TECHNICAL BULLETIN

# Borates in electrolytic capacitors

U.S. Borax special quality (SQ) products may be used in several different ways in the manufacture of both "wet" and "dry" electrolytic capacitors. Our ammonium pentaborate SQ, *Optibor*® SQ (boric acid), and borax decahydrate SQ are high-purity, refined borates especially suited for the stringent requirements needed for capacitor fabrication.

An electrical capacitor is a device which stores electrical energy. It is constructed of two conducting surfaces separated by an in sulating or dielectric medium. The "wet" electrolytic capacitor differs from other types in that only one of its conducting surfaces is a metallic plate, while the other is a chemical compound. The dielectric is a very thin film of oxide of the metal constituting the metallic plate. The "wet" and "dry" types are basically the same, except for physical construction and the degree of liquidity of the electrolyte.

While aluminum and tantalum are both in use as metallic plates in electrolytic capacitors, aluminum finds widest use. In the manufacture of aluminum-plate capacitors, borate chemicals are used in many formulations as well as in various parts of the process.

The aluminum used is typically in the form of thin foil, most often with its surface chemically "roughened" or etched. Following the etching process, the foil must be thoroughly cleaned before a thin oxide film is formed. Ordinarily, a series of cleaners alternating with water washes is required to remove impurities. Borax and boric acid are among the cleaning agents employed.

The active dielectric oxide film is formed by immersing the foil in an aqueous electrolyte solution consisting of boric acid and either ammonium or sodium borate, and then applying an electrical voltage. It is essential that the electrolytes be kept free of impurities such as chlorides, nitrates, sulfate, and iron. After formation of the film, the anode foil is rinsed clean often with a boric acid solution.

The capacitor is assembled by inserting the anodes into their containers (usually aluminum cans in the case of the "wet" types) and adding the working electrolyte. The electrolyte is usually an aqueous solution of *Optibor* and ammonium borate, although formulations containing a polyhydric alcohol such as glycerin, ethylene glycol, or other glycols offer greatly increased range of operating temperatures.

The "dry" type of capacitor is so called because the electrolyte is non-aqueous and is of relatively low conductivity. Although this requires some changes in physical structure, the etching, cleaning, and film formation steps are generally similar to the processing carried out for "wet" types of capacitors.

The electrolytes used range from viscous liquids to nearly solid masses. Some more commonly used mixtures include glycolammonium borates, ammonium acetate-borates, and amine borates. Water-soluble organic acids, alone or with associated salts such as ammonium borates, have been frequently employed. The use of ammonium salts appears to be particularly advantageous where high voltage applications are important.

Purity of ingredients is essential to production of high quality capacitors. A technical report produced for Wright Air Development Center holds that "the ultimate useful life of an electrolytic capacitor depends on the complete elimination of the slightest trace of contaminants and the maintenance of the electrolyte in proper chemical composition."

## References

Deely PM. 1938. Electrolytic capacitors: The theory, construction, characteristics and application of all types. South Plainfield, NJ: The Cornell-Dubilier Electric Corp.

Coursey PR. 1937. Electrolytic Condensers: Their Properties, Design and Practical Uses. Chapman and Hall, Ltd.

Georgiev AM. 1945. The Electrolytic Capacitors. New York: Murray Hill Books.

WADC Technical Report 57-1: Techniques for Application of Electronic Component Parts in Military Equipment, Resistors, Relay, Capacitors. 1957. Vol 1. McGraw-Hill Book Co, Inc.

Specification MIL-C-62A: Cable, Special Purpose, Electrical, Multi-Conductor (2 conductors), and Single Shielded M270762/JEED. Sept 24, 1987.

Specification MIL-C-3871: Capacitor, Fixed, Electrolytic (Ac,Dry Electrolytic, Nonpolarized). 1980.

## 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 650 customers with more than 1,800 delivery locations globally. We supply around 30% of the world's need for refined borates from our world-class mine in Boron, California, about 100 miles northeast of Los Angeles.

## About 20 Mule Team products

U.S. Borax produces the *20 Mule Team*® borates family of products from naturally occurring minerals and have an excellent reputation for purity and safety when used as directed. Borates are key ingredients in a number of industrial applications including fiberglass, glass, ceramics, batteries and capacitors, wood preservatives, and flame retardants.

High quality, high reliability, high performance borate products. It's what we're known for.

20 MULE TEAM BORAX™
RioTinto

borax.com