

Borates in detergency

Borates and perborates offer benefits in detergency, and although they have been incorporated into soaps and washing powders for many years, their potential has not been fully understood or realized. Some of these benefits are:

- Alkaline buffering and pH control of washing solution
- Water softening by producing (via sequestration) a soluble calcium complex
- Surfactant performance by preventing precipitation of a calcium/surfactant complex
- Pigment-soil removal and prevention of redeposition
- Perborates are excellent detergent bleaches



Alkaline buffering

High alkalinity in the wash water improves detergency and helps with the cleaning process. Negative electrostatic charges on the fabric and soil are created in such systems. These negative charges repel each other and help to remove the soil from the fabric. Alkalinity helps to remove fatty soils through saponification.

Benefits of borates/perborates

- Borates are excellent pH buffers in the range of pH 9.1-9.3, their natural pH.
- Perborates are more alkaline (pH 10.4 for 1.0% solution) and like borates have excellent buffering capacity in the pH range 9-10.

Other detergent components

Sodium carbonate buffers work best at about pH 10 which, unlike borates, is not its natural pH (11.6 for a 1.0% solution).

Water softening

There is a need to reduce calcium and other metals to improve water hardness and allow the detergents to function well. The three most important ways of doing this are:

- The formation of soluble complexes of the calcium ion
- The formation of insoluble complexes of the calcium ion
- Ion-exchange of the calcium ion

Detergent components that perform these types of functions and soften the water are called builders.

Benefits of borates/perborates

Borates and perborates act as sequestrant builders, forming soluble complexes with the calcium ion and thus removing its unwanted effect. The formation of soluble complexes is often the best way to achieve a builder effect.

Other detergent components

Insoluble complexes, for example with carbonate or percarbonate, can precipitate onto the fabric during washing, leaving harsh-feeling deposits. Ion-exchangers are typically insoluble zeolite particles that can also build up on fabrics.

Surfactant performance

To improve surfactant performance, positively charged calcium ions associated with wash waters and certain soils must be prevented from complexing with the negatively charged surfactants used in detergent formulations, since the resultant complexes would be insoluble. Should this reaction take place, some of the surfactant is effectively removed from the wash and unable to perform its function.

Benefits of borates/perborates

- Borates and perborates prevent the precipitation of important types of negatively charged surfactants (unless exceptionally high levels of calcium are present in the wash).
- They compete successfully with the surfactant for the calcium ions and form the soluble complexes thus enhancing the water softening qualities of the detergent as discussed above.

Other detergent components

Carbonates and percarbonates also prevent the precipitation of surfactants by producing a calcium carbonate precipitate. However this precipitate can deposit on fabrics causing a graying effect and harsh feel.



Soil removal

To improve surfactant performance, positively charged calcium ions associated with wash waters and certain soils must be prevented from complexing with the negatively charged surfactants used in detergent formulations, since the resultant complexes would be insoluble. Should this reaction take place, some of the surfactant is effectively removed from the wash and unable to perform its function.

Benefits of borates/perborates

- Borates and perborates cause a greater reduction in the interfacial tensions than is simply due to pH, thus improving oily soil detergency.
- Particulate soil deposition is inhibited by borates through their specific influence on surface charge—this is not just a pH effect.

Other detergent components

Tripolyphosphates also show similar behavior to borates and perborates in reducing these interfacial tensions. Carbonate and percarbonate appear only to reduce interfacial tension through their influence on the pH of the solution.

Bleaching chemistry

In detergency, bleaching can be understood as the process of whitening, lightening, and brightening fabrics by chemical means. Hydrogen peroxide and chlorine are the most effective bleaches in some contexts, but neither can be incorporated directly into washing powders.

Benefits of borates/perborates

- Excellent detergent bleaches
- Very stable in detergent powders
- Effective yet gentle-to-clothes as an oxidizing bleach
- The borate component aids overall detergency
- A very rapidly-dissolving version (perborate monohydrate) is especially useful in cooler wash/short cycle application

Other detergent components

Sodium percarbonate is used as bleach in some detergents but is much less versatile because of instability in most formulations.

Detergency performance

Two fully formulated zeolite-based detergents, containing in one instance 20% percarbonate and the other 20% perborate, were tested on four types of soiled cotton.

Those soil tests in which perborate performance exceeded percarbonate performance included:

- Clay
- Clay and sebum
- Carbon black/olive oil
- Carbon black/mineral oil

In the fourth soil test, the perborate and percarbonate detergents performed equally well.

Other borate/perborate benefits not listed above

- Borates are excellent enzyme stabilizers in liquid detergents
- As little as 1% perborate helps to inhibit dye transfer
- The reaction with neighboring hydroxyl groups enhances performance of sugar-based builders and surfactants





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

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.

