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MINING ENGINEERING

A PUBLICATION OF THE SOCIETY FOR MINING, METALLURGY, AND EXPLORATION, INC.

High Tech Surface Mining

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DEPARTMENTS

COVER —

This issue looks at trends in surface mining equipment development, beginning on page 503. And, as in each June, **ME** also reviews what happened the previous year in the industrial minerals industry. The review begins on page 523.

THANK YOU

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HIGH TECH SURFACE MINING

INDUSTRIAL MINERALS REVIEW

TECHNICAL PAPERS (peer reviewed and approved)

Cement, a Spanish cement company in which Lafarge already held 54% stake.

Management and workers, backed by a consortium of Polish banks and foreign investors, offered to purchase the Gorazdze cement works, Poland's largest and most modern cement producer. The works reduced 1.9 Mt (2.1 million st) of cement in 1992 or 11.8% of the country's output.

Onoda Cement Co. of Japan made plans to acquire Chichibu Cement Co. in a stock swap. The move would make Onoda Japan's largest cement producer.

Cementos Mexicanos formed a joint venture company with Mobley Environmental Services to build two fuel-blending plants in Mexico.

The company was to supply alternate fuel for Cementos Mexicanos cement kilns.

Domestic cement industry

Essroc Materials Inc. acquired the marketing and sales areas of the Midwest Portland Cement Co. Holnam Inc. bought the Box Crow Cement plant in Midlothian, TX for $91 million.

KRC Aggregates, a subsidiary of MDU Resources Group, Inc., acquired the Alaska Basic Industries, Inc. of Anchorage, AK. Medusa Cement purchased the Demopolis, AL, cement plant and nine terminals from Lafarge Corp. for $45 million.

Lafarge Corp. planned to restructure and consolidate its 11 regional operating units into six in the cement and construction material lines.

The cement restructuring was divided into western, eastern and US regions with other office locations in Calgary, Montreal, Quebec and Southfield, MI.

The Lehigh Cementon plant in Cementon, NY was slated to close in early 1994. Lone Star Industries Inc. planned to sell its Nazareth, PA cement plant and several joint ventures as part of a bankruptcy plan.

Independent Cement installed $1.2 million state-of-the-art equipment to reduce dust emissions.

Hercules Cement planned to spend $35 million to modernize its Stockertown, PA plant to address environmental issues.

Ash Grove Cement Co. was to start burning scrap tires and used oil at its Leamington, UT plant. Lafarge Corp. installed new equipment at the Davenport, IA plant to facilitate the use of waste fuels, such as tires and used plastics.

Early cement shipments in 1994 were on average 5% higher than in 1993. Demand for cement is expected to outstrip capacity in some regions of the country, such as in the south Atlantic, west-south-central and mountain regions. Imports are forecast to reach 9 Mt (9.9 million st) in 1994 and 12 Mt (13.2 million st) in 1995. ♦

Chlorine

R.E. Shamel,
Consulting Services Corp.

US chlorine production in 1993 amounted to 10.9 Mt (12 million st). That is a 2.7% increase over 1992 levels. This resulted in a 96% operating rate, based on effective capacity.

Declining chlorine demand for solvents, pulp bleaching and chlorofluorocarbons was more than offset by increased demand for chlorine for PVC plastics, phosgene intermediates for urethanes and ethylene dichloride exports.

Strong demand for chlorine increased the supply of coproduct caustic soda.

At the same time, demand for caustic soda in aluminum and pulp and paper weakened. This led to the development of a temporary oversupply for caustic soda.

Imports-exports

Because chlorine is difficult to store and transport, it is generally consumed near the point of production. Only a small amount is imported or exported. Imports of about 200 kt/a (220,000 stpy) came mostly from Canada. Exports are only in the range of 30 kt/a (33,000 stpy).

Uses

The largest use of chlorine is to make ethylene dichloride, an intermediate for vinyl chloride monomer and PVC resins. The second largest use is in the pulp and paper industry as a pulp bleaching agent.

Chlorinated organic chemicals, such as solvents, are the third largest use. That is followed by inorganic chemical uses, including the production of titanium dioxide from titanium tetrachloride.

Hydrochloric acid can be obtained by burning chlorine. Chlorine also remains the best disinfectant for water treatment, although environmental concerns may reduce this use.

Due to unexpectedly strong demand for chlorine and high industry operating rates, contract prices rose from $60/t ($54/st) in January 1993 to about $155/t ($140/st) in December 1993.

On the other hand, coproduct caustic soda dropped from about $220/t ($200/st) in January to $125/t ($113/st) in December.

Thus, the combined price remained at about $280/t ($254/st) for those who bought both coproducts.

Industry news and issues

Environmental pressures are increasing regarding the use of chlorine in pulp bleaching.

Proposed new regulations are expected to dramatically reduce US chlorine consumption in this area. Oxygen delignification, ozone, hydrogen peroxide and chlorine dioxide will be the key replacement products.

Trends and outlook

With a steady recovery of the US economy expected during 1994, the Gross National Product-driven chloralkali industry should also experience a relatively solid year in terms of overall pricing and production.

Consulting Resources predicted that US chlorine production will likely reach a record of 11.1 Mt (12.2 million st) in 1994.

Longer term, little, if any, growth is expected in US chlorine demand. ♦

Chromite

J.F. Papp, *US Bureau of Mines*

Chromite is the only source of chromium for metal alloys and chemicals. It is also itself used in refractories and foundry sand. Chromite is accompanied by various amounts of silicate gangue minerals and is generally beneficiated.

Compositions vary widely, from 22% to 58% Cr_2O_3, with the important Cr:Fe ratio varying from 1.5 to 4. Alumina, magnesia and iron oxide are other components. Silica content ranges from 0.5% to 22%. High silica chromites are acceptable for some uses if the chromite is a hard, lump-type and the rest of the chemistry — Cr_2O_3 content and Cr:Fe ratio — is favorable.

The US has no commercial chromite deposits. It has been 100% import-dependent for many years. World production of chromite in 1992 (latest available data) was about 9.8 kt (10,900 st), a 19% decrease over that of 1991.

The decline in demand for chromite ore in 1992 resulted from reduced demand for chromium in the former Soviet Union. Production in 1993 was expected to be less than that of 1992. This was due to the reduced demand for chromium from the metallurgical industry of the former Soviet Union and integration of that region's resources into the world economy in 1993.

US chromite ore supply in 1993 was about 300.6 kt (331,350 st). (Supply is imports for consumption, 254.8 kt or 280,800 st, plus stock decrease, 45.8 kt or 50,480 st). About 6.8% of the domestic supply was consumed by the refractory industry, the remainder by the chemical and metallurgical industry.

Chromite is generally used in refractory applications where furnace atmospheric conditions range from alkaline to neutral and hot face temperatures are highest. Examples include the hot zones of copper furnaces and cement kilns, the uncooled sidewalls of electric arc steel furnaces and the uppermost zone of glass checkers (Carniglia and Barna, *Handbook of Industrial Refractories Technology*, Noyes Publications, 1992, p. 262).

Chromite prices declined in 1993. Published prices indicated a decrease for South Africa refractory grade while Philippine ore remained steady, as reported by *Industrial Minerals*. US minimum, maximum and weighted average chromite ore import values declined. The price of South African and Turkish chromite ore remained steady, as reported by *Metals Week*.

Chromite refractories were first applied to open hearth steel production in France in 1879 and were reported used in the United States in 1890. Chromite use grew with open hearth steel production until about 1950 when basic oxygen furnaces were replacing open hearths.

Chromite containing refractories (mainly magnesia-chrome brick) are today used mainly in steel ladles, argon oxygen degassers, copper smelting furnace, cement kilns and glass furnaces. General demand for chromite refractories is related to general economic conditions. Historically, the first major chromite demand in the steel industry was for use in open hearth furnaces then, to a lesser degree, for use in electric furnaces. US open hearth furnaces have been phased out. Stainless steel producers have shifted from chromite to magnesite-carbon refractories in electric arc furnaces.

There is concern about the disposal of spent brick in cement kilns and glass-tank regenerators. This is because of the presence of hexavalent chromium, which is a carcinogen. Substitution for chromite refractories has been occurring in the glass industry. Fused magnesite-chrome refractories substitute for the less sophisticated, traditional sintered magnesite-chrome refractory used in AOD and ladle refining vessels. This substitution results in increases in refractory life and, therefore, lower refractory consumption per unit of steel produced.

In cement kiln applications, a variety of doloma-, zirconia-, magnesia-, and spinel-containing refractories compete with chromite-containing refractories.

The world chromite market was reviewed from the perspective of the refractory and foundry consumer industry. It was reported that Albania and the former Soviet Union have displaced some traditional suppliers of chromite in world markets. It was forecast that the foundry and refractory chromite demand trend would continue in decline. Foundry chromite demand was found to be declining due to reduced manganese steel casting. Refractory demand was found to be declining under pressure from competing technology and product and, in the United States, from regulatory pressure. (Griffiths, 1993, "Chromite markets crumble," *Industrial Minerals*, No. 304, January, pp. 48, 49, 51, 53).

Chromite refractory use in the United States could be significantly impacted by Environmental Protection Agency (EPA) regulation of waste containing chromium. EPA has determined that chromium-containing wastes exhibit toxicity. (Note that this is a regulatory determination and not a determination of fact. In other words, EPA has decided to regulate all chromium-containing materials as if they were toxic because they have the potential of becoming toxic.) EPA has, therefore, established a policy that if the extract from a representative waste sample contains chromium at a concentration greater than or equal to 5 mg/L (total soluble chromium), it is hazardous.

EPA has promulgated a treatment standard for chromium-containing refractory brick wastes based on the fact that they can be made chemically stable before disposal or recycling. EPA has also determined that some chromium-containing refractory brick wastes can be recycled as feed stock in the manufacture of refractory bricks or metal alloys. EPA recognized that there is insufficient capacity to process inorganic solid debris (treatable material that is greater than 9.5 mm or 0.4 in. in size and requires cutting, or crushing and grinding in mechanical sizing equipment) before chemical stabilization.

The legislative history under which chromium containing waste is regulated and the classification of and disposal requirements for chromium waste were reviewed. (Marvin, 1993, "Chrome-bearing hazardous waste," *American Ceramic Society Bulletin*, Vol. 72, No. 6, June, pp. 66-68).

EPA extended the processing deadline for chrome waste greater that 9.5 mm (0.4 in.) in size to May 1994.

The National Defense Stockpile (NDS) conversion program accounted for part of the chromite consumption in 1993. Under a program begun in 1984, the Defense Logistics Agency (DLA), Department of Defense, has been converting chromite from the NDS into ferrochromium. In 1993, about 154 kt (170,000 st) of chromite ore were converted into ferrochromium. The ferrochromium produced under this program reverts to the NDS stockpile. DLA planned to sell chemical, metallurgical and refractory grade chromite ores from the NDS.

On average (1983-1992), about 87% of US chromium consumption is used in the metallurgical industry, 10% in the chemical industry and 3% in the refractory industry. The main source of chromium for the metallurgical industry is imported ferrochromium and its main end use is stainless steel production. ♦

Clays

L.A. Arrington-Webb,
Thiele Kaolin co.

In 1993, every clay type experienced an increase in sales and/or use, according to the US Bureau of Mines. The estimated value of all marketable clays sold or used in the United States increased by 20% to $1.8 billion. The total tonnage of clays produced increased 7%.

Clay exports decreased in 1993 from 4.2 to 4.1 Mt (4.6 to 4.5 million st). Imports of clays increased 12%, with China and Mexico being major sources.

Fullers earth

The estimated production of fullers earth in the United States during 1993 was 2.5 Mt (2.7 million st). This was a slight increase from 1992's production of 2.4 Mt (2.6 million st). The increase