NUCLEAR GRAPHITE

In 2015, ASTM International revised its standard for nuclear-grade graphite to graphite having a purity threshold of 99.995% carbon as graphite (Cg) and, critically important, less than 2 parts per million (ppm) equivalent boron concentration (EBC) (source: ASTM Standard C1233-15). Nuclear graphite must be free of neutron-absorbing material, in particular boron, which has a large neutron capture cross section.

A critical material for the construction of both historical and modern nuclear power reactors — in addition to numerous defense and aerospace applications — nuclear graphite is one of the purest materials manufactured at industrial scale. Graphite retains its physical properties, including strength, at exceedingly high temperatures.

THE PROBLEM: SYNTHETIC GRAPHITE

Historically, almost all graphite utilized for nuclear applications has been synthetic graphite (also known as artificial graphite or electrographite). Synthetic graphite is a man-made substance manufactured by the high temperature processing of amorphous carbon materials. The primary material used to manufacture synthetic graphite is petroleum coke. Petroleum coke, or pet coke, is the solid carbon residue that remains after the coking process is performed on petroleum residue.

The exact process used to manufacture synthetic graphite is varied and can be quite complex, in addition to being expensive and tremendously energy intensive (e.g. graphitizing the material in a furnace for 12 weeks at 2,800 °C). Recent advancements in the nuclear industry have exhausted the amount of synthetic nuclear-grade graphite available for purchase.

THE SOLUTION: NATURAL GRAPHITE

Research at world-leading nuclear science research laboratories such as Oak Ridge National Laboratory has demonstrated that natural graphite can be used as a substitute for synthetic graphite to produce nuclear graphite — and is preferred both from performance and price considerations. However, achieving both the stringent contaminant levels and the very small particle size at sufficient purity has, in the past, limited its use as the purification of those small graphite crystals has proven to be difficult. Purity aside, very few upgraded graphite products can pass the EBC requirement for nuclear use. Enter Canada Carbon.

CANADA CARBON: NATURAL NUCLEAR GRAPHITE

Canada Carbon Inc. has 100% ownership of the Company’s flagship Miller HydroThermal Lump/Vein (HLV) Graphite Project in Grenville, Québec, Canada (~60 miles west of Montréal). In October 2013, the Company demonstrated for the first time that the Miller HLV graphite surpassed the purity and EBC threshold for nuclear graphite. As reported on May 1, 2015, Canada Carbon achieved 99.9998% C\textsubscript{t} purity utilizing commercially available nuclear graphite thermal upgrading, with a calculated EBC of only 0.72 ppm. On May 13, 2015, the Company announced that Evans Analytical Group certified the Canada Carbon’s Miller HLV graphite is of sufficient purity for nuclear applications.

“\textit{I have been analyzing high-purity graphite for nuclear applications for many years at Evans Analytical, and these purity results for natural graphite are comparable to the purest natural graphite samples I have assayed, and compared to results published around the world. The high temperature heat treatment experiment clearly points toward unique physical characteristics of this Miller vein material. In all my years of analyzing graphite this behaviour is unprecedented.”}"

Dr. Karol Putyera
Vice President, Purity Survey Analysis Services
Evans Analytical Group
Canada Carbon has achieved 99.9998% Ct purity, with a calculated EBC of only 0.72 ppm

NUCLEAR GRAPHITE USAGE
- Moderator
- Reflector
- Shielding
- Fuel Coating for Pebble Bed Reactors
- Numerous Defense and Aerospace applications

NUCLEAR GRAPHITE FUNCTIONALITY
- Radiation Moderation
- Thermal Conductivity
- Thermal Shock
- Structural Integrity
- Stability

NUCLEAR GRAPHITE PROPERTIES
- Small crystalline size
- Extremely low concentrations of:
  - Neutron-absorbing elemental contaminants
  - Oxidation-promoting elemental contaminants
  - Activation relevant isotopes
  - Metallic corrosion-relevant elemental contaminants
  - Fissionable elements
- Appropriate particle shape
- Appropriate particle-size distribution
- Stable crystal structure

Small Modular Reactors
The B&W mPower™ is an example of a proposed small modular reactor (SMR), designed by Babcock & Wilcox, and to be built by Generation mPower LLC — a joint venture of Babcock & Wilcox and Bechtel. The mPower™ is a Generation III+ light-water integral pressurized water reactor (IPWR), with the reactor and steam generator located in a single vessel. The reactor has a rated thermal output of 530 MWt and electrical output of 180 MWe. The reactor has an expected lifetime of 60 years.

Source: United States Nuclear Regulatory Commission
Photo: Babcock & Wilcox Nuclear Energy Inc.