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CGThermal

Ceramic. Graphite. Heat Exchangers. Process Equipment.

High Technology Products and Services for Your Most Demanding Corrosive Chemical Environments

CG Thermal LLC was founded in March 2010 with the acquisition of the graphite and ceramic heat exchanger business of Apex Engineered Products. Our key personnel have over 125 years experience in the design and manufacture of these and similar products through their employment in senior positions at The Carborundum Company, Pfaudler, Metaullics Systems Co., and Carbone Lorraine. This experience and dedication to serving the needs of the chemical process industry is now brought to bear at CG Thermal, the only full service American owned company providing these products and services.

Our mission is to consistently deliver well-engineered, superior-value solutions to the world's leading chlor-alkali, fine chemical, specialty chemical, steel pickling, olefins, aromatics, petrochemical, agricultural chemical and fertilizer producers. We build on the industry's leading graphite, ceramic and thermal design technologies in the heat exchanger and chemical processing equipment we offer.

For example, CG Thermal's standard graphite heat exchanger construction provides for a fully contained tube side design which eliminates external exposure of the graphite while also greatly reducing the tensile loading on the floating tube sheet. In order to meet the requirements of critical processes, every unit is designed, manufactured and tested to meet especially high internal quality and fabrication standards. Each unit also meets industry standards such as ASME,TEMA, and ASTM.

CG Thermal is located in Northeast Ohio, considered by many to be the birthplace of impervious graphite and ceramic heat exchangers. With over 30,000 ft^2 (2800m^2) of manufacturing space, we are a full-service technical provider/manufacturer with complete in-house thermal and mechanical design capabilities. All CG Thermal units are supplied with thermal performance and mechanical guarantees. Our engineering staff and trained external service network are at your disposal at any time to support your operations or maintenance/repair program.

The Big Advantage: Impervite® Graphite

Impervite® brand impervious graphite is a composite material consisting of a graphite base material impregnated with a proprietary phenolic resin using a well-controlled process. Impervite impervious graphite heat exchangers are ideally suited for processes involving the heating or cooling of sulfuric acid, hydrochloric acid, phosphoric acid, nitric acid, waste acids and chlorinated hydrocarbons.

The base graphite is chosen for optimum physical properties to maximize the penetration depth of our phenolic resin impregnation in the graphite, resulting in optimum impervite properties. When choosing raw graphite, the critical properties we consider are grain size, grain distribution, percent of voids, strength and thermal conductivity. All of these properties are important to ensure a final product that meets our high expectations and quality standards.

It is interesting to note that carbon and graphite are produced using the same process - the difference is that the carbonization process is terminated at about 840°C (1550°F) where graphitizing requires temperatures in excess of 2800°C (5100°F). Therefore, the physical and thermal properties of carbon and graphite are different: carbon has higher initial strength properties but is more of an insulator and is less tough; graphite is less brittle and has higher thermal conductivity. CG Thermal supplies only fully graphitized tubes.

Though graphite's initial strength is not as high as carbon's, its superior resistance to vibration and fatigue and lower thermal expansion rate make it the better heat exchanger material. High thermal conductivity in the raw graphite is an indication of the degree of "graphitization." A low thermal conductivity means that the graphite structure is most likely not fully graphitized and contains a higher percentage of carbon.

In very rare cases, the phenolic impregnation is not as corrosion-resistant as the raw graphite. Exceptions to the rule typically can be found in very high-reducing environments. However, it must be noted that if the phenolic resin is in question, then the graphite base must also be suspect.

In such rare cases, CG Thermal recommends you consider our universally-resistant Umax ceramic heat exchanger.

The resin used by CG Thermal to produce Impervite has been the industry standard for over 25 years and has properties that are field-proven to match specifically with our treat process. This resin is a water-based phenolic resin consisting of a phenolic compound, solvent and carrying fluids. The viscosity and water miscibility of the resin are constantly measured as they are an indication of the resin quality and of the degree of cross-polymerization that has taken place.

Impervite is produced using a four step impregnation process that, depending upon the geometry of the graphite being treated, can be repetitive:

1. The graphite is heated to drive off moisture and contamination.
2. The graphite is subjected to a high vacuum to remove the air from the voids, and the phenolic resin is introduced into the tank.
3. The tank is subjected to high pressure to force the resin into the voids, maximizing graphite penetration depth.
4. The resin in the graphite is polymerized to the desired hardness using controlled heating.

The rate of polymerization is closely monitored because if the process is performed too quickly or too slowly the graphite will not be fully impregnated, and porosity or micro-cracks can result.

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. Impervite graphite heat exchangers meet or exceed all other impervious graphite in thermal conductivity and efficiency.

Typical Block Material Properties	Raw	Impregnated
Type	Medium Grain	Medium Grain
Maximum Grain Size (Inches)	0.03	0.03
Bulk Density (g/cc)	1.75	1.84
Flexural Strength (psi)	2,900.00	4,640.00
Compressive Strength (psi)	5,700.00	9,120.00
Thermal Conductivity (BTU/hr-ft F)	62	62
Scleroscope Hardness	40	40
Typical Tube Properties	Raw	Impregnated
Type	Fine Grain	Fine Grain
Grade	GSXP	Impervite
Maximum Grain Size (Inches)	0.008	0.008
Density (g/cc)	1.67	1.90
Flexural Strength (psi)	3,800.00	6,380.00
Compressive Strength (psi)	9,665.00	11,310.00
Thermal Conductivity (BTU/hr-ft F)	58	58

Impervite® Shell & Tube Heat Exchangers

Standard and custom designed units are available in both 7/8" (22mm) and 1.50" (38mm) inside diameter tubing. Our thermal design engineers will precisely size the optimum unit to meet your process specifications. Heat transfer areas range from 12.0 ft^2 (1.12m^2) to 14,678 ft^2 (1471 m^2).

CG Thermal shell and tube exchangers have large cross-sectional flow areas relative to competing graphite heat exchanger designs, making them well suited for high fouling applications or when the allowable process pressure drop requirements are low. Typical applications include condensers, vaporizers, absorbers, coolers and heaters.

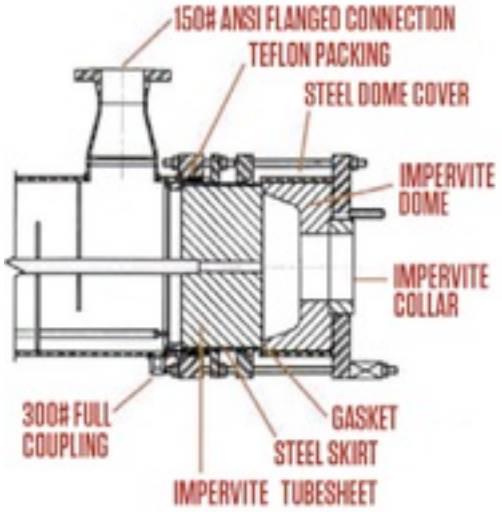
All CG Thermal shell and tube products are manufactured using Impervite® fully graphitized tubing. The high thermal conductivity and low coefficient of thermal expansion increases the tube resistance to thermal shock and increases its thermal efficiency.

Standard Heat Transfer Areas (in f^2/m^2) for 22.22mm (7/8") ID Tubes

		Tube Length**											
Nominal Shell Diameter	Number of Tubes	6 ft.	1.83 m	9 ft.	2.74 m	12 ft.	3.65 m	18 ft.	5.48 m	24 ft.	7.31 m	27 ft.	8.2 m
6"/152mm	8	26.2	2.45	40	3.74	53.7	5.02	81.2	7.59	62	5.79	70	6.5
8"/203mm	14	35.6	3.33	54.3	5.07	72.9	6.81	110.2	10.30	109	10.19	122	11.4
10"/254mm	27	50.6	4.73	77.1	7.21	103.6	9.68	156.7	14.64	210	19.63	236	22.1
12"/304mm	38	71.2	6.65	108.6	10.15	145.9	13.64	220.5	20.61	295	27.57	332	31.0
16"/406mm	64	120	11.21	183	17.10	246	22.99	371	34.67	497	46.45	560	52.3
18"/457mm	85	159	14.86	243	22.71	326	30.47	493	46.07	660	61.68	744	69.5
20"/508mm	109	204	19.07	311	29.07	418	39.07	632	59.07	846	79.07	953	89.1
24"/609mm	163	306	28.60	466	43.55	626	58.50	946	88.41	1266	118.32	1426	133.3
28"/711mm	230	431	40.28	657	61.40	883	82.52	1334	124.67	1786	166.92	2012	188.0
32"/812mm	304	570	53.27	868	81.12	1167	109.07	1764	164.86	2361	220.65	2659	248.5
36"/914mm	380	712	66.54	1086	101.50	1459	136.36	2205	206.07	2951	275.79	3324	310.7
38"/965mm	442	829	77.48	1263	118.04	1697	158.60	2564	239.63	3432	320.75	3866	361.3
44"/1118mm	596	1117	104.39	1703	159.16	2288	213.83	3458	323.18	4628	432.52	5123	478.8
48"/1219mm	721	1352	126.36	2060	192.52	2767	258.60	4183	390.93	5599	523.27	6307	589.4
50"/1270mm	782	1466	137.01	2234	208.79	3002	280.56	4537	424.02	6073	567.57	6840	639.3
52"/1320mm	847	1588	148.41	2420	226.17	3251	303.83	4914	459.25	6577	614.67	7409	692.4
54"/1371mm	913	1712	160.00	2608	243.74	3504	327.48	5297	495.05	7090	662.62	7986	746.4
56"/1422mm	984	1845	172.43	2811	262.71	3777	352.99	5709	533.55	7641	714.11	8607	804.4
58"/1473mm	1069	2004	187.29	3054	285.42	4103	383.46	6202	579.63	8301	775.79	9351	873.9
60"/1524mm	1147	2150	200.93	3277	306.26	4403	411.50	6655	621.96	8907	832.43	10033	937.7
62"/1575mm	1225	2297	214.67	3499	327.01	4702	439.44	7107	664.21	9513	889.07	10715	1001.4
64"/1625mm	1304	2445	228.50	3725	348.13	5005	467.76	7566	707.10	10126	946.36	11406	1066.0
72"/1829mm	1678	3146	294.02	4793	447.94	6441	601.96	9736	909.91	13030	1217.76	14678	1371.8

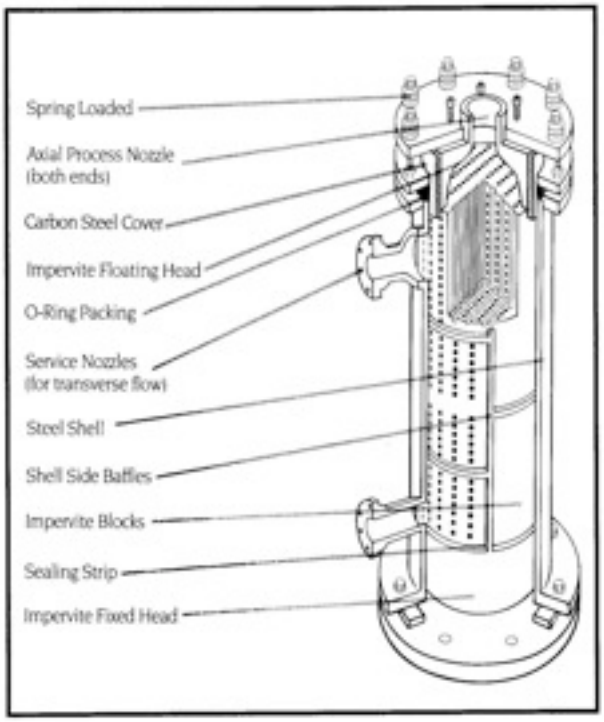
Standard features include:

- Every unit tested to meet ASME code requirements and demanding in-house standards.
- Exclusive skirted floating tube sheet design eliminates harmful tensile loading on the tube sheet and allows for full ASME code stamp by containing all the graphite within metal. Reference diagram.
- Standard operating limits up to 100 psig (6.89 barg) and 340°F (171°C).
- Single-piece non-segmented tube sheets.
- Phenolic resin impregnation.
- Complete flow vibration analysis performed on all new units to ensure the lowest operating stresses within the unit due to fluid flow.
- Flat-plate graphite nozzle design that eliminates the grooves and stress loads on the graphite nozzles which can lead to failure/cracking.
- FRP, Teflon or metal baffles utilized in place of the graphite baffles supplied by others - graphite baffles are prone to breakage and make tube replacement more difficult.



Shell material options and various corrosion resistant coatings are available upon request.

Impervite® Multi-Blox® Cylindrical Block Heat Exchangers



CG Thermal cylindrical block heat exchangers are designed and built for non-stop service: 24 hours a day, 365 days a year. These units are the smartest, sturdiest solution for your most demanding applications where down time or cross contamination is simply not an option.

The units utilize a rugged, cylindrical graphite element with a high slender ratio that all but eliminates the dangerous bending stresses found in other graphite heat exchanger designs. The units have excellent resistance to thermal shock, water/steam hammer and other mechanical abuses.

Our cylindrical units utilize some of the longest monolithic blocks available. These long blocks greatly reduce the number of required sealing gaskets and minimize the effects of "point loading" on the graphite. Point loading can and does lead to block cracking.

To increase the life and reliability of the unit during operation, our Multi-Blox® unit has some of the largest hole pitches in the industry. By spreading out the holes we are able to increase the graphite rib between each hole up to three times more than industry standard offerings, lowering operational stresses that would crack other blocks and lead to failures. We can supply up to 1" (25.4mm) process holes.

Standard Heat Transfer Areas (in Ft^2/M^2) for Multi-Blox® Heat Exchangers

	Element Size															
Nominal Shell Diameter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
6"/152mm	1.5/.14	2.9/.27	4.4/.41	5.8/.54	7.3/.68	8.7/.81	10.2/.97	11.6/1.1	13.1/1.22	14.5/1.38	16/1.52	17.4/1.66	18.9/1.77	20.3/1.93	21.8/2.0	23.2/2.2
8"/203mm	3/.28	6.1/.58	9.1/.87	12.2/1.16	15.2/1.44	18.3/1.74	21.3/2	24.4/2.32	27.4/2.6	30.5/2.9	33.5/3.19	36.6/3.48	39.6/3.77	42.7/4	45.7/4.35	48.8/4.64
10"/254mm	5.2/.49	10.3/.96	15.5/1.47	20.6/1.96	25.8/2.45	30.9/2.94	36.1/3.43	41.2/3.85	46.4/4.41	51.6/4.9	56.7/5.4	61.9/5.89	67/6.38	72.2/6.87	77.3/7.36	82.5/7.86
12"/304mm	7.3/.65	14.5/1.38	21.8/2.0	29/2.76	36.3/3.46	43.6/4.15	50.8/4.84	58.1/5.53	65.3/6.21	72.6/6.9	79.9/7.6	87.1/8.29	94.4/8.99	101.7/9.68	108.9/10.37	116.2/11
14"/357mm	8.6/.82	17.1/1.62	25.7/2.44	34.3/3.27	42.8/4	51.4/4.89	60/5.71	68.5/6.52	77.1/7.34	85.7/8.16	94.2/8.97	102.8/9.79	111.4/10.6	119.9/11.41	128.5/12.71	137.1/13
16"/406mm	10.8/1.03	21.7/2	32.5/3	43.4/4.13	54.2/5	65.1/6.2	75.9/7.22	86.7/8.25	97.6/9.29	108.4/10.32	119.3/11.36	130.1/12.39	141/13.42	151.8/14.45	162.6/15.48	173.5/16.52
18"/457mm	14.7/1.4	29.4/2.8	44.1/4.2	58.9/5.60	73.6/7	88.3/8.4	103/9.8	117.7/11.2	132.4/12.6	147.2/14	161.9/15.42	176.6/16.81	191.3/18.21	206/19.61	220.7/21	235.4/22.41
20"/508mm	19.8/1.88	39.7/3.78	59.4/5.66	79.4/7.56	99.2/9.44	119.1/11.34	138.9/13.22	158.8/15.12	178.6/17	198.5/18.90	218.3/20.8	238.2/22.68	258/24.57	277.8/26.46	297.7/28.35	317.5/30.24
22"/559mm	25/2.38	50/4.76	75/7.14	100/9.52	125/11.9	150/14.28	175/16.66	200/19	225/21.42	250/23.8	275/26.19	300/28.57	325/30.95	350/33.33	375/35.71	400/38.09
24"/609mm	30/2.85	60/5.71	90/8.57	120/11.42	150/14.28	180/17.14	210/20	240/22.86	270/25.7	300/28.57	330/31.42	360/34.28	390/37.14	420/40	450/42.86	480/45.71
26"/660mm	36/3.42	72/6.86	110/10.47	143/14	180/17.42	220/20.95	257/24.47	293/27.9	330/31.42	367/34.95	403/38.38	440/41.9	477/45.43	513/48.85	550/52.38	587/55.9
28"/711mm	43/4	86/8.19	131/12.47	175/16.66	219/20.85	263/25	307/29.23	350/33.33	394/37.52	438/41.71	482/45.9	526/50	569/54.19	613/58.38	657/62.57	701/66.76
30"/762mm	49/4.66	99/9.42	142/14	193/18.76	246/23.42	296/28.19	345/32.86	394/37.25	443/42.19	493/46.95	542/51.61	591/56.28	640/60.95	690/65.71	739/70.39	788/75.04
38"/965mm	58.4/5.56	113/11.14	175/16.66	234/22.28	293/27.8	350/33.33	409/38.95	467/44.47	525/50	584/55.62	642/61.14	701/66.76	758.9/72.28	817/77.8	876/83.42	934/88.95
Element Length Inches/mm	8.9/226	17.7/449	26.6/676	35.5/901	44.36/1127	53.25/1352	62.13/1578	71/1803	79.89/2028	88.75/2254	97.63/2479	106.5/2705	115.4/2931	124.3/3157	133.1/3380	142/3606

** Additional diameters and lengths, and/or design criteria available upon request

Standard and custom features of our two different cylindrical series (MB and EB) include the following:

- Maximum heat transfer area in minimum envelope size
- Process hole diameters of 0.375" (9.50mm), 0.50" (12.7mm), 0.750" (19mm) and 1.00" (25.4mm)
- Design pressure up to 150 psig (10.34 barg)
- Immunity to thermal shock throughout unit operating temperature range up to 350°F (175°C)
- Standardized longer blocks with fewer gaskets (less chance for leaks)
- Full mechanical and thermal guarantee
- All components 100% quality checked and hydro-tested
- High-reliability design for reduced operating and maintenance costs
- Design allows complete access to both the service and process side of unit, making it easy to clean and maintain
- Vertical, horizontal or sloped mounting available
- Both process and service side of the unit can be supplied with a full ASME SEC VIII Div 1 code stamp

Impervite® Cubic Block Heat Exchangers

CG Thermal Impervite® cubic block heat exchangers offer many of the same features as our heavy duty cylindrical block heat exchangers and are fabricated using the same high quality impervious graphite, but typically at a lower investment cost. Our cubic design is your first choice for low pressure condenser service or when there is a corrosive fluid on both sides of the unit. Also, the true counter-current flow pattern is ideal for applications that require low temperature approaches or temperature cross.

Cubic heat exchangers offer the maximum heat transfer area in the smallest envelope size, typically resulting in lower capital investment costs. Both the process and service sides can be fitted with highly corrosion resistant Impervite, making them the ideal choice as interchangers. In applications where high fouling is expected, easy access to both the process and service side holes make cleaning convenient and simple.

Features and Benefits

- Heat transfer area range of 20 ft² (1.9m²) to 650 ft² (61m²)
- Maximum heat transfer area in minimum envelope size
- High thermal efficiency, even with low temperature approach and temperature cross
- Process hole diameters of 0.375" (9.50mm), 0.50" (12.7mm), and 0.750" (19mm)
- Design pressure up to 75 psig (5.17 barg)
- Single piece, monolithic Impervite® cubic element
- Full mechanical and thermal guarantee
- All components 100% quality checked and hydro-tested
- All the metal components can be supplied with a full ASME SEC VIII Div 1 code stamp
- Design allows easy access to both the service and process side of the unit, making them easy to clean and maintain

Umax® Advanced Ceramic: For Your Most Demanding Chemical Processes

Umax® advanced ceramic is the most universally corrosion and erosion-resistant material in the chemical processing industry. This brand of alpha sintered silicon carbide is an advanced ceramic that handles your corrosive chemicals - including mixed acids, hydrofluoric acid, free halogens, caustics and all other chemicals typically found in the industry's most reducing and oxidizing environments.

Its extreme hardness, high theoretical density, excellent strenth properties and absence of free silicon make Umax advanced ceramic inherently corrosion and erosion-proof. Umax advanced ceramic is your universal value-added replacement for expensive reactive metals, nickel-alloys, not-so-conductive Teflon, and brittle glass and graphite.
Our Umax tubes are superior in that they are warranted against the failures typically found in the other materials

Umax® tubing is supplied with a 2 year unconditional performance guarantee.

currently used in the CPI market. Each tube is independently tested to over 1,000 psig and comes with an unconditional two-year guarantee against corrosion and erosion.
Umax's unique properties are not achieved using impregnations (as in graphite) or reactive layers (as in reactive metals). Instead, Umax is a homogeneous, extremely inert material. Umax advanced ceramic is a sturdier alternative to reactive metals and nickel alloys which are prone to pin hole leaks and stress crack corrosion. It will maintain its original tube surface structure thoughout its operating life, lowering the fouling rate in most chemical processes. It can also be cleaned with high pressure fluids with no danger of tube damage.

Umax® Ceramic units are completely field-repairable using standard tools.

Unlike other ceramics and graphites used in the CPI market, Umax is truly 100% resistant to thermal shock and mechanical damage throughout its operating range. This is due to its high thermal conductivtiy, low thermal expansion rate, and high flexural and tensile strength properties.

	Umax® Ceramic	Impervious Graphite	Tantalum	304SS	Borisilicate Glass
Specific Gravity	3.1	1.9	16.6	8.0	2.2
Flexural (psi)	60,000	6,380	50,750	75,000	1,000
Compressive (psi)	560,000	11,310	NA	75,000	150,000
Mod. Elast. (x10^{6}psi)	59	2.3	27	28	98
CTE (10-6 in/in f)	2.2	1.04	5.8	9.3	1.8
Conductivity (BTU/ft-hr F)	58	58	32	9.1	0.67

"U" Value Comparison for Common Applications

"U" without wall	Operation Type	Umax (.060")	Tantalum (.020")	Glass (0.39")	Teflon (.025")
300	Evaporator (water/	294	295	122	45
250	Heater (water/steam)	246	247	112	44
200	Cooler (water/steam)	197	198	101	42
150	Condenser (organics/	148	149	87	39
50	High Vacuum Condensing	50	50	40	26
20	Cooler	20	20	18	15