Borate functions

- Bioessential effects
- Biocidal or biostatic effects
- Buffering effects
- Cross-linking effects
- Anticorrosion effects
- Detergency & cleaning effects
- Fire retarding effects
- Glass-forming effects
- Metallurgical effects
- Powder processing & physical effects
- Nuclear & spectroscopic effects

Also used in the manufacture of advanced materials and specialty chemicals and reagents
Agriculture – Boron as micronutrient fertilizer

- Lack of optimal soil boron levels is considered the most significant micronutrient deficiency in the world.
- Boron fertilizers are widely used throughout the world to increase the yield and value of important food and fuel crops.
- Our agricultural products are sold through authorized Ag fertilizer dealers.
Ceramic - Refractories

Products:
• Borax Decahydrate,
• Optibor Boric Acid,
• Boric Oxide

Types:
• Kilns, furnaces
  ▪ Glass, ceramic, steel, smelters, enamels

Benefits:
• Secondary binder to give the refractory mixture sufficient strength to retain its shape and configuration until the ceramic bond forms.
Borosilicate glasses

Types of borosilicate glasses:
- Flat panel display
- Insulation fiberglass
- Kitchenware
- Laboratory
- Pharmaceutical
- Optical
- Sealing
- Art

Benefits:
- Improve aqueous durability and resistance to chemical attack.
- To increase resistance to thermal shock due to low thermal expansion
- Act as a powerful flux
- Increase mechanical strength
- Inhibit devitrification
Energy-Related Applications of Borates

**Solar Energy**
Ingredient in glass for solar thermal devices and dopant in photovoltaics

**Wind Energy**
Borate-containing textile fiberglass is an important component in wind power generators

**Oil Recovery**
Borate-based oilfield chemicals (fracturing fluids, proppants, cement additives), alkaline surfactant flooding, etc.

**Fiberglass Insulation**
Borosilicate glass (single largest use of borates)

**Cellulose Insulation**
Fire retardant use of borates
Fire retardants

Borates are widely used to fire retard cellulosic materials, including cotton batting, wood products, and cellulose insulation.

Functions:
- Suppress glowing and smoldering
- Reduces smoke generation
- Promotes char forming
- Protection for ferrous & nonferrous metals
- Acts as a buffer
- Neutralizing acid materials
Consumer Products

**Detergents**
- Boost surfactant performance
- Softens water
- Enhance stain removal
- Enzyme stabilizer
- Improves alkaline buffering

**Hand Cleaning**
- pH control
- Abrasive properties
- Softens water

**Hard Surface Cleaners**
- Improves alkaline buffering
- Oil and soil removal
- Corrosion protection
- Abrasive function
- Viscosity control
Cleaning and Detergency

Detergent builder effects of borax

- **pH buffering**: Borax is a buffer for pH 9.2 - an optimal pH regime for performance of detergents and promotes dislodging and emulsification of fatty/oily soils

- **Sequestration**: Borates behave as sequestrants for Ca$^{2+}$ and Mg$^{2+}$ ions giving surfactants improved tolerance for the presence of these metals

- **Antiredeposition**: Borate helps suspend soils and prevents redeposit of stain components

- **Corrosion inhibition**: Borates are corrosion inhibitors for ferrous metals, thus reduce corrosion to laundry machine and dishwasher parts. Borates are usefully added to silicates, often added to mitigate corrosion.
Personal Care Products

- Borax Decahydrate Technical & SP
- *Optibor* Boric Acid Technical & EP

- Skin Creams & lotions
- Hair shampoos
- Eye drops
- Foot Powders
- Bath salts
- Denture cleaners

Benefits:

- Alkaline buffering
- Emulsification of waxes and oils
- Viscosity control
- Soft abrasive
- Moisture retaining qualities
Industrial Fluids

Examples:
- Automotive coolants
- Lubricants
- Brake fluids
- Hydraulic fluids
- Metal working fluids

Borate functions:
- Corrosion control
- Buffering
- Lubrication (including EP additives)
- Freezing point depression/ Boiling point elevation
- Water scavenging
- Acid scavenging
Metalworking fluids

Benefits of boric acid

• Rust inhibition
• Reduction of friction and wear - lubricity
• Efficient cooling capacity
• Stability
• No offensive odor
Borates as corrosion inhibitors

Soluble Borates

- Borates passivate ferrous metal surfaces to inhibit corrosion
- Borax used in boilers and recirculating water to inhibit corrosion
- pH control by borax plays a role
- Anodic passivation mechanism poorly understood

Functionality

- Anodic passivation
Adhesives, Caulks & Sealants

**Starch Adhesives**
- Borates used to crosslink and tackify starch adhesives
  - Corrugated box board
  - Paper bags
  - Carton sealing
  - Gummed paper/tape
  - Tube winding

**Caulks & Sealants**
- Borates mainly used as fire retardants in caulks and sealants
Crosslinking

Borax (crosslinker) = \( \text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} = 4 \text{B(OH)}_3 + 2 \text{NaOH} + 3 \text{H}_2\text{O} \)
Oil field chemicals

Applications/benefits:

- **Drilling & exploration**
  - Oil well cement retardants
    - A set retardant for down hole plugging of oil wells using cements more commonly called drilling muds.
  - Drilling fluids
    - Fluid loss additive, lubricant, pH control, corrosion inhibitor, viscosity modifier, shale stabilizer

Production and improved oil recovery

- **Hydraulic fracturing fluid**
  - Fluid gelation
- **Water flooding profile control**
- **Alkaline flooding**
- **H₂S scavenger**
Metallurgical

Products:
* Neobor  Borax Pentahydrate
* Borax Decahydrate

Types:
- Wire drawing
- Welding & brazing compounds
- Steel Alloy
- Smelting of nonferrous metals
- Plating/jewelry
- Mining

Benefits:
- pH adjustment in bath
- Anticorrosive agent
- Lubricant carrier
- Flux
Metallurgical

Product: *Optibor* Boric Acid

Plating – e.g. Nickel Chrome

Benefits:

Electrolyte solution of *Optibor* Boric Acid for pH control & stability

Acts as buffer during electrolysis

Prevents nickel deposits from being hard, cracked or pitted
Gypsum Board

Product: *Optibor* Boric Acid

Benefits:

- Increase board flexure strength
- Reduce board weight
- Provide better adhesion of paper backing to the board
- Reduce the curing time
- Create harder gypsum board edge to prevent nail pull
- Increases production speed
Water Treatment Markets

Water Treatment

- **Function:** The use of borates in heat exchangers including central heating systems, water cooling towers, and other circulating non-potable water devices.
  - Buffer, Alkalinity, Anti-corrosion
- **Borates:** Borax Decahydrate, *Neobor* Borax Pentahydrate, *Optibor* Boric Acid, Sodium Metaborate

Pool/Spas Chemicals

- Enhances performance of bromine & chlorine-based products for pools and spas plus other apps.
- **Borates:** *Neobor* Borax Pentahydrate, Borax Decahydrate, *Optibor* Boric Acid

*Note – for algal control applications a suitable registered product is required.*
### General List of Borate Applications

- **Adhesives**
- **Agriculture**
- **Antifreeze**
- **Boron hydrides & carbides**
- **Brake fluids**
- **Cement**
- **Ceramics / frits**
- **Corrosion inhibitors**
- **Detergents & cleaners**
- **Electrolytic capacitors**
- **Fire retardants**
- **Fuel additives**
- **Glass**
- **Gypsum board**
- **Industrial chemicals**
- **Iron & steel**
- **Leather tanning**
- **Lubricants**
- **Metal refining**
- **Metalworking fluids**
- **Nuclear power plants**
- **Nylon**
- **Oil field chemicals**
- **Personal care**
- **Photography**
- **Pool treatment**
- **Rare earth magnets**
- **Solders & welding**
- **Textiles**
- **Waxes & polishes**
- **Water treatment**
- **Wire drawing**
- **Wood treatment**
Summary

• Borates are important in our everyday lives and for life in general

• Borates have biological importance and also find many applications in the manufacture of a wide range of everyday products
  ▪ Glasses & ceramics
  ▪ Building materials
  ▪ Agriculture
  ▪ Metallurgy
  ▪ Consumer goods
Technical Support

• Expertise in a wide variety of borate applications to help you and your customers with application development.

• Knowledgeable staff of scientists and engineers specializing in borate interactions.

• Laboratory capabilities offered to customers in chemical and physical analysis include:
  - Inductively coupled plasma – optical emission spectroscopy (ICP-OES)
  - Powder X-ray diffraction
  - Thermal analysis
  - Particle size analysis
  - Other misc. testing

• A Product Stewardship group to support all regulatory and safety needs.