

BORON

By Peter A. Edbrooke

Boron compounds are used in a wide variety of products and manufacturing processes, and there are currently over 300 industrial and specialty applications, including: fluxes; agriculture; fire retardants; corrosion inhibition; lubricants; glass forming; detergents; ceramics; neutron absorption; and wood treatment. The combination of depressed economic conditions in the US, the Brazilian energy crisis, and product substitution in the perborate sector resulted in a 4% fall in global B_2O_3 demand in 2001. In US dollar terms, some prices are reported to have weakened slightly against a background of suppliers offering improved service.

Consumption and Uses

Fibre-glass manufacture is the largest single end use of borates. This application alone consumes nearly one third of the global B_2O_3 production. Sodium borates are a critical ingredient in insulation fibre-glass formulations as they promote glass forming at reduced temperatures and enhance the insulation properties of the final product. North America is the largest regional market for insulation fibre glass and, during 2001, borate demand by the industry was relatively resilient despite the slowdown in the economy. Low interest rates fuelled strong performance in the building industry despite the poor economic climate.

Borates also play an important role in the production of continuous strand and textile fibre glass. Boric oxide reduces the liquidus temperature of the glass to prevent devitrification during fibre forming. It also lowers the surface tension of the molten glass to allow for smooth fiberisation at the bushing. Borate demand by textile fibre-glass manufacturers was reduced significantly during 2001 due to high product inventories resulting from the economic downturn. Modest recovery in the continuous strand fibre-glass sector is expected in the second half of 2002.

Perborate, as an oxygen-carrier in detergent bleaching systems, is another important end use for borates, particularly in Europe. This market has faced stiff competition in recent years due to substitution by sodium percarbonate, and declined by 10-15% in 2001 to approximately 120,000 B_2O_3 . Borates are also widely used in washing liquids and household cleaning products.

Borates are used in the manufacture of frits and glazes to increase the strength, scratch resistance, and chemical resistance of ceramic wares such as wall and floor tiles, tableware and porcelain as well as enameled appliances. These applications account for about 15% of borate sales. Demand in the ceramic sector held up well in 2001, but enamel production slowed due to lower levels of consumer confidence.

Borosilicate glass applications consumed about 10% of global B_2O_3 production. The addition of borate to glass formulations increases thermal resistance and mechanical strength, and enhances aqueous and chemical durability. Growth in the borosilicate glass sector has generally been flat to negative in recent years due to product substitution by tempered glass and plastics. The North American borosilicate glass industry has been particularly hard hit and, as a result, decreased capacity during 2001.

In agriculture, boron is considered an essential micronutrient for crops, accounting for about 8% of global B_2O_3 consumption. Cotton, oil palm, coffee, and sugar beet are examples of crops that are boron susceptible. During the year 2001, low commodity prices, unfavourable weather conditions and pressures on farm economies negatively affected the applications of fertilisers and boron.

With the exception of the insulation sector (insulation fibre-glass, and cellulose insulation

where borates provide fire-retardancy properties), demand by other end-use sectors was soft during 2001.

New Applications

Work on the development of new applications for borates was stepped up. An intriguing potential new application for borates reported by Rio Tinto Borax is the use of sodium borohydride as an important component in hydrogen-based fuel cells. Although currently prohibitively expensive relative to fossil fuels, hydrogen-based fuel cells could be a longer term, environmentally friendly alternative for powering motor vehicles.

Production

The US is the largest borate producing country, accounting for more than 45% of global production, followed by Turkey with 30-35%. The South American countries - Argentina, Bolivia, Chile and Peru combined - account for slightly less than 10%, with the remainder coming from China and Russia. Supply is dominated by two companies, Rio Tinto Borax and Eti Holding, which between them supply around 75% of the borates used in the world.

Rio Tinto Borax, a wholly owned subsidiary of Rio Tinto plc, produces a wide range of refined industrial and speciality borate products from its mines at Boron, California, and in Salta Province, Argentina. Mine output in 2001 fell by 5% to 564,000 B₂O₃ as a result of the market decline. A cost reduction programme gained momentum, partly offsetting the effects of a downturn in sales. However, Rio Tinto reported a 14% fall in borate earnings. There were no major operational changes during 2001.

The other main US producers are IMC Chemicals (IMCC), a subsidiary of IMC Global Inc., and American Borate Co. ABC supplies borate minerals from its underground mine in Death Valley, California, and IMCC produces soda ash and industrial borates from brines at Searles Lake, California. IMC also produces boric acid and speciality borates at its Italian subsidiary, Societa Chimica Larderello; however, in November, local newspapers

reported that boric acid production is to stop due to increasing financial losses. IMC Global has been endeavouring to dispose of its chemicals operations since 1998. The IMC Salt and Australian soda ash businesses were successfully divested in 2001, and IMC reports that it expects to sell the remaining operations by June 30, 2002.

Eti Holding is a Turkish State Economic Enterprise (SEE), producing borate minerals and refined products from its four mines in western Turkey. Exports, which account for more than 90% of the production, were adversely affected by the market decline in 2001, falling by 7% to some 365,000 B₂O₃. Expansion of its borax pentahydrate plant at Kirka was completed in the fourth quarter, bringing the capacity to 480,000 t/y and work continued on the construction of a 100,000 t/y boric acid plant at Emet. In May, a contract to build a 240,000 t/y sulphuric acid plant was awarded to an SNC-Lavalin/Dogan consortium. The plant will replace the existing 120,000 t/y unit at Bandirma which is inadequate to meet the combined needs of the Bandirma and Emet boric acid plants.

In the 2000 Annual Report, Eti Holding's chairman outlined plans to increase borate refining capacity from 500,000 t to 1.2 Mt/y in line with its policy to produce and market value-added products rather than boron minerals. In December 2000, Eti Holding was placed in the 'scope of privatisation' in response to calls from the IMF for Turkey to hasten privatisation of state-owned industry. However, removal of the borate mines from state control met strong resistance, and the company was returned to its SEE status in August.

In South America, borates occur mainly as 'salar' type deposits high in the Andean Altiplano where they are exploited by a number of smaller operators, producing a variety of mineral products and refined borates.

In Argentina, output fell around 20% due to the adverse exchange rate and the decline in its principal market, Brazil. The main

producers are Rio Tinto Borax, producing refined sodium borates and fused products; Ulex SA, producing graded mineral products, and Procesadora de Boratos Argentinos, producing calcined mineral concentrates. In addition, there are two small boric acid producers and several independent minerals operations. Compania Gavenda, a borax refiner, ceased production during the year.

In Bolivia, borates occur in salars in the south west of the country. The main producer, Tierra Ltda, based at Apacheta, stopped boric acid production in 2000.

Chilean borate production increased by 15% in 2001 to some 45,000 t B_2O_3 - the two main producers both increasing output. Quiborax is the largest South American boric acid producer, based on ulexite extracted from the Salar de Surire in northern Chile. Its growth over the past four years has come mainly from mineral sales. SQM produces granulated ulexite to complement its range of agricultural products, and boric acid. With earlier operational problems overcome, SQM reported boric acid sales up 47% to 12,800 t.

After ore shortages caused by mine flooding in 1999/2000, output from Peru's sole borate producer, Inkabor, recovered in 2001, up 50% to 16,000 t of B_2O_3 . Inkabor, a subsidiary of Gruppo Colorobbia of Italy, mines ulexite at Laguna Salinas in southern Peru, and processes it at Arequipa and Lima to produce boric acid and other refined and mineral products.

Chinese borate production is based mainly in Liaoning and Jilin Provinces in northeast China, with minor production in Xizang (Tibet). In northeast China, the magnesium borate, szaibelyite, is mined and refined in numerous small state-owned or privatised plants. The principal product is borax decahydrate, sold mainly in the domestic market. Total Chinese production is estimated to represent about 7% of global production.

In Russia, the main borate producer is the Bor operation at Dalnegorsk in the Russian Far East, where the borosilicate mineral, datolite is mined and refined to produce boric acid and synthetic calcium borate. The operation was returned to the administration of the regional government in the final quarter of 2000, after the Energomash-Bor joint venture had been declared illegal. Production, which had come to a standstill for two months, quickly returned to normal, and in August it was reported that the boric acid plant capacity had been increased to 120,000 t/y. After falling by over 20% in 2000, Russian boric acid exports returned to 1999 levels.

Environmental and Regulatory Developments

Rio Tinto Borax published a Social and Environmental Report based on a framework developed through its sustainable development project which is part of the wider Global Mining Initiative. The European Commission continued to develop indicators for sustainable development for the non-energy extractive industry, and also a draft Best Available Technology (BAT) reference document for borate mining. In Europe, borates continue to be hazard and risk evaluated for their safety under conditions of normal handling and use under EU directives related to classification and labelling and risk evaluation of existing substances. The US Food and Nutrition Board announced that the essentiality data on boron was adequate to establish a daily Tolerable Upper Intake Level (UL) of 20 mg of boron.

Outlook

At the present time, the market seems poised for a slow recovery during the second half of 2002 and first half of 2003, though recent increases in energy costs could dampen expectations. Global boric acid supply is projected to tighten considerably over the next year. The overall borate market is considered to be relatively mature with a long term global average growth rate of about 1% per year.