Technical Bulletin

Borates in electrolytic capacitors

Ammonium pentaborate SQ, *Optibor*® SQ (boric acid), and Borax Decahydrate SQ may be used in several different ways in the manufacture of both "wet" and "dry" electrolytic capacitors. The purity of the materials used is of prime importance and U.S. Borax Special Quality grades of borates are especially suited to these requirements and have a long history of successful use in 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 boric acid 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 glycol-ammonium 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".

U.S. Borax is proud of its service to the electronic industry in providing chemicals of the highest standards of purity in its Special Quality (SQ) grades of Borax, boric acid, and ammonium pentaborate.

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References

(1) Deely, P. McK., “Electrolytic Capacitors”, Cornell Dubilier Electric Corp. 1938.
(2) Coursey, Philip R., “Electrolytic Condensers”, Chapman & Hall, Ltd., London, 1937.
(3) Georgiev, Alexander, “Electrolytic Capacitors”, Murray Hill Books, New York, 1945.
(4) WACD Technical Report 57-1, Vol. I. “Techniques for the Application of Electronic Component Parts in Military Equipment”, McGraw-Hill Book Co., Inc. 1957.
(5) Specifications MIL-C-62A, MIL-C-3871

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 east of Los Angeles. We pioneer 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

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.