Research Group

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in mineral resources, mining, metal and chemical industries in the CIS

Review of Cement Market in Russia and Central Federal District

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Abbreviations

CFD – Central Federal District
ZHBI – ferroconcrete articles
ZHBK – ferroconcrete constructions
combine **KPD** – combine of large-panel house building
DSK – house-building combine
ZBK – Plant of Building Constructions
KPP – Combine of production enterprises
UPTK – Department of production-technological making up a set
UK – Management Company
TD – Trade House

Annotation

The report is devoted to studying Russian cement market and prospects of its development. The report includes 7 Sections, 237 pages, 110 Tables, 33 Figures and 2 Appendixes. The report is a desk study. As information sources, data of Rosstat, Federal Customs Service of Russia (FCS), official domestic railage statistics of Ministry of Railways of Russia, the sector and regional press, annual and quarterly repots of companies, internet-sites of company-producers of cement were used.

The first Section presents review of modern technologies of cement production, description of leading world producers of technological equipment for cement production and engineering companies.

The second Section presents appraisal of standing of resources base of cement industry in Russia, including data on cement resources reserves, regional pattern of their location, as well as data on resources base of leading Russian producers of cement.

The third Section is devoted to production of cement in Russia. The report contains statistics of output of cement in the country in 1997-2006, data on regional and commodity structure of the production and volumes of cement production by various producers. Besides, the Section contains data on current standing of leading players of Russian cement market, including ownership pattern, available production capacities, range of products, plans of the business development, flows (destinations) and volumes of cement shipment and release prices on cement.

The fourth Section analyses data of Federal Customs Service of Russia on foreign trade operations with cement in 2000-2006, with data on regional structure of export-import supplies, the main Russian exporters and importers of cement.

The fifth Section, devoted to consumption of cement in Russia, contains supply-demand balance of cement for the latest 7 years and estimation of dynamics of apparent consumption of cement in Russia. Besides, the Section analyses dynamics of prices on cement at domestic market, as well as estimates regional and sectoral (“by end-uses”) structure of cement consumption in Russia as a whole and Central Federal district (CFD) and seasonality of the supplies.

The sixth Section presents is devoted to analysis of price conjuncture of Russian cement market, including analysis of dynamics of prices on cement at domestic market for the latest years, review of export-import prices on the product and forecast of price conjuncture of the market up to 2010.

The seventh Section presents forecast of development of cement market in Russia and CFD up to 2015, including forecast of cement production, development of cement end-uses and cement consumption in Russia as a whole and CFD.

The appendixes contain contact information on producers of cement in Russia, available classifications of cements and requirements, imposed on grade of cements by State Standards.

Introduction

Cement industry is one of the oldest industrial sectors in Russia, peak of which fell to 60-80s of the 20th century, when (in 1962-1989) the country was the greatest producer of cement in the world, with peak of 85.3 mln tonnes in 1989. But later the production considerably decreased in connection with overall worsening economic situation in Russia and sharp dropping construction works volume, to 26 mln tonnes only in 1998.

The high rates of cement output growth in the country for many years was owed by raising capital investments and volumes of building-and-erection works. Notice that around 80% of cement produced were consumed in the building sector, being locomotive of cement sector development. The setback in building industry caused corresponding drop of production in cement industry. Additional negative effect on cement production was produced by sharp growth of prices on power resources, materials in conditions of high inflation rate, high degree of wearing technological equipment and shortage of funds for production modernization. This all resulted in decreasing profitability of cement companies, up to bankruptcy and complete stopping production in some cases.

However, starting in 1999, improving of standing of Russian cement industry takes place, and, since that time, stable growth of cement production in the country takes place.

1. Review of modern technologies of cement production, global engineering companies and producers of equipment

1.1. Technology of cement production

Production of cement consists of several technological operations, which can be conditionally subdivided into 2 groups. The first one is operations on production of clinker, and the second is milling the clinker together with gypsum and other additives to obtain portlandcement.

Production of clinker consists of mining resources, grinding, milling and mixing them in specified proportion, and roasting the mix. Depending on method of preparing the resources mix, production of clinker is subdivided into dry, wet and combined methods. Preparing the resources mix at cement plants includes crushing the material, sizing, milling, correction of the mix composition and its homogenizing. Choice of variant of realizing each technological operation and corresponding equipment depends on properties of processed resources.

In ***wet method,*** fine milling the resources mix is conducted in aqueous medium to obtain charge as aqueous suspension – slime 30-50% moist. At present time, in Russia around 87% clinker are produced by wet method.

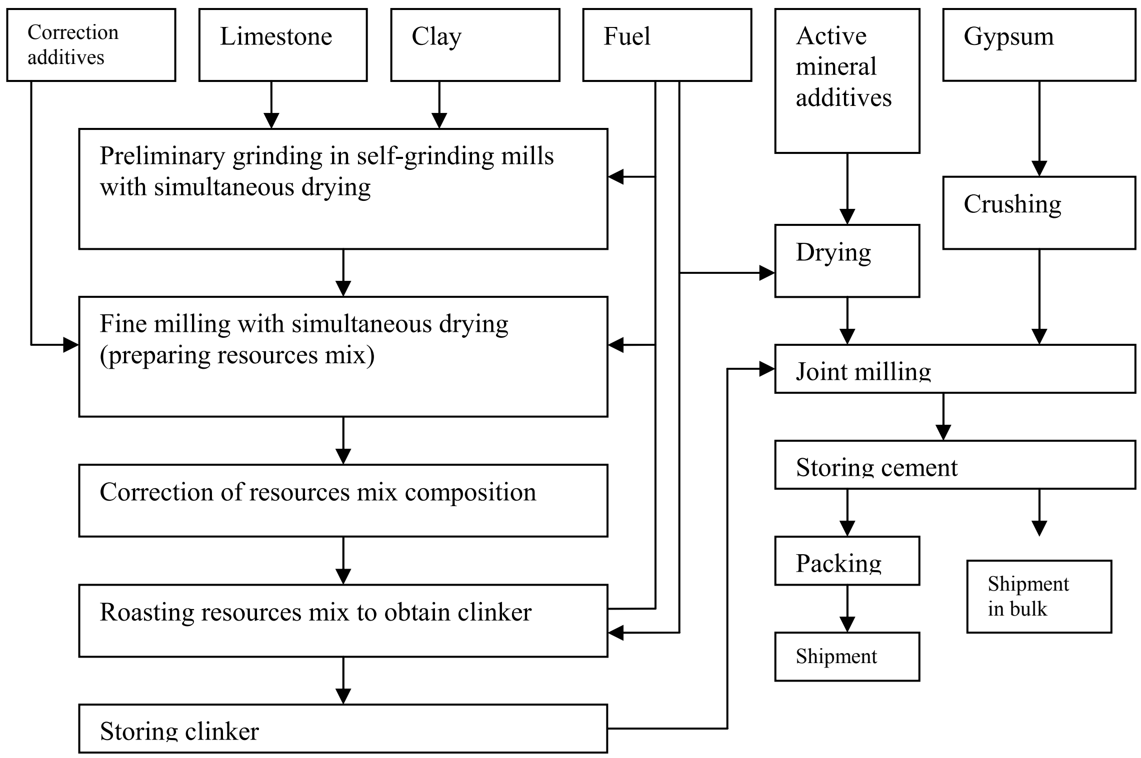
In dry ***method***, the resources mix is prepared as fine-milled dry powder, so before or in the process of milling, the resources are dried. The methid is the most widespread in the world, and in a number of countries, share of clinker production by the method reaches 100%.

Combined method can be based both on wet and dry methods of charge preparation. In the first case, the resources mix is prepared by wet way as slime, and then is dewatered at filters to moisture 16-18% is fed to roasting into kiln as semi-dry mass. In the second case, the resources mix is prepared by dry method, and then is granulated with addition of 10-14% of water and is fed to roasting as granules 10-15 mm in diameter.

Each method of clinker production can be realized in form of several technological schemes, differing both by sequence of operations and kind of equipment used.

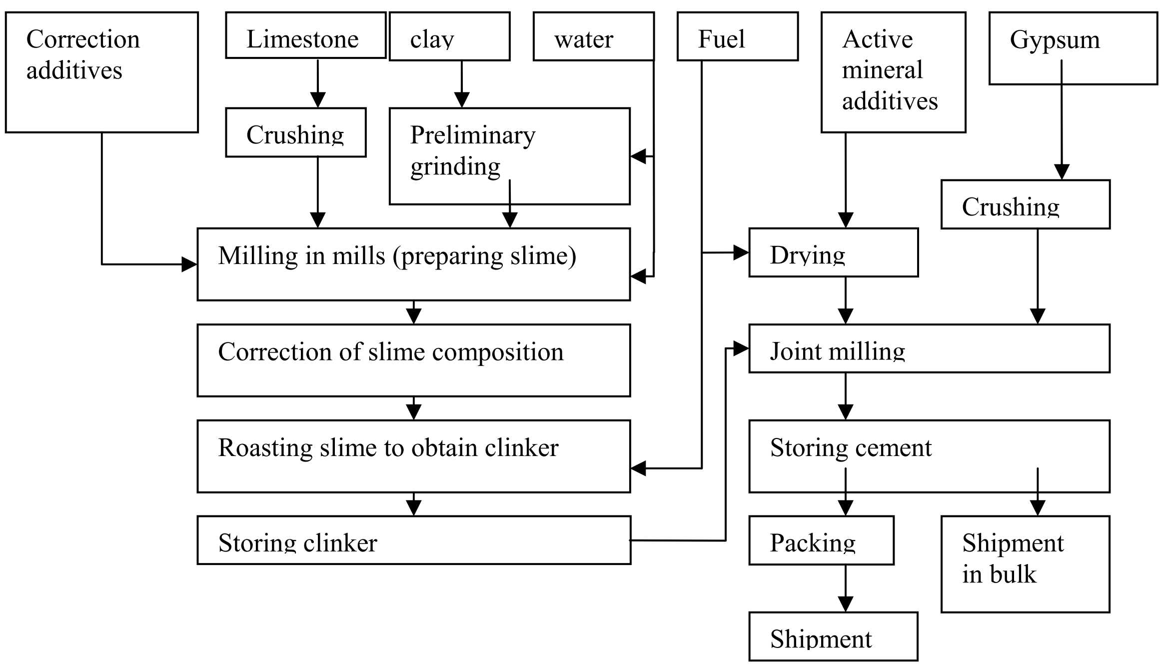
Schematic flow sheets of cement production by dry and wet methods are presented in Figures 1 and 2.

Figure 1. Schematic flow sheet of cement production by dry method



Source: Sulimenko L.M. "Technology of mineral binding materials and articles on their base" – M: Vysshaya shkola, 2005

Figure 2. Schematic flow sheet of cement production by wet method

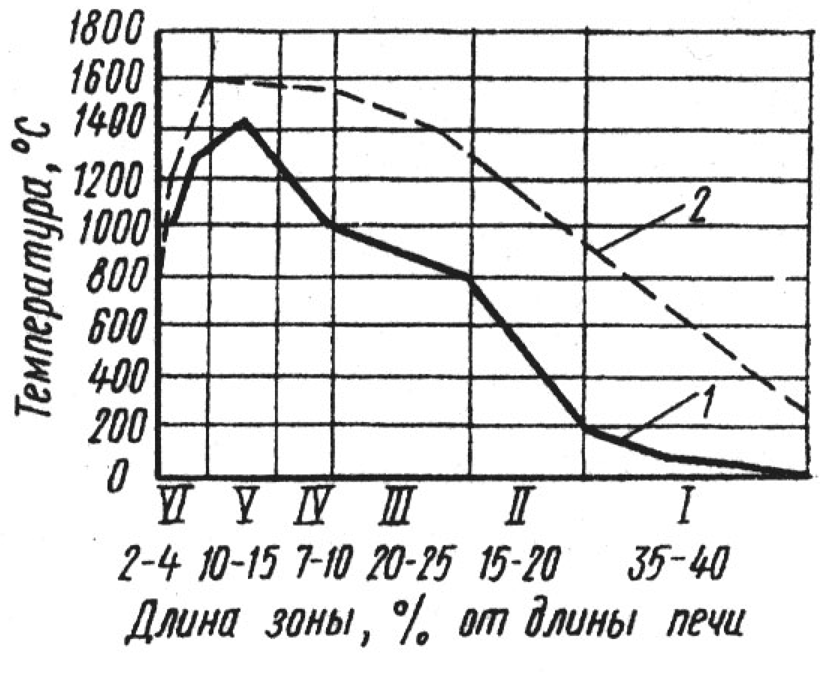


Source: Sulimenko L.M. "Technology of mineral binding materials and articles on their base" – M: Vysshaya shkola, 2005

Formation of portlandcement clinker consists in several physico-chemical processes, resulting in changing mineralogical composition of clinker and formation of microcrystalline structure of the product. The processes occur in pre-set temperature intercals – technological zones of kiln.

In the main roasting facility – rotary kiln – at wet method of cement production, in direction of moving the material, the following zones are distinguished: I – evaporation, II – heating and dehydration, III – decarbonization, IV – exothermic reactions, V – caking, VI – cooling. Preparation zones I-II fill 50-60% of kiln length, decarbonization zone – 20-25%, zone of exothermic reactions – 7-10%, caking zone – 5-10% and cooling zone – 2-4%. In Figure 3, distribution of temperatures of material and gas flow by zones of rotary kiln is shown.

Figure 3. Distribution of temperatures of material and gas flow by zones of rotary kiln



Length of zone, % of kiln length
1 – material; 2 – gas flow; I–VI – zones of kiln

Source: Sulimenko L.M. "Technology of mineral binding materials and articles on their base" – M: Vysshaya shkola, 2005

In the evaporation zone, slime for a long time keep temperature around 100°C and only in the end is heated to 200°C. Heat consumption in slime moisture evaporation are around 35% of total energy consumption. When heated, the slime initially is liquefied, and then is thickened. In production of clinker by dry method this zone in roasting kilns is absent that allows to decrease considerably the kiln sizes.

In the heating zone, at temperature 200-650°C, organic admixtures are burnt out, and dehydration begins with decomposing clay components, with forming a number of intermediate compounds, effecting then on rate of CaO binding.

In the decarbonization zone, at temperature 900-1200°C, dissociation of carbonates of calcium and magnesium proceeds with forming CaO and MgO, as well as continuing decomposing clay minerals.

At increasing temperature, solid-phase reactions proceed in the mix, resulting in formation of di-calcium silicate, aluminates and alumino-ferrites of calcium. Usually, at temperature 900-1200°C, decomposing $CaCO_3$ outstrips forming CaO-containing minerals, so in the end of the decarbonization zone, content of free CaO inthe material reaches maximum - 30-35%.

In the zone of exothermic reactions, at temperature 1200-1300°C , a process of solid-phase caking the material is completed and, as a result, minerals $3CaO{\cdot}Al_2O_3$, $4CaO{\cdot}Al_2O_2{\cdot}Fe_2O_3$ and $2CaO{\cdot}SiO_2$ are formed. However, in the mix, some amount of free CaO remains, required for saturation of di-calcium silicate up to three-calcium silicate.

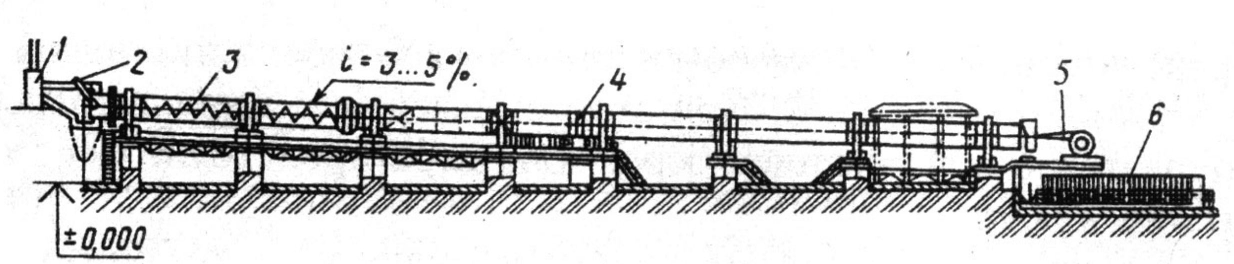
In the caking zone, at temperature 1300-1450°C, partial melting of the material proceeds, with complete consumption of free CaO to form to three-calcium silicate for 20-30 minutes.

In the cooling zone, temperature of clinker decreases to 1000-1100°C. A part of liquid phase is crystallized to form clinker minerals and the rest is solidified as glass.

Notice that borders of zones in rotary kiln are rather conditional and unstable. Changing regime of the kiln operation, one can shift borders and length of the zones and this to regulate process of roasting.

Rotary kiln appears as steel drum, composed of envelopes, joint by welding or riveting, and has inner refractory lining (Figure 4).

Figure 4. Design of rotary kiln



1 – smoke exhauster; 2 – feeder for feeding slime; 3 – drum; 4 – drive; 5 – ventilator with burner nozzle for blowing of fuel; 6 – grate cooler

Source: Sulimenko L.M. "Technology of mineral binding materials and articles on their base" – M: Vysshaya shkola, 2005

Section of the kiln can be both cylindrical and complicated with widened zones to prolong time of occurring the roasted material in them.

Kiln, installed at angle of 3-5°, rotates with frequency 0.5-1.5 min^{-1} (rpm). Rotary kiln mainly operate by principle of counterflow. Resources go from upper (cold) end, whereas fuel-air mix, burning out throughtout 20-30 m of the kiln length, arrives from lower (hot) end of the kiln. The hot gases heat the charge up to required temperature. Duration of the material stay in the kiln depends on frequency of its rotation and tilting angle, constituting, for instance, in kiln 5×185 m from 2 до 4 hours.

Flame and hot gases heat both the material and lining of the kiln. In turn, the lining gives the heat to the roasted material by direct contact. At each rotation of the kiln, in the process of contact with gas flow, temperature of kiln lining increases, and, at contact with the roasted material, the temperature decreases.

Productivity of rotary kiln depends on its inner volume, tilting angle of kiln and rotation frequency, temperature rate of gases moving quality of resources and other factors.

An important advantage of rotary kilns is their technological universality, owed by possibility to use resources of various kinds. In production of cement clinker by dry method, the kiln is fed by granular resources mix with grain size 7-15 mm or fine-dispersed powder with particles up to 200 mcm, in production by wet method; slime with moisture 35-45% is fed to the kiln.

Sizes of rotary kilns are determined by kind of roasted product, required temperature and duration of roasting. Length of rotary kilns for roasting cement clinker in wet method of production is 150-185 m, diameter– 4-5 m. In roasting of dry resource mixes, kilns with external heat-exchangers are used. Sizes of such kilns are much smaller than those of the wet method-kilns, as processes of preparing resources are performed in external heat exchangers with intensive convective heat exchange, providing effective use of heat of exhaust gases. Length of kilns, operating by dry method, is commonly 60-80 m at diameter of 4-7 m.

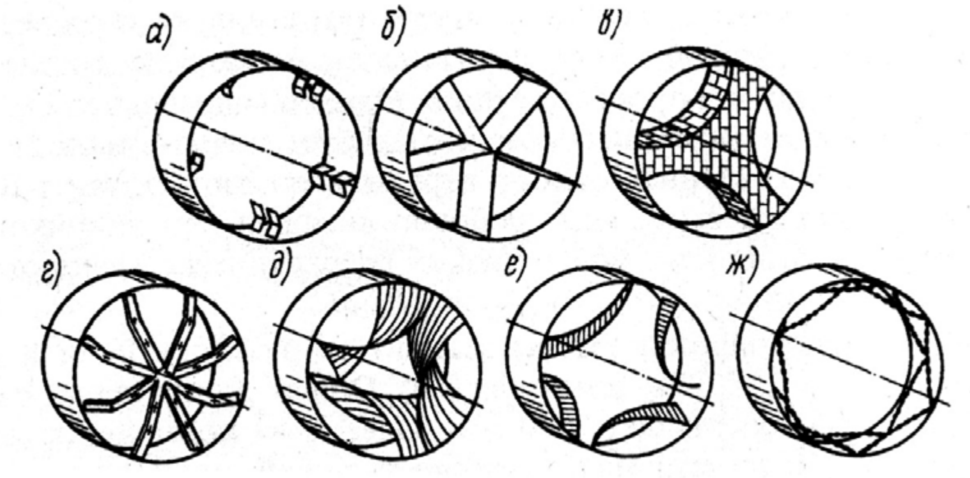
Effective use of heat in rotary kilns is provided by installing system of intra-kiln and external heat-exchange devices. ***Intra-kiln heat exchangers*** have developed surface to provide improved heat exchange and, thus, to economize heat; in addition, the facilities facilitate process of mixing and decrease dusting.

In wet method of cement production, the most applicable of intra-kiln heat-exchangers are chain curtains, providing heating and drying slime to moisture 8-10% after the curtain. Chain curtains of common chain types and of festoons type (festoons of chain) are applied. The latter is around 2 times less metal-consuming at the same heating effectiveness and lower hydraulic resistance and dusting.

Length of chain curtain part of kiln is around 25-60 m, depending on kiln size. Total length of chains in modern kilns is 2000 m and more; their surface area reaches 1500 m^2. Optimal area of chain surface is to be set – to provide optimal moisture of slime at minimizing heat consumption and dusting Temperature of gases at chain curtain part of kiln of 700-800^{o}C. Further increasing the temperature results in burning out chains.

For zone with higher temperatures, heat-exchangers of special design are designated (Figure 5). The simplest kind is lifting vanes, made of metal of ceramics, providing increasing height of the material lifting, change a part of the material into flash (suspension) standing, decreasing thickness of layer.

Figure 5. Designs of inner heat-exchangers of rotary kilns



а – interspersing (lifting) vanes; б, в – cellular; г – link; д – arc; е – cycloid; ж - chain

Source: Sulimenko L.M. "Technology of mineral binding materials and articles on their base" – M: Vysshaya shkola, 2005

In cellular heat-exchangers, being roasted material is divided into several flows to increase surface of contact with hot gases. These type heat-exchangers are installed after chain curtains: metals heat-exchangers in zone of temperatures 700-1000°C, ceramic ones - 1200-1400°C.

Link heat-exchangers are presented by a set of massive links, joint with each other by pin hinge; heated by gases links gives heat to the resources mix when immersing in its layer. Such heat exchangers serve as protecting shields for chain curtains, preventing their burning out. Link heat exchangers are made of heat-resistant steels and can operate up to 1100°C. Besides, arc, cycloid and other kinds of heat-exchangers are applied.

As possibilities of placing intra-kiln heat exchangers are restricted (they fail at high temperatures), in some cases for utilizing hot gases, external heat exchangers are used, for instance, slime concentrators.

Slime concentrator is a rotary drum of grates, fixed in supporting beams (Figure 6).