30762	79651	6.99	-
Belgorod Region	19	54560	460229	40.36	182959
Voronezh Region	11	58751	108715	9.53	64645

Federal district, Subject of the Federation	Number of deposits	Balance Resources, 000 ton			C_2
		A+B	$A+B+C_1$		
			Total	% to resources in Russia	
South	**6**	**8546**	**15843**	**1.39**	**-**
Rostov Ростовская Region	6	8546	15843	1.39	-
Privolzhsky	**55**	**163135**	**377922**	**33.14**	**54337**
Mordovia Republic	2	3590	11510	1.01	-
Penza Region	3	10844	23679	2.08	-
Ulyanovsk Region	16	44887	78676	6.90	9602
Samara Region	3	12630	25312	2.22	37744
Saratov Region	16	43174	147509	12.94	6991
Volgograd Region	13	47631	89976	7,89	-
Orenburg Region	2	379	1260	0,11	-
Total in RF	**117**	**356801**	**1140271**	**100,0**	**305352**

Source: State Register of Mineral Resources in RF, Chalk

Privolzhsky Federal District occupies second place by quantity of resources and boasts 33.1% of chalk reserves in Russia. Southern Federal District shares insignificant resources of total Russian chalk (1.4 %). There are almost no explored reserves of chalk in Northern and Northwest regions of Russian Federations. From among accounted in release "Chalk" chalk deposits, 47 are registered in the balance sheet of industrial enterprises ($A+B+C_1$ category reserves total 729 million ton, C_2 category make 84 million ton), 70 deposits are the State reserve of Russia ($A+B+C_1$ category reserves make 407 million ton, C_2 category - 221 million ton).

Among all registered deposits, 42 are considered as being developed. A+B+C1 category chalk reserves of being developed deposits make 62.76 % of total Russian chalk reserves. Five deposits are being prepared for development and their resources make 1.56 % from total Russian reserves.

The largest by reserves of chalk are the following deposits: Lebedinskoye (24.1%) and Prioskolskoye (10.6%) in Belgorod Region as well as Kopanishchenskoye (5.2%) in Voronezh Region and Volskoye (5.4%) in Saratov Region. In total, the share of 10 top deposits exceeds 63% of resources of this kind of mineral raw materials (see Table 3).

Table 3: Major Deposits of Chalk in Russia

Deposit	$A+B+C_1$ Category Reserves, million ton	Share in Total Reserves of RF, %	State of Exploitation

Source: State Register of Mineral Resources in RF, Chalk

It is worth mentioning that all without an exception registered in the balance sheet release "Cement raw materials" chalk deposits could be considered as key deposits of the Russian Federation. The largest of them are Fokinskoye, Belgorodskoye, Stoylenskoye, Kremenskoye, Soldatskaya Tashla, the Communar, Klimovskoye, the Bolshevik, Sebriakovskoye, Krasny October. However, the chalk being extracted at these deposits is used only in manufacture of cement and not applied to GCC production.

The largest deposits of high quality chalk are in Belgorod region. There are over 29 explored deposits of a chalk with confirmed reserves of 1 billion ton in this Region. Prospective reserves of chalk in Belgorod Region are practically limitless. The largest chalk deposits are Lebedinskoye, Stoilenskoye and Logovskoye. Thus, Lebedinskoye and Stoilenskoye deposits boast 75% of discovered resources of chalk in Belgorod Region. These two deposits are exploited for mining of iron ores whereas the chalk is just overburden during extraction of iron ore.

Deposits of chalk of Voronezh Region correspond to Turonian-Coniacian age. The chalk possesses high rate (up to 98.5%) of calcium carbonate and low contentof non-carbonate impurity – below 2%; it is enriched with amphoteric silica, brought, obviously, from Santon era sediments. The chalk lies immediately under surface and is covered with eluvia chalk or by Quaternary sediments. Prominent feature of the chalk from deposits in Voronezh Region is its water saturation. Moisture rate in the chalk reaches 32 % resulting in serious difficulties during its extraction and processing. The largest deposits in Voronezh Region could be Kopanishchenskoye, Buturlinskoye, Kruprennikovskoye and Rossoshanskoye.

Russia at above-mentioned deposits extracts and dumps over 15 million ton of chalk annually, this way irrevocably losing it. Only insignificant its part (near 5 million ton) is used for manufacture of cement and extraction of milled chalk.

Chalk Deposits Description

Lebedinskoye chalk deposit is located in Belgorod Region. The chalk sediments occurrence is of sub regional nature with small immersing to the East. In the central part of a deposit the karst is developed. Seam thickness of the mineral varies in a range of 13.2-66 m at average formation of 49.6 m. Quality of a chalk is sustained. The density of rocks is 1,820 kg/m^3, natural humidity is 14.7-42.1%. Chemical composition of chalk: $CaCO_3$ – 97.52%; CaO – 54.65%; $MgCO_3$ – 0.53%; MgO – 0.26%; Fe_2O_3 – 0.25%; Al_2O_3 – 0,22%; K_2O – 0.05%; Na_2O – 0.1%; P_2O_5 – 0.07%.

Kopanishchenskoye chalk deposit is located in Voronezh Region. Sediments of Quaternary, Neogene, Palaeogene and Cretaceous systems generate deposit area. Effective bulk represents tabular accumulation of homogeneous white writing chalk of Coniacian-Turonian tier of cretaceous system and fluctuates within 16.5-85 m (at average of 35 m). Vertically the body is divided into two packs, from which the bottom contains to 98% of calcium carbonates and magnesium, while top is slightly less rich (96-97.5%). Overburden rocks are presented by loams with coarse-grained inclusions and make only 1.8-2 m. Effective bulk of the deposit not irrigated. Chemical composition of the chalk: $CaCO_3$ – 98.1%; $MgCO_3$ – 0.34%; Fe_2O_3+Al_2O_3 – 0.45%; insoluble with HCl residue – 1.6%.

Zeleonaya Poliana (Green Glade) chalk deposit is located in Belgorod Region. Sediments of Cretaceous, Palaeogene, Neogene and Quaternary systems generate geological structure of deposit area. Effective bulk is presented by white writing chalk of Campania tier of the top chalk. The rock is combined of fine-grained calcite with the