The growing boric acid market

Borax keeps pace with Integrated Process Management (IPM) and capital investment

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Boric acid demand is increasing

Boric acid is the fastest growing, large volume borate material worldwide. Over the past five years, global sales of boric acid have grown by approximately 100 kmt per year to over 600 kmt and are forecast to grow another 150 kmt over the next five years. Overall economic growth, new applications, and the substitution of minerals are three fundamental reasons for increasing demand.

The global economy is projected to grow over 3% per year in the next few years leading to increasing boric acid demand, particularly in certain geographical regions such as Asia. In North America and Europe, the substitution of CCA with alternative wood preservatives is creating significant new demand for boric acid. The global trend of replacing cathode ray tube (CRT) televisions and monitors, which are made without borates, with flat panel monitors such as liquid crystal displays (LCD) and thin film transistors (TFT), both of which are made with boric acid has created another major new market. Well established end uses such as textile fiberglass and ceramic frits and glazes which have used boric acid, nonsodium borate minerals, or both depending on the manufacturer are increasingly converting to boric acid for the energy and environmental benefits that it affords. Further, boric acid is also a feedstock for other fast growing, value added borate materials such as disodium octaborate tetrahydrate and zinc borate.

Borax is the major supplier of boric acid

Through its three boric acid refining operations in the Argentina, France, and the United States, the Rio Tinto Borax group (Borax) is the largest supplier of industrial and specialty boric acid. Borax supplies over 40% of the world's demand for boric acid under the Optibor® brand family of products. Most of the company's boric acid is produced at its Boron, California refinery, which is located at the company's principal mine site. Boron is also close to the Los Angeles harbor allowing for reliable distribution throughout the world. Responding to recent and anticipated changes in the marketplace, Borax has invested to increase boric acid capacity in the United States, build new boric acid capacity in Argentina, and focus the production of specialty boric acid products in France.

Borax increases boric acid capacity significantly in the US

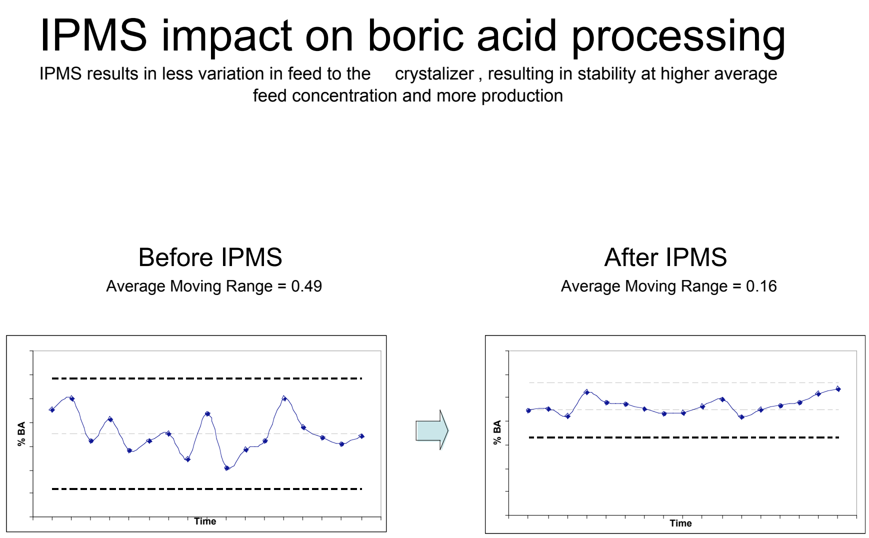
U.S. Borax Inc., the American operation of Borax, operates the largest boric acid plant in the world. Built in 1979 and designed to produce 180 kmt, the plant now produces over 260 kmt of boric acid per year. From a flow sheet perspective, the process of making boric acid is relatively simple. It involves dissolving borate ore in dilute sulfuric acid, separating the liquid from the insoluble solids (clay and rocks), crystallizing boric acid from the liquid, and dewatering, drying, and screening the resultant crystals. However in a production environment, the manufacture of boric acid requires considerable engineering sophistication and experience to efficiently produce a high quality, consistent product. Recent productivity breakthroughs at U. S. Borax have focused on replacing systems that created limitations. For instance, we installed heaters to help us dissolve more ore, giving us more capacity at the front end of the process. We also installed new filters to increase capacity for dewatering at the back end. Further, U.S. Borax plans to invest another $17 million on equipment enhancements to increase boric acid capacity by an additional 28 kmt by 2005. To maximize value from our previous, new, and future capital investments, plant engineers have implemented an Integrated Process Management (IPM) system to increase production even more.

IPM is an important part of the capacity increase

Integrated Process Management (IPM) is a disciplined approach to achieving operational excellence. In the boric acid plant, the series and dependent nature of our process means the impact of variation on quality, throughput and cost can be significant. IPM was seen as the means to reduce variation leading to significant business benefits.

Specifically, IPM was used at the Boron boric acid plant for process optimization to improve throughput while at the same time, sustaining or improving product quality. And this process has been designed to be dynamic, involving constant feedback loops for continuous improvement.

The first application of IPM at the boric acid plant was to increase crystallizer feed concentration to a level that was previously thought to be unsustainable. The lower variation allowed the feed concentration to be maintained at a higher level, resulting in higher production (please see below).



Next steps will be to apply IPM to dissolver and dryer systems, then to use the system to review and improve the boric acid plant as a whole. Based on the excellent experience at the boric acid plant so far, IPM is already planned for implementation in other production areas.

The IPM Implementation Process

The IPM process started with an analysis of customer and business values, and involved development of high level metrics and the essential step of "process value stream mapping." For the boric acid plant the business value was straightforward – increase throughput leading to an increase in sales revenue. The “process mapping exercise” involved people from all levels of the process and was used to identify sources of variation in the system that affect throughput, such as:

- Materials – are we using different parts, raw materials, ore quality?
- Manpower – are we each doing the same job differently?
- Measurement – are our measurement tools or results consistent?
- Machine – does each piece of equipment operate – or fail to operate- differently?
- Methods – are we all following the same procedures?

The mapping analysis provided the following:

- A blueprint of the process showing how work at the process level (shop floor) aligns with outcomes at the business level (top floor).
- A prioritized set of critical “throughput levers” telling us where to work first to achieve the greatest impact.
- A clear understanding of the interdependence of the process steps ensuring that improvement efforts at one part of the process “flowed through” to increased throughput.

The second stage of our IPM effort was to address these variations through the development and implementation of the following systems for day-to-day process management:

- Statistical process control and response– to reduce variations in pH, moisture, silicates and insoluble materials that may occur due to changes in raw materials among other factors. These variations can affect product quality and ultimately product quantity.
- Improving workplace systems – to make sure only the necessary tools are on hand, easy to find and use, and that routines for cleaning, inspecting, and replacing these items are in place. Our aim was to make the workplace “support” the operator rather than “hinder” the work process.
- Visual controls – to provide clear, simple, graphic information to enable routine tasks to be performed consistently from operator to operator.
- Standardized work practices – to define content, sequence, timing, and outcomes for every procedure, removing ambiguity from routine procedures and problem solving tasks.

IPM provides systems for day-to-day process management, leading to stable and predictable operation – the first step in our pathway to operational excellence. The systems described above all work to help people who work in the process to identify variations in the process - quickly, easily and uniformly – and take effective (and quick) corrective actions through two simultaneously functioning feedback loops – the blue loop and the black loop.

The blue loop provides ongoing feedback to help operators correct for variations whereas the black loop seeks to identify root cause reasons for variations. Without solid root cause analysis and solution implementation, sustainability would be very difficult. A successful “black loop” system is the glue that holds the IPM process management system together and provides the “fuel” for continual improvement.

IPM is a road to sustainable development

IPM, as a tool for business improvement and total operational excellence, can have significant social and environmental benefits in addition to production and financial gains. At Borax, sustainable development (SD) is core to our business strategy and virtually all initiatives are judged on their sustainable development impact. At Borax, sustainable development is characterized by three pillars:

- Environmental impact – involving product stewardship, pollution prevention, and resource stewardship
- Social impact – involving safety & human health, stakeholder engagement & transparency, and communities.
- Economic impact – involving shareholder return and economic contribution.

The implementation of IPM has quantifiably improved our resource utilization but the impacts on other environmental measures such as energy use and greenhouse gas production are yet to be made. Borax has created a baseline for such analyses by previously performing Life Cycle Assessments (LCA) of all products, including *Optibor*, manufactured at its Boron operation.

From a social impact perspective, IPM has resulted in a cleaner and more orderly work environment. The program is however too new to provide meaningful comparative data for health and safety benefits to workers. However, the benefits to the operators in terms of reduction in day-to-day problems and aggravation are clearly demonstrated and evident in every day practice.

From an economic perspective, IPM has been a big win – increased capacity, improved yields, continuous equipment optimization, minimum capital investment, and corporate learning that can applied to other areas are just some of the benefits that have immediate and long term payoffs to the bottom line. IPM has enabled us to achieve stability and predictability in day to day operations, enabling us to maximize the capability of our existing assets and providing a solid base upon which Borax can build through other business improvement initiatives such as Lean or Six Sigma in the future as business objectives require.

Summary

The increasing world demand for boric acid has created pressure on Borax to increase capacity to maintain its position as the leading supplier of the material worldwide. Borax has done this through building and consolidating boric acid capacity in Argentina and France, and primarily by increasing boric acid capacity at its principal operation in Boron, California. The capacity increase at Boron has been through capital investments and the optimization of this capital through the implementation of IPM. Optimization, from our perspective is not a stagnant state but rather a continuous process that seeks to constantly improve output and quality through the blue and black feedback loops within IPM. In addition to the economic benefits, IPM has afforded other benefits such as positive environmental and social impacts to align with Borax's strategic drive to be the premier and sustainable supplier of boric acid to the marketplace. Additionally, the application of IPM has demonstrated a successful business improvement model and learning that can be applied to other part of our business.

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