Reliable Thermocouples for High Temperature Applications

Conax Buffalo High Temperature Thermocouples are specifically designed for durability and reliability in high temperature applications to 4200˚ F (2315˚ C). Such applications generally involve oxidizing, reducing, inert gas or contamination atmospheres that challenge the life of the thermocouple. Conax brings more than 50 years of experience in the design and manufacture of temperature sensing devices to the selection of appropriate materials and designs to maximize the life and reliability of thermocouples in these environments. This catalog reviews the primary characteristics of materials used in thermocouple elements, sheaths and insulations and outlines our standard configurations. For further assistance in determining the appropriate temperature sensing assembly for your application or for custom needs, contact a Conax sales engineer at 800-223-2389.

Thermocouple Types

Choose the thermocouple type from the temperature range table below. Minimum requirements for all Conax Buffalo thermocouples are standard limits of error and are denoted by a single letter (eg. S). Special limits of error are also available and are designated by a double calibration letter (eg. SS). For limits of error, see the Tolerance Chart on page 15.

Catalog Type	Calibration	Upper Service Temperature	Remarks
S	Platinum-10% Rhodium vs. Platinum	2700˚ F (1480˚ C)	For use in oxidizing, inert and vacuum atmospheres
R	Platinum-13% Rhodium vs. Platinum	2700˚ F (1480˚ C)	For use in oxidizing, inert and vacuum atmospheres
B	Platinum-30% Rhodium vs. Platinum-6% Rhodium	3100˚ F (1700˚ C)	For use in oxidizing, inert and vacuum atmospheres
C*	Tungsten-5% Rhenium vs. Tungsten-26% Rhenium	4200˚ F (2320˚ C) 3450˚ F (1900˚ C)	For use in hydrogen or inert atmospheres For use in vacuum atmospheres

** Formerly Conax Buffalo Type W5, Type C not an ANSI official designation.*

Note:
- *Upper Temperature Limits per ASTM E230 for 24 AWG wire for Types S, R and B.*
- *For Type C, special limits of error wire is not available (ref. ASTM E988).*
- *Platinum calibration not recommended for direct immersion in vacuum atmosphere, use with protection tube.*

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High Temperature Operating Temperatures Up to 4200˚F (2315˚C)

Insulation Materials

Material	Upper Service Temperature	Melting Point	Remarks
Alumina (Al_2O_3)	3450˚ F (1900˚ C)	3686˚ F (2030˚ C)	High-purity aluminum oxide is the standard insulation material supplied for Conax Buffalo high temperature thermocouple assemblies. Alumina offers high thermal conductivity and high electrical resistivity.
Hafnia (HfO_2)	4352˚ F (2400˚ C)	5054˚ F (2790˚ C)	Hafnium oxide is usually present in zirconium ores in amounts ranging from .5 to 2 percent. Refined high-purity hafnia offers a higher electrical resistivity at elevated temperatures than yttria or zirconia. Hafnia's resistivity is comparable to that of beryllium oxide, but hafnia does not present the potential health problems associated with beryllium oxide. Hafnia is therefore replacing beryllium oxide in many applications. Hafnia is the commonly recommended insulation for Conax Type C thermocouples.

Other Insulation Materials

Material	Chemical Symbol	Upper Service Temperature	Remarks
Beryllium Oxide	BeO	4200˚ F (2315˚ C)	High electrical resistivity, toxic dust, special handling required
Magnesium Oxide	MgO	2500˚ F (1370˚ C)	Used primarily with compacted sheathed thermocouples
Thorium Oxide	ThO_2	4532˚ F (2500˚ C)	Low electrical resistivity, good resistance to reducing environments
Yttrium Oxide	Y_2O_3	3632˚ F (2000˚ C)	Low electrical resistivity, stabilizer material for zirconium

Sheath Materials

Material	Upper Service Temperature	Melting Point	Remarks
Molybdenum (Mo)	3400˚ F (1871˚ C)	4730˚ F (2610˚ C)	Molybdenum offers excellent mechanical properties at elevated temperatures and is exceptional for use in reducing or neutral atmospheres. Molybdenum offers superb thermal shock resistance and has potentially unlimited life at high temperatures in a vacuum. Pure hydrogen, argon and helium atmospheres are completely inert to molybdenum. Performance is poor in oxidizing atmospheres. Above 800˚ F (427˚ C), molybdenum will react with oxygen.
Tungsten (W)	4200˚ F (2315˚ C)	6100˚ F (3380˚ C)	Tungsten has the best strength at high temperatures of all the common refractory metals. Tungsten provides good abrasion resistance. It can be used in hydrogen at all temperatures, and in dry argon and helium. Tungsten is not recommended for use in oxygen bearing environments, as oxygen is known to cause physical degradation in only a few hours depending on temperature and oxygen content.
Tantalum (Ta)	4500˚ F (2482˚ C)	5425˚ F (2996˚ C)	Tantalum is best used in reducing or neutral atmospheres and in a vacuum environment. Its performance is poor in oxidizing atmospheres, and it must be protected from gases such as oxygen and nitrogen at temperatures above 570˚ F (300˚ C). Tantalum is outranked by tungsten for high temperature strength. Tantalum is excellent for thermal cycling applications and is the most corrosion resistant of the refractory materials. It is almost completely immune to attack by acids except hydrofluoric acid.
Alumina (Al_2O_3)	3450˚ F (1900˚ C)	3686˚ F (2030˚ C)	High-purity aluminum oxide offers high thermal conductivity, high electrical resistivity and good resistance to thermal shock. It also offers excellent resistance to chemical attack. Aluminum oxide functions well in oxidizing, reducing or high vacuum applications, but is not recommended for high vacuum environments in the presence of graphite at temperatures exceeding 2372˚ F (1300˚ C).

** Molybdenum, Tungsten and Tantalum sheath assemblies are backfilled with argon and sealed to prevent oxidation.*

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