

# Borates in salt glazing



## 1. Introduction

Salt glazing is a method of applying a glaze to heavy clay products near the end of the firing cycle when the clay is nearly vitrified. Salt is volatilized in the kiln and the vapors react with the surface of the ware to form a sodium-aluminum-silicate glaze. Sewer pipe and drain tile are commonly glazed in this manner. This affords impervious, permanent, cleanable surfaces with a high resistance to chemical corrosion and physical shock.

The addition of a borate to salt greatly improves the finished glaze by virtue of the fluxing effect of the  $B_2O_3$  which in effect, allows glaze formation at lower temperatures. The degree of improvement will depend on several factors which include the clay and the kiln. Also a borate addition will assist in overcoming the glaze defects:

- Dull thin glazes
- Light colored glazes
- Roughness
- Blistering
- Scumming
- Crazeing
- Fire checking
- Lime popping
- Pig skinning
- Dull spots on the glaze

In addition to improving the finished glaze, the use of a borate in salt will yield the following benefits:

- Reduce salt glazing temperature
- Increase the chemical resistance of the glaze
- Make the glaze more impervious to gases and liquids

## 2. Recommended types of borates

In recent years, *Neobor*<sup>®</sup> borax pentahydrate ( $Na_2B_4O_7 \cdot 5H_2O$ ) has largely replaced borax decahydrate ( $Na_2B_4O_7 \cdot 10H_2O$ ). *Neobor* borax pentahydrate is a more concentrated form of Borax which allows a savings in reduced transportation, handling and storage.

The use of *Optibor*<sup>®</sup> boric acid in periodic kilns has been limited by cost. Although *Optibor* boric acid does cost more than the borax products, it has certain advantages when used in salt glazing mixtures. *Optibor* boric acid, however, is used more frequently in tunnel kilns especially where the salt and borate are injected into the kiln as a water solution.

## 3. Salt glazing techniques

Salt glazing techniques vary according to clay composition, the type of kiln available and in accordance with the individual practices. The following briefly outlines two of the most widely used and recommended techniques:

### 3.1 Periodic or intermittent kiln

Salting usually begins in periodic kilns about six hours before finishing, when the trials removed from the kiln show that the clay ware is not quite vitreous. The fires should be bright each time before salt is added, and most people use from three to five saltings. An average charge would be about 300 lbs of salt for a kiln holding about 20 tons of 4 inch pipe. Normally three charges of rock salt would be used, all of about equal weight. The salt is added directly to the fires although it is occasionally dropped through the crown, or blown in by the fan attached to mechanical stockers. To get the vapor well into the pipe and avoid dry centers, there should be a good draft.



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The addition of a borate to the salt greatly improves the finished glaze. The fluxing effect of the  $B_2O_3$  encourages glaze formation at a lower temperature. The borate can either be added to each salting, to the first and last saltings, or just to the last salting. To take advantage of the fluxing effect of the  $B_2O_3$  and produce a smooth glaze, it should be present in at least the final salting.

The amount of borate to be added will vary depending on the type of clay and the type of borate used. The following are typical addition rates for the various borates, based on the weight of salt used:

Borax decahydrate	5 to 15%
Neobor borax pentahydrate	4 to 12%
Optibor boric acid	4 to 8%

## 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. We are 1,000 people serving 500 customers with more than 1,700 delivery locations globally. We supply 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles. We pioneer the elements of modern living, including:

- **Minerals that make a difference:** Consistent product quality secured by ISO 9001:2015 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

## 3.2 Tunnel kilns

The suggested procedure is to blend 100 lbs of granulated salt, 10 lbs of *Optibor* boric acid, and 40 gallons of water in a salt dissolver to produce an 80% saturated brine solution. The brine solution is introduced into the kiln through four brine atomizers inserted axially in the center of four special burner units for salt vaporization. The salt brine is mixed with the hot flame of the burners which cause it to be ionized and evaporated instantly. The steam which is generated in this process creates a uniform glaze over the entire surface area of the ware. The brine solution is introduced into the kiln for two minutes at intervals of 15 minutes by means of an automatic time cycle system. Approximately 240 lbs of salt are used to glaze 100 tons of sewer pipe.

## About 20 Mule Team® products

20 Mule Team borates are produced from naturally occurring minerals and have an excellent reputation for safety when used as directed. Borates are essential nutrients for plants and key ingredients in fiberglass, glass, ceramics, detergents, fertilizers, wood preservatives, flame retardants, and personal care products.



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