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Value in the use of anhydrous boron in glass

Allen Zheng discusses the value in use that various anhydrous boron compounds provide in glass melting processes.



Allen Zheng is APAC Development Specialist for U.S. Borax.

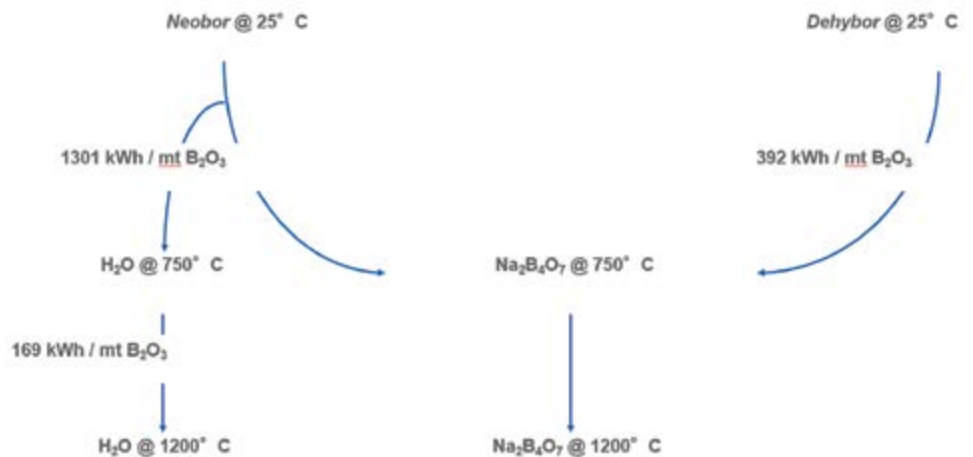


Figure 1: Energy necessary to melt borate products.

In the case of sodium tetraborate (commonly used in borosilicate glass or C-glass fibre applications), hydrous refers to $\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$, whereas anhydrous refers to $\text{Na}_2\text{B}_4\text{O}_7$. In other words, anhydrous boron is a more concentrated form of boron, containing 1.4 times more B_2O_3 . The additional value that anhydrous products bring goes beyond the concentration difference of B_2O_3 .

Higher chemical concentration helps with debottlenecking the pull capacity and logistic/materials handling costs. The lack of crystal water in anhydrous and the absence of puffing and decrepitation phenomena are fundamental to other volatility related benefits.

Energy savings

An anhydrous product, such as Dehybor, will use less energy to melt than a hydrous product, such as Neobor. The actual savings will depend on the energy source and plant condition (see figure 1).

From a theoretical calculation, using anhydrous batch will enable an energy reduction of approximately 3%. Recent laboratory studies managed by

CelSian and performed within the framework of a GlassTrend consortium project used a time-dependent batch energy measurement system. They showed that glass batch using anhydrous is able to achieve more than 11% in energy savings, which is consistent with typical C-glass producer feedback (see figure 2).

Energy savings are an important consideration for C-glass manufacturers located in countries where gas prices are relatively high. Apart from gas price, savings will also be subject to plant-specific variables, such as the amount

of cullet used and the choice of raw materials. With less volatility loss of B_2O_3 , the Dehybor batch will further enhance the energy savings.

Improved productivity

Apart from a higher concentration in B_2O_3 , anhydrous products also have a higher bulk density, so anhydrous batch will create more space for

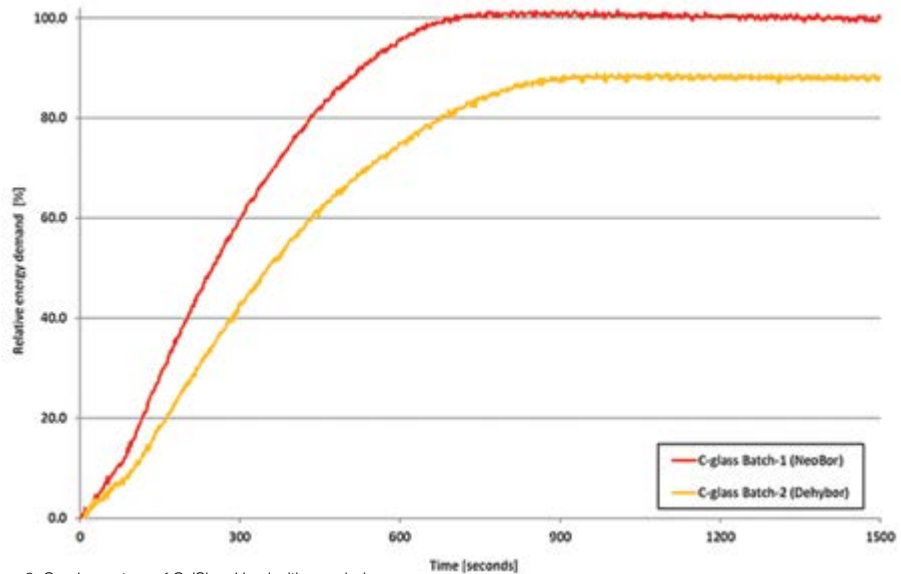


Figure 2: Graph courtesy of CelSian. Used with permission.



This article is based on a paper presented at the GlassTrend spring seminar on raw materials processing and recycling in May 2020. www.glasstrend.nl

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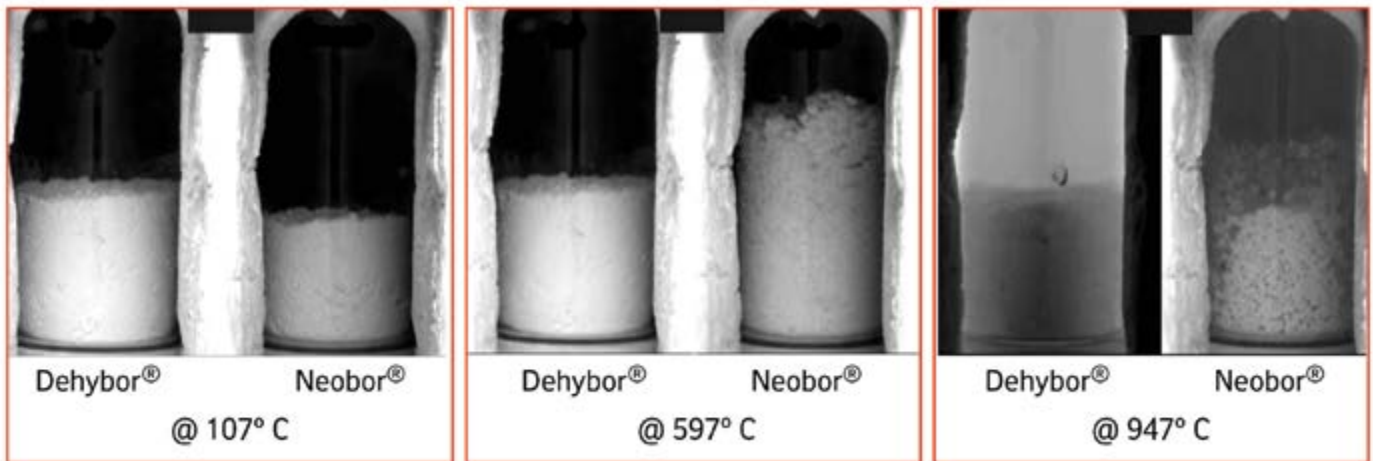


Figure 3: Photograph courtesy of U.S. Borax. Used with permission.

other raw materials, debottlenecking capacity when pull is constrained.

Typically, AB-consuming C-glass producers have reported a 3% capacity gain when using an anhydrous product. Although the extent of gains are subject to batch formulation and other process constraints, improved productivity is usually considered the most significant component of the value-in-use of anhydrous products. This provides not only a long-term benefit but also a flexible short-term alternative to capital investment.

Reduced volatility loss

Boron is volatile and subject to loss through emissions. High emissions could mean:

- Loss of raw materials and the expense that incurs.
- Additional cost involved with handling dust captured by the abatement system, if available.
- Environmental compliance pressure.
- Process challenge.

An anhydrous product will improve volatility, reducing boron loss through emissions. In part, the significant differences in behaviour are attributed to puffing and decrepitation phenomena of Neobor when releasing

water from the crystal structure. The observation can be replicated in high temperature observation camera systems that record the height and condition of batch at different time and temperature intervals (figure 3).

Typical emission loss of B_2O_3 in the Dehybor batch and the Neobor batch are 5% and 10% respectively. In some Asian C-glass producing plants, where the emission loss of using Neobor is more severe than 10%, hydrous products provide an attractive solution.

Reduced erosion to the furnace

While it is hard to quantify in the short-term, the reduction of boron and sodium volatility will then, in theory, improve corrosion resistance of a furnace and lower the lifetime maintenance costs.

One qualitative case study relates to a C-glass producer who collected wall deposition during a furnace cold repair and sent them to U.S. Borax for testing. The laboratory identified high Al_2O_3 and high B_2O_3 . According to the manufacturer, the elevated Al_2O_3 level was believed to be from the furnace's high Al bricks. After switching to an anhydrous borate product, the company found that the occurrence of wall deposition had been reduced (figure 4).

Composition	SiO_2	Al_2O_3	Na_2O	B_2O_3
Content	17.7%	23.2%	15.8%	31.8%

Reduced freight cost and end product quality

Because of its higher concentration, anhydrous products translate into freight benefits. Furthermore, although sporadically and less commonly mentioned, some manufacturers commented that anhydrous batch helps the application and process control of low quality cullet containing melt.

Future work and limitations

Despite all of the significant benefits of using Dehybor, some C-glass producers have suggested that it cannot be used in cold top electric furnaces due to earlier occurrences of volcano with Dehybor batch. U.S. Borax is researching the boundary and enablers of anhydrous products in this furnace type.

Keep in mind that the applicability and the extent of each benefit are subject to plant conditions and may vary in real world applications. U.S. Borax's technical service team works with customers to explore and verify these benefits through controlled plant trials. The technical service team can also provide other value-added services, including defect analysis and raw materials analysis. ●

Dehybor and Neobor are registered trademarks of U.S. Borax.

About U.S. Borax

U.S. Borax, part of Rio Tinto, is a global leader in the supply and science of borates - naturally-occurring minerals containing boron and other elements. The company employs 1000 people serving 500 customers, with more than 1700 delivery locations globally. Some 30% of the world's need for refined borates is supplied from a world class mine in Boron, California, approximately 100 miles north east of Los Angeles. The company pioneers the elements of modern living, including:

- Minerals that make a difference: Consistent product quality secured by ISO 9000:2001 registration of its integrated quality management systems.
- People who make a difference: Experts in borate chemistry, technical support and customer service.
- Solutions that make a difference: Strategic inventory placement and long-term contracts with shippers to ensure supply reliability.

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Figure 4: Photograph courtesy of U.S. Borax. Used with permission.