CGThermal
Process Technology Solutions
for Harsh and Corrosive Process Streams

Impervite® Graphite

Shell and Tube Heat Exchanger

Longer Operational Life • Highest Resistance to Thermal Shock

Excellent resistance to fatigue stress resulting in longer operational life:

- Highest thermal conductivity
- Exceptional thermal shock resistance
- High toughness, lower brittleness
- Low thermal expansion rate
- Exceptional thermal stability
- Fully graphitized

MADE WITH PRIDE IN THE USA
100% AMERICAN OWNED & OPERATED

Time-Tested Heat Transfer

CG Thermal Impervite® impervious graphite tube is manufactured by subjecting a fully graphitized porous graphite tube to our state-of-the-art proprietary vacuum/temperature/pressure impregnation of modified phenolic resin.

By carefully measuring the resin properties and matching the characteristics of the graphite, we can guarantee a final product that consistently meets our mechanical, thermal and corrosion resistant standards. All phases of the impregnation process are computer controlled, recorded and archived verifying the manufacturing process is exactly per our specification.

The result is an industry leading Impervite® graphite exchanger that meets or exceeds all other phenolic impregnated graphite units in the very important exchanger properties of thermal conductivity, thermal shock resistance and thermal stability. The absence of carbon in our fully graphitized tube minimizes the brittleness while maximizing the toughness and fatigue resistance.

THERMAL SHOCK RESISTANTANCE COEFFICIENT

	IMPERVITE®	BRAND 1	BRAND 2
CONDUCTIVITY (W/K M) (Radial)	109 (@100 DEG C)	70 (@130 Deg C)	31
TENSILE STRENGTH (Mpa)	28	28	30
CTE (x 10-6/C)	2.52	2.5	3.1
YOUNG'S MODULUS (Gpa)	15.1	14	15.8
THERMAL SHOCK RESISTANCE	**80.2**	**56**	**18.98**

1. Thermal Shock resistance = $\frac{\text{Conductivity * Tensile Strength}}{\text{CTE * Young's modulus}}$
2. Brand 1 and Brand 2 properties are from published values.

Some manufactures have made the decision to use a"graphite" tube that is not fully graphitized to lower costs. Minimizing graphitization and using a "carbon/graphite" tube does lower the production cost but also ***lowers the thermal conductivity, increases the thermal expansion rate, lowers the thermal shock resistance, and lowers the ability of the tube to absorb impact energy.***

THERMAL CONDUCTIVITY OF IMPERVITE TUBING

Grade	Size	ER Range x10-5 Ohm-in		Estimate K (BTU ft)/ft2 hr F)		Estimate K (Watts /m K)	
		20 Deg C	100 Deg C	20 Deg C	100 Deg C	20 Deg C	100 Deg C
Impervite - Min/Max at ambient temperature		41	35	54	63	93	109
		Min	Max	Min	Max	Min	Max

PROPERTY	METRIC	IMPERIAL
Maximum Operating Temperature**	174 Deg C	345 Deg F
Flexural	47 Mpa	6,583 psi
Thermal Conductivity	109 w/k-m	58 Btu/hr*ft2*F
Compressive	81.51 Mpa	11,831 psi
Tensile	28.31 Mpa	4,110 psi
Coefficient of thermal expansion	2.52 (-6) /K	1.40 (-6) / F

** For G mark certification.

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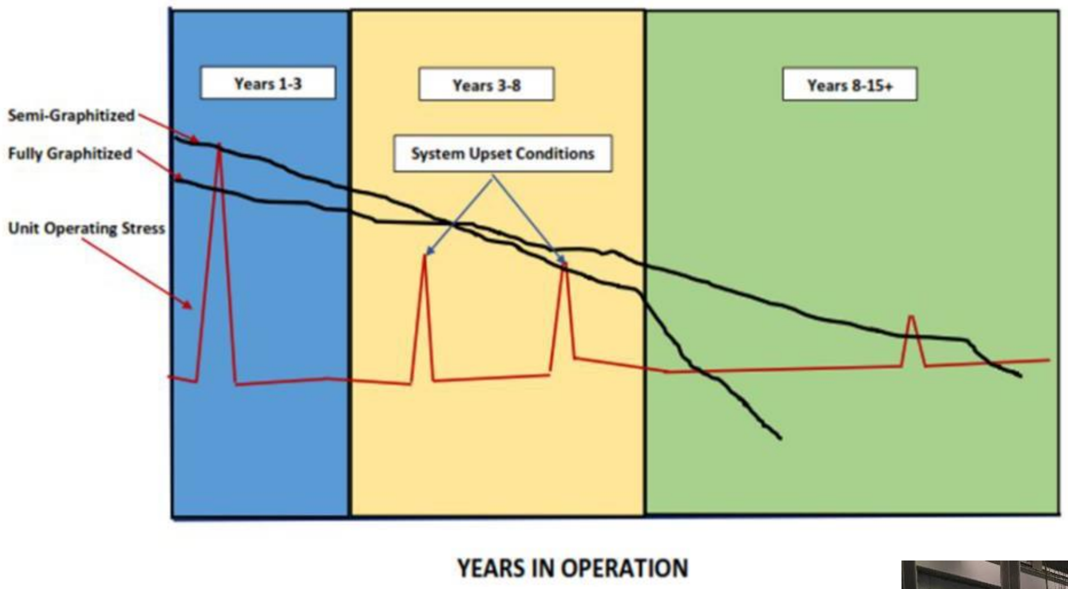
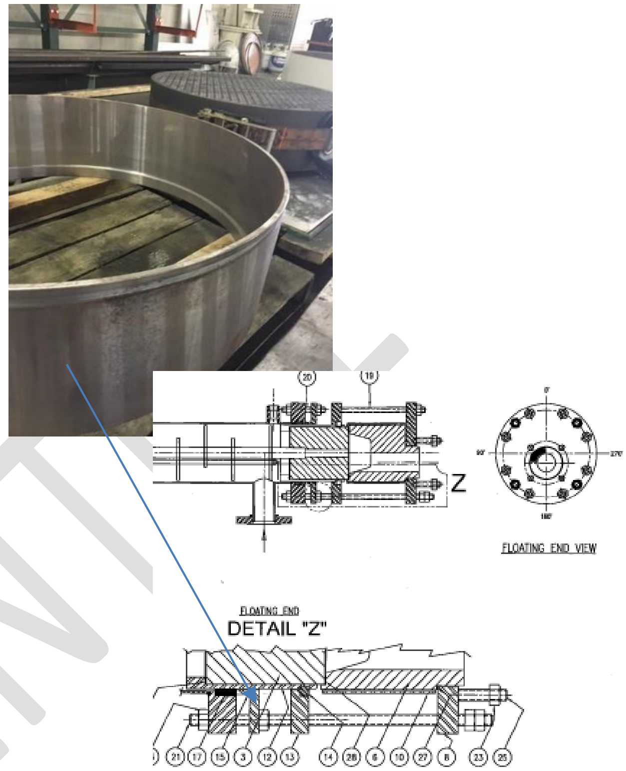


Advanced Design, Manufacturing

Recognizing that CG Thermal heat exchangers must perform during critical processes, they are designed, manufactured and tested to meet especially high internal standards as well as ASME SEC VIII Div 1 requirements.

- 100% of Impervite® tubing is subjected to both an air-under-water and higher pressure hydrotest after impregnation and prior to being assembled in an exchanger.

- Impervite® tubes are available up to a monolithic length 12’ long. Should the optimum tube length exceed 12’ the tubes are joined using our ASME certified, computer controlled and monitored cementing process. The assembled tubes are hydrotested after joining.



Fully Metal Encased Tube Side Construction

As standard practice CG Thermal fully encases all exposed graphite components in ASME SEC VIII code stamped metal covers and skirts, protecting the graphite from externaldamage and eliminating dangerous tensile loads on the floating tube sheet caused by grooved floating tube sheet design. The design includes a high precision machined floating tube sheet "skirt" which transfers the floating head mechanical and hydraulic forces on to the back side of the floating tube sheet, putting this graphite component in compression, which is the "best practice" for graphite design.

It is worthwhile noting that virtually all graphite exchangers carrytube side process fluids which create class 1, div I or II hazardousarea conditions in the workplace. Increased emphasis should therefore be placed on tube side integrity.

ASME Code Markings*

There are two options available for applying the ASME Certification Marks

ASME Sec. VIII Div. 1 Certification Mark with **the U designator**

Applied to a graphite heat exchanger without the need to apply the G mark designator when the following conditions have been met:

- All of the metal pressure retaining components of the completed unit have been designed andfabricated per the requirements of ASME Sec. VIII Div. 1.
- The assembled unit is tested per Code requirements.
- There are no external graphite pressure retaining components.

ASME Sec. VIII Div. 1 Certification Mark with **the U and G mark designators**

Applied when meeting the requirements of ASME Sec. VIII Div. 1 and applying the rules of Part UIG.

- The G mark is required when there are graphite components (tube sheets and process domes) notencased in metal, used as external pressure-retaining components (the pressure boundary)
- The Gmark is a design option openly acceptable to the industry and has the advantage of potentially reducing manufacturing costs due to the elimination of the metal pressure-retainingcomponents on the graphite tube sheet and domes.
- An end user can elect to use this option with the metal encased design described above, for addedprotection against catastrophic failure.