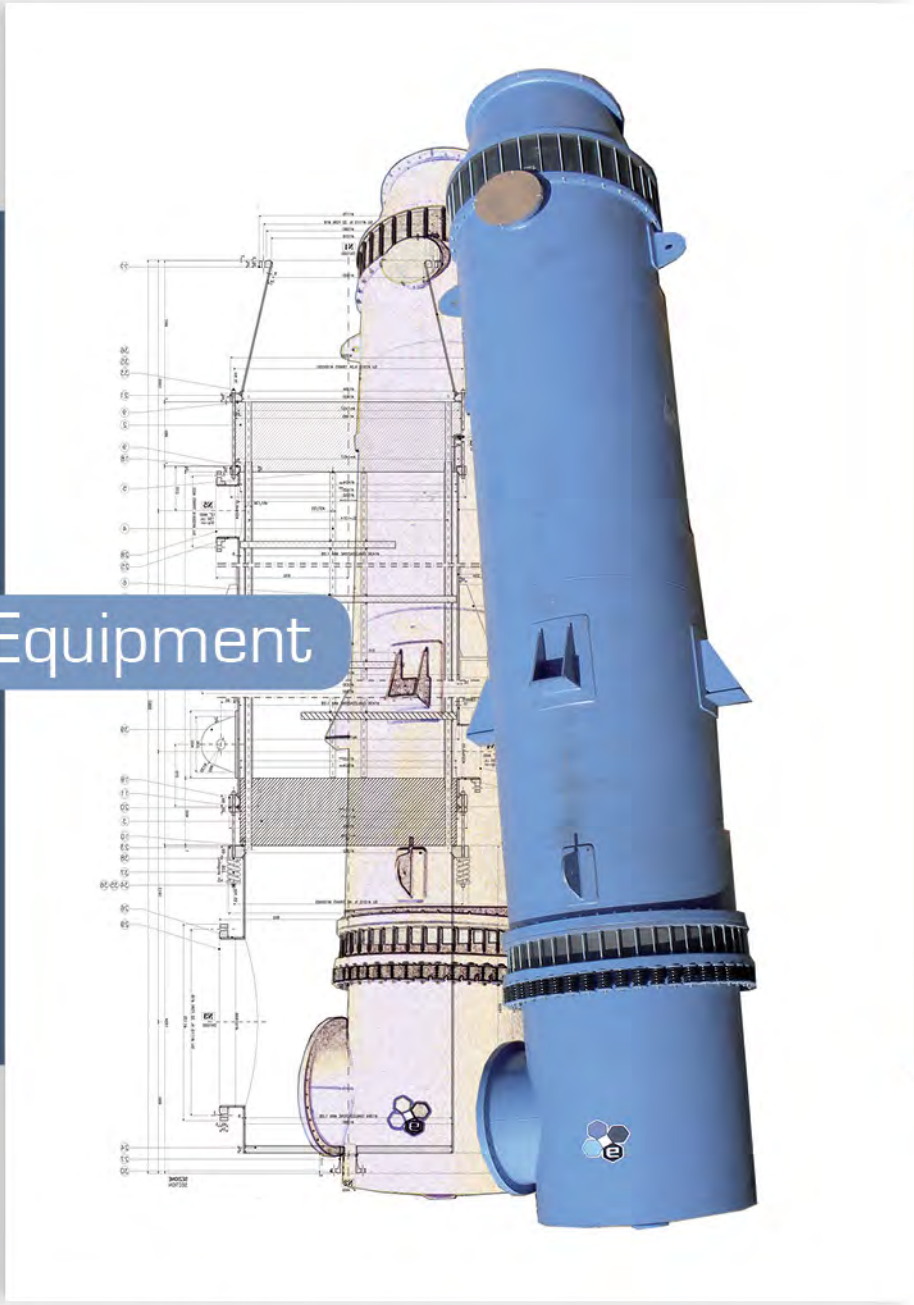
ecarb
equipment and systems



Process Equipment

Graphite | Fluro-polymeric and rubber linings | Silicon carbide | Exotic metals

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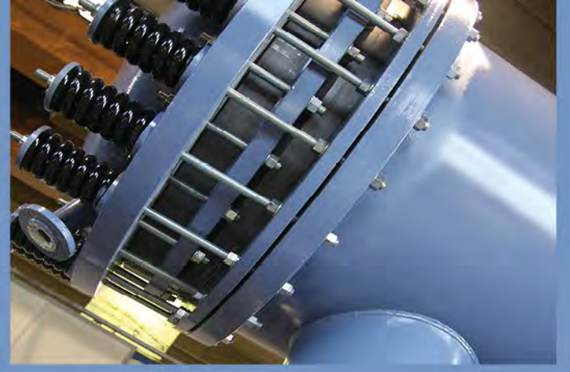
Engineerd by passion

Ecarb Quality Management System is certified according to ISO 9001:2008 and our production set up has achieved TUV certification according to severe Pressure European Directive 2014/68/UE requirements. Our PED certification enables autonomous production of pressure vessel up to Cat. IV, better than other expensive and blazoned competitors.
We work with authentic passion and our daily activities are inspired by **Ecarb**'s core values: engineering excellence and customer satisfaction.
Graphec® products are designed in every detail to maximise lifetime and ensure easy and safe maintenance and operation.
We never use uncertain raw material: we carefully select the material grade that better fit service requirements, sourced **exclusively from premium western suppliers**.

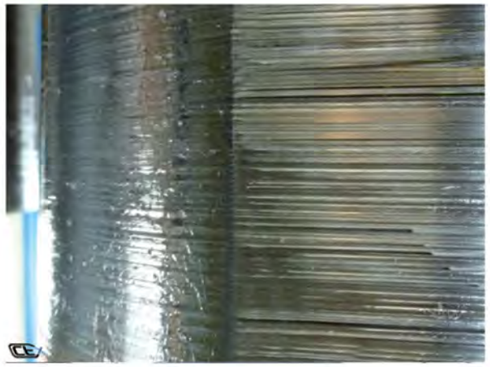


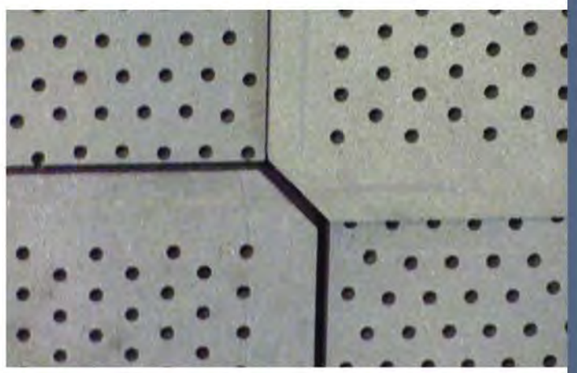
References

Ecarb was founded on 2009, to provide continuity to long personal stories of indubitable competence and passion for process equipment manufacturing.
We quickly collected many references in almost all process applications, gaining the trust of many important chemical companies. Our files are available to make any purchase experience comfortable and safe.

Graphec®
graphite for process equipment

Graphite has unique chemical and physical properties. Raw graphite is originally porous and it is chemical resistant to many substances in a wide temperature range. **Graphec®** is an impregnated graphite, fully impervious and inert to a wide range of aggressive chemicals up to 230 °C. Thermal conductivity (up to 160 W/m°K) is much higher than any other common material, so that graphite is ideal for heat exchanger manufacturing.



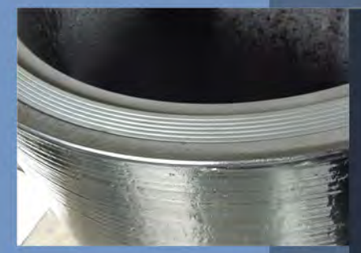


Optimal raw material selection

Ecarb is an equipment manufacturer, not raw graphite producer. We source raw graphite from primary western suppliers and we impregnate and machine it in our shop. This is far to be considered as a minus, it is rather a touchable advantages for our customers.
Raw graphite is available in a wide range of grades, coming from different production processes: extrusion, pressing, vibro-moulding and isostatic pressing. Each grade has specific features, which can be further adjusted by additional treatments (normally pitch impregnation and baking), whose final task is to reduce porosity and to increase the density of the material. This production diversity leads to a huge variety of material grades available on the market.

Ecarb is not forced to use its own raw graphite, we are free to select the optimal graphite grades, available among many possible alternatives. Only one criterion drives raw material selection: physical-chemical features must match specific process requirements. We use always the most suitable material grades, in order to produce premium equipment, with enhanced lifetime and higher reliability.

We use high quality graphite, sourced solely from selected European and US manufacturers. After impregnation in our shop, Graphec® graphite is certified according to severe AD2000 N2 standards. Quality is a must.



Graphec Material Clusters

The most relevant parameter to classify raw graphite grades for process application is the POROSITY. The lower is the porosity, better are the mechanical properties and corrosion resistance features.

- A more compact material pattern makes a stronger material.
- Lower void content reduces the possibility of interstitial permeation between impregnation agent and graphite.
- A lower porosity implies a lower content of impregnation agent and, consequently, higher resistance versus the medias that are corrosive toward the impregnation agent only.

Porosity is the key-parameter to define the final performance of impregnated graphite. Other relevant parameters are graphitization grade, tensile strength and average size of the graphite primary grains.

In order to group all possible graphites in material clusters, with homogeneous features, we use raw material porosity as main driver of material classification. So our graphites **Graphec®** iHP, iSP and iLP are respectively manufactured starting from High Porosity material, Standard Porosity material and Low Porosity material.

Micrograph of graphite before impregnation.			
Impregnated graphite			

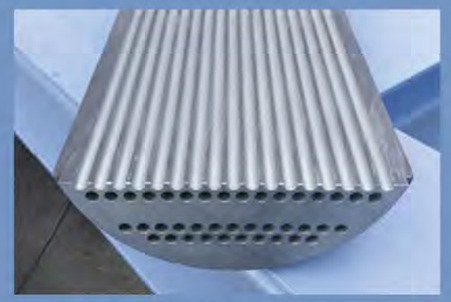
MATERIAL CLUSTER	iHP	iSP	iLP
Min. material homologation acc. AD2000 N2	G 12 5 170	G 20 10 200	G 20 00 200
Tensile strength, MPa@20°C	> 12	> 16	> 20
Tensile strength average % variation over 10°C	max 15	max 10	0
Max design temperature [°C]	180	200	220
Density before impregnation, Kg/m^3	1600	1700	1750
Thermal conductivity of blocks [W/mK]	120	140	150
Radial thermal conductivity for tubes [W/mK]			> 50
Block height [mm]	2500	2700	1830
Max Porosity, %	20	15	12
Averag grain size (mm)	1,5	0,7	0,01

Graphec xLP

Along the years, we successfully developed extraordinary grades of graphites, with unique features.
These special grades are particularly adapt for **pharmaceuticals** applications, and they are grouped under the commercial name of **Graphec®** xLP. **Graphec®** xLP may succeed where materials proposed by our competitors have shown to fail.
This family include following special graphites:

- PHE-xLP: Low porosity of raw material is further densified by treatment with organic medias, so to obtain a very low permeability (one order of magnitude less than other low porosity graphites). Than, a final impregnation cycle with phenolic resin allows to have full imperviousness. Due to very limited presence of phenolic resin, this material has extraordinary mechanical resistance (> 28 MPA of tensile strength), very high temperature rating (>230°C) and an extraordinary resistance to caustic substances (as soda or potash), which normally attack common graphites, over 10% concentration.
- PFA-xLP: it is a composite material with double impregnation layer. The first layer, process side, is performed starting from PFA suspension. PFA is a thermoplastic material, so it penetrates inside the graphite bulk, it melts and it creates resistant bonds with graphite. A second impregnation with phenolic resin is performed along service side surface, to create a double barrier to diffusion and permeation. PFA is inert to all caustic medias and organic solvents, so that PFA-xLP is a clean and cheap alternative to massive Silicon Carbide in fine&pharma applications.
- SIC-XLP: low porosity isostatic graphite is covered by a layer of massive Silicon Carbide. The universal chemical resistance of SiC matches machining versatility and limited price of graphite.

PFA penetrates deep inside pores
and it melts inside graphite



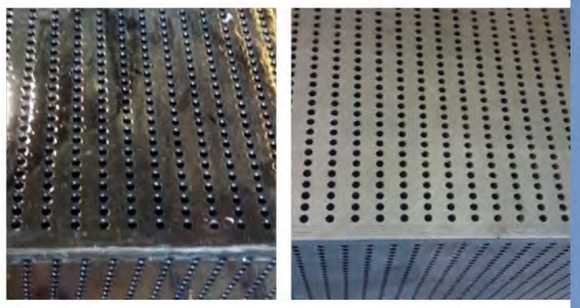
Section of a Silicon Carbide impregnated block

Impregnation

Impervious graphite is produced by impregnation of raw graphite with phenolic resin or fluropolymers. Once selected the best most suitable material grade, we perform impregnation and we check mechanical features but tensile test on minimum 12 specimens for each single lot, at two different temperatures. Impregnation is carried out in autoclaves: our impregnation cycle goes through deep vacuum and high pressure (14 bar g). Curing is performed in automatic ovens, under severe temperature and pressure control. Each single piece is submitted to tightening test, with air at 4 bar g for 30' in an automated testing station to check the perfect success of impregnation process.

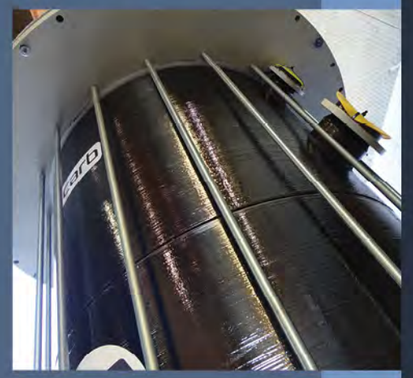
Impregnation medias are:

- phenolic resin, in the form of water base resol solutions
- PFA suspension: **Ecarb** does not use PTFE, wich does not melt, but just creates a superficial layer of sintered polymer.



Phenolic resin impregnation (before and after finishing)

Round block after PFA impregnation (before cleaning)



CFx

Ecarb has developed a carbon fibre reinforcement technique, to manufacture graphite components with superior mechanical resistance. A carbon fibre wrapping (CFx) is applied around tubes, blocks, column segments, tube sheets or headers, to limit risk of cracks and minimize leakages in case of damages. ***Carbon fibre cords are pre-tensioned during wrapping operation*** to enhance the reinforcing effect. Because of carbon fibre thermal behaviour (thermal dilatation coefficient is negative), carbon fibre wrapping increases resistance to thermal shock end enhances lifetime of the unit. Cracking and bursting pressure of tubes increase up to 100%. In case of heavy accident, pre-tensioned carbon fibre wrapping will prevent from a large fragmentation, avoiding further damages or leaks.

Ecarb CFx reinforcement systems is smart and flexible: we use cords of various filament densities and customized wrapping paths, for each specific application.

Graphec® ST
shell & tubes heat exchangers

Graphec® ST are composed by a graphite tube bundle fitted in a metallic cylindrical shell. Graphite S&T heat exchangers ensure complete and safe segregation between service side and process side, due to lack of gaskets or welding between tubesheets and tubes, which are joined by thermal cementing.
Bundle is a unique monolithic piece, resistant to thermal shock, fully cleanable and easy to run.
Versatile design makes these units ideal for a wide range of services: cooler, heater, condenser, reboiler, falling film absorber, evaporators.

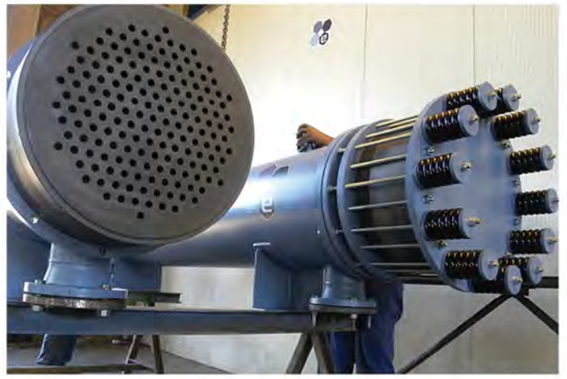
Model selection:
the best solution in an infinite range of possibilities

Graphec® ST product range covers almost all common heat exchange process needs. Exchange area varies from 0,35 m2 to >1.000 m2. Maximum design conditions are 220°C @ 20 bar g.
Ecarb performs accurate thermal sizing to identify the heat exchanger that better fits with specific process conditions. Diameter, number and length of the tubes, process passes number, baffles spacing and cut: we cross available geometric parameters to identify THE optimal design.
The best choice will never match any available standardized product model, so we are flexible to customize any unit, avoiding any additional constrain leading to sub-optimal process performances.

Maintenance and operation

ST units are fully cleanable, so that they can be used in very dirty applications, like raw phosphoric acid production. Headers may be disassembled to have direct access to bundle and perform easy and quick repair. Maintenance operations are normally cheap and simple. It is possible to replace graphite tubes in few hours, using an established and easy procedure. Every detail is studied to minimize exposure to damages and to ensure safe operation and long lifetime.
Design of each component is adjusted according to requirements of the use.
Each unit is fully drainable and easy to vent (self-venting, when possible).

Ecarb will suggest every kind of accessory, when useful to extend lifetime and ensure better operating conditions: anti-erosion disposals, conveyors, pressure safety valve, PTFE bellows, impingement plates, lined shell, etc.



Graphite tubes, outstanding quality

Ecarb selects among 4 sizes of tubes made of ultra-fine low porosity graphite **Graphec®** iLP. External carbon fiber wrapping (CFx) can be applied to enhance mechanical resistance and reliability. **Ecarb** tubes have superior physical features and they are submitted to rigorous tests, after production and before bundle assembling. Material and test certificates are available on request. Original monolithic length of **Ecarb** tubes is up to 6200 mm.
Longer tubes, up to 9 mt, are produced by thermal cementing.

Tensile strength [MPa] @20°C	> 30
Compression strength, [MPa	> 45
Eccentricity [mm]	< 0,8
Bursting pressure [barg	> 60
Maximum temperature (bulk), °C	220
Thermal conductivity [W/mK	50
Max. length of not cemented tube [mm	≈ 6200
Permeability (air) [cm^2/S]	< 10
Air testing pressure [barg	20
Hydraulic test pressure [bara	10
Tube diameters (int/ext, mm)	16/25 • 16/25 • 22/32 • 25/37 • 38/51

Tubesheets

Tubesheets are the most critical components of heat exchangers and they are continuously stressed during operations.
Tubesheets can be made of Graphec iSP, iLP or PHE-xLP, eventually protected by anti-erosion sleeves, made of amorphous carbon or PVDF.
Tubesheet thickness depends on design conditions and it is determined using high safety factor (minimum 9 times more than theorical values).
Carbon fiber reinforcement (CFx) is suggested to increase reliability of units submitted to severe thermal and mechanical cycles.

Headers

Available construction materials: graphite (Graphec iSP, iLP or PHE-xLP), rubber, glass or PTFE lined steel.
Headers geometry is adapted to specific service requirements. Special long headers can work as separation chamber for partial condensers. Headers may be equipped with mixer, anti-erosion baffes or conical conveyor. CFx (carbon fibre wrapping) is optionally available.

Shell

Ecarb manufactures internally shells and all steel parts, thereby controlling quality, compliance with tolerances imposed by graphite and lead time.
Available options:

- CS - Carbon Steel
- SS - Stainless Steel
- RL - Rubber Lined Carbon Steel
- TL - PTFE Lined Carbon Steel
- GL - Glass Lined Carbon Steel
- PP - Polypropilene

Gaskets

The use of high quality Gaskets ensures perfect sealing among headers, shell and bundle. Expandend PTFE cord are sourced by Gore Sealent Technologies®.
The O-ring around the floating tubesheet is normally made of Viton®.

Tightening system

Ecarb's advanced design includes a double tightening system, separately ensuring sealing and compensation of thermal dilatation.
One tie-rod set serves tubesheet/header coupling. The second one is equipped with elicoidal springs to enable free movement of floating tubesheet inside the metallic shell. Advantages:

- separate tie rod sets enable optimal compression of each gasket at different tightening forces;
- in case springs fail or tie rods are blocked, no leakage of process media will occur between tubesheet and header.

Graphec®
Block heat exchangers

Graphec® Block Heat Exchangers are assembled stacking graphite blocks in a metallic shell. Blocks are drilled along axial and cross sectional direction. Corrosive process media flows through longitudinal holes, while service media crosses the blocks on the cross sectional direction. Service media is collected in the shell (for cylindrical RB heat exchangers) or in metallic plates (for SB, cubical ones).

RB Exchangers have cylindrical blocks. Diameter varies from 160 mm to 910 mm. Blocks are sealed by fluro-polymer gaskets and surrounded by a cylindrical shell. **Graphec®** RB are strong, cheap, and compact. They are typically used for pickling bath heating and as universal condensers, due to very favourable ratio between surface and volume.

SB Blocks Heat Exchangers have several cubic blocks (side from 200 mm to 610 mm) pressed together by long tie-rods to reach necessary exchange area. They are suitable when it is necessary to segregate the process circuit from service circuit, reducing contamination risk. Service media runs through two lateral conveyors for each block, so that each block is a modular exchange unit and eventual leaks of process media among blocks will not be collected in the service side.

MB Monoblock Heat exchanger. A single prismatic graphite block is drilled along x and y axes. Medias into the two circuits can be both corrosive, and they are collected by two headers each. A robust assembling of 6 metallic plates ensures the proper compression and makes this geometry suitable for high pressure application. A versatile set-up of passes on the two circuits lets these units successfully run very challenging services, like those with temperature cross or very different flow rate between the two medias.

Accurate model selection

Graphec® RB, SB and MB product range covers almost all common heat exchange requirements. Exchange area varies from 0,1 m^2 to >500 m^2. Maximvum design conditions are 250°C @ 20 bar g.

Ecarb performs accurate thermal sizing to define the heat exchanger that better fits with process conditions. Block diameter and number, holes diameters, process and service flow passes: we cross all possible parameters to identify optimal geometry, the best possible combination to minimize price, providing easy-to-use and problem-free units.
We study each unit as a unique case.
Our flexibility becomes a tangible value for our customers.

	RB	RB D	SB	MB
Process side drilling pat	single	double	single	single
Block height [mm	255•350•500		200-610	up to 2200
Block main size [diameter or side] [mm	160-910		200-610	220
Graphite Thermal conductivity [W/mK	150		150	150
Holes diameters, process side [mm]	8•10•12•16•20		8•16	7•8•9•10•16
Holes diameters, service side [mm]	8•10		8•10	8•10
Max design pressure [barg	20		5	16
Max design temperature [°C	230		230	230
Max number of blocks	20		12	-

Maintenance and operation

Ecarb's block heat exchangers (**Graphec®** RB, SB and MB) are compact with large exchange surface within limited dimensions, just like plate heat exchangers. They are optimal solution in case of limited lay out availability. Headers and blocks may be quickly disassembled and each block can be replaced or cleaned.

Ecarb applies a fair price policy for spare parts, to avoid unreasonable maintenance costs.

Accurate mechanical design is carried out to ensure safe operation and long lifetime. Every detail is designed to minimize failure risk. Each unit is fully drainable, easy to vent and it may be equipped with a wide range of process accessories.

Graphite blocks: a matter of quality!

It is possible to choose among twenty blocks diameters, three blocks height and six holes diameters, from 8 mm up to 20 mm. Single or double drilling paths are possible.
Graphec® blocks are made of all available graphite grades, iHP, iSP, iLP, PHE-xLP, PFA-xLP and SIC-xLP.
Material selection depends on process media. Tensile strength varies from 12 MPa (iHP) up to >28MPa (xLP).
Standard graphite is impregnated with phenolic resin.
PHE-xLP, PFA-xLP and SIC-xLP blocks heat exchangers are a cheaper and safe alternative to massive Silicon Carbide tube heat exchangers and they can be extensively used in pharmaceutical synthesis plant, as condensers or post-condensers, enabling a clean and universal operation.

Shell & steel part

Ecarb manufactures internally shells of Graphec RB, lateral conveyor of Graphec SB and tightening plates of Graphec MB, thereby controlling quality, required tolerances and lead times.
Material options:

- CS - Carbon Steel
- SS - Stainless Steel
- RL - Rubber Lined Carbon Steel
- TL - PTFE Lined Carbon Steel
- GL - Glass Lined Carbon Steel

Gaskets

Gaskets sealing headers, shell and blocks are expanded PTFE cord supplied by Gore Sealant Technolog®. Viton O-ring or a PTFE stuffing box is installed between floating header and shell.

Tightening system

An elastic tightening system compensate differential thermal dilatation between steel and graphite blocks.
For **Graphec®** RB, cylindrical block type, tightening is ensured by coil springs or a by a metallic bellow welded to the shell, whilst sealing between shell and floating header is given by Viton® O-ring or a stuffing box.
For **Graphec®** SB and MB compensation in provided by helical or washer springs, installed at tie-rods ends

Headers

Available construction materials: graphite (graphec iHP, iLP or iSP), rubber, glass or PTFE lined steel. Headers design is adapted to specific service requirements. Special long headers are designed to work as separation chamber for partial condensers. Headers may be equipped with mixer, anti-erosion baffles or washing devices.
CFx (carbon fibre wrapping) may be applied around cylindrical headers (RB model) to provide superior mechanical strength and to minimise leakages in case of damages.

Special design for condensers

Blocks heat exchangers offer a surprising range of design options, and we will select the best solution for any specific process need.
In pharmaceutical or in regenerations plant, organic solvents are condensed using cold water as cooling media. Afterwards, uncondensed gases are further cooled down in a second condensation step (post condensation).
Graphec® SB and **Graphec®** MB blocks heat exchangers may be arranged to have two cooling circuits, working in cross-current.
This geometry enables to have condensation and post-condensation into one unique items, using two different cooling medias.
Another design specific for condensers is the two pass vertical arrangement of RB cylindrical blocks heat exchanger. Inlet gases run through a primary pass with large cross section, entering from top nozzles, and they are condensed inside the process holes. Condensate is collected at the bottom of the unit. Uncondensed gases are vented through a second auxiliary pass, with a smaller cross section area. Uncondensed finally run out through a second nozzle, located on the top of the unit.
This arrangement permits an efficient liquid-gas separation.

Graphec® Columns

Ecarb manufactures columns and tower for mass transfer services, made of corrosion resistant materials: graphite, exotic metals and lined steel (PTFE, Halar®, PVDF, PFA, rubber or ebonite). The drawing of each components is adapted to selected construction material, which will need specific design tricks and shrewdness, in order to simplify manufacturing cycle and enhance operation reliability.
Because of its mechanical properties, thermal stability and wide corrosion resistance, graphite is a brilliant alternative to metals and plastic.
Proven advantage of graphite column is the absolutely longer lifetime: no corrosion, no permeation, no ageing. Graphite columns last more than any expectation.

Graphec® column product range covers all common mass transfer requirements. Column diameter may vary from 160 mm up to 2400 mm. Actually no height limitation is given. It is possible to select among packed, plate columns or a mixed solutions. A long serie of internals, accessories and design options is available.
Ecarb performs accurate process sizing using specific SW and design tools, for standalone columns or for complete process units, such as distillation or absorption packages.

Maintenance and operation

Graphite Graphec columns are easy to install and to disassembly. **Ecarb** has developed preoprietary repair techniques, to perform cheap and quick repair of each graphite components.

Our graphite: a matter of quality!

Graphec columns are made of many possible graphite grades: iHP, iSP, iLP, PHE-xLP and PFA-xLP. Material selection depends on process media and pressure rating. Tensile strength **Graphec®** graphite varies from 12 MPa (iHP) up to >28MPa (PHE-xLP).
Ecarb uses only graphite from primary western suppliers, TUV certified according to AD 2000 N2.

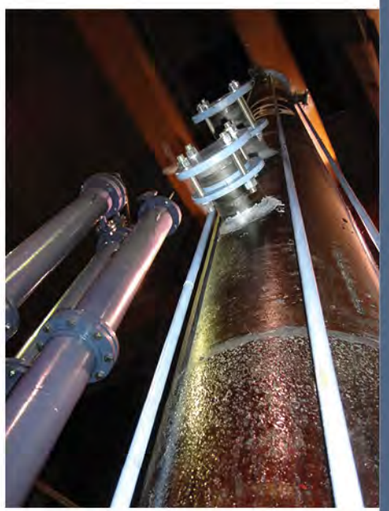
Column internals

Graphec product line includes a comprehensive range of internals made of graphite, PP, PVDF or PTFE.

- distributor plate: massive graphite plate with weir crowns, of different diameters, in order to have a regular liquid distribution along the section of packing columns. **Graphec®** distributors have high rangeability, fully compatible with most diffused random and structured packings.
- distributor pipes: graphite or PTFE inlet pipes, for distribution of gas inlet stream.
- dip pipes, made of graphite or PTFE
- tunnel cap, sieve trays and bubble cap trays: designed to have high efficiency in mass transfer, for distillation or absorption columns. Bubbles caps may be removable to facilitate plate cleaning and maintenance.
- downcomers and weirs: full range of accessories for plate column
- chimneys plate, to have full re-distribution of liquid and gas phase
- support grids with high cross sectional area, in order to support packing, with limited low pressure drop on gaseous phase.
- packing: graphite Raschig rings (from 1/2 " to 2")
- Graphite vacuum support rings or grids for PTFE lined column
- Handholes for packing maintenance.

Columns geometry

Graphite column are assembled tightening a variable number of graphite column segments. Differential dilatation between graphite and steel tie-rods is compensated by coil springs or washer springs.
Monolithic segments can be manufactured up to 2700 mm height, and 1900 mm diameter.
Larger columns may be manufactured by assembling segmented rings up to 2400 mm diameter.
Seals among the column segments are expanded graphite flat gaskets or expanded PTFE cord, supplied by Gore Sealant Technologies®.
Actually there is no limitation to columns height.
Columns may be installed on a metallic basement or using a metallic ring with lateral supports.
Graphite lateral nozzles are robust and easy to connect to UNI and ASA standard flanges.



CFx

To ensure safety and robustness even in extreme conditions, graphite can be reinforced by carbon fiber wrapping (CFx) or armoured by metallic shield.
CFx (carbon fibre wrapping) is applied around each column segment to provide superior mechanical strength and to minimise leakages in case of damages.
Carbon fibre cords are tensioned during wrapping operation. Carbon fibre cords will strongly embrace graphite rings, so to provide increased resistance to thermal and mechanical shocks.
We select among different carbon fibre cords to provide variable thicknesses of wrapping (from 0,1 to 5 mm) on the base of level mechanical protection required by the service.

Graphec® Graphite columns advantages

Graphite columns provide relevant advantages:

- Superior resistance to gas permeation (i.e. versus PTFE)
- Full and unconditioned vacuum resistance without any additional safety device.
- Flexibility: it is possible to change Graphec column geometry, just adding new connections or new sections, without wasting existing pieces.
- Graphite is not subject to detachment or swelling, as lined carbon steel.
- Superior thermal stability:
  - Graphite is dimensionally stable. PTFE liner may implode or detach due to plastic deformation of PTFE with temperature cycles.
  - Graphite can be used from -60°C up to 230°C. No imbrittlement at low temperatures and higher temperature rating.
  - Resistance to thermal gradient: many lining techniques imply strong limitation in operations, because liner may crack or detach when submitted to relevant temperature gradient, both in terms of sudden heating and differential temperature between inner and outer surface.

Special column with integrated heat transfer units

- Falling film absorber: a section dedicated to falling film absorption can be integrated into a graphite column. Absorption section consists of graphite tube bundle, with upper tubesheet equipped with crowns, whose function is to form liquid film.
- Head condenser: tube bundle or drilled block can be integrated in the upper segment of a distillation column.

Graphec® Quenchers

Acid gases at high temperature (up to 1800 °C) are obtained as by-products of industrial processes or as flue gas from waste incineration. A quencher cools rapidly and safely down hot gases, avoiding dioxins formation, which occurs at intermediate temperatures. Immediate gas cooling is given by sudden vaporization of water inside quenchers. **Ecarb** may propose complete package to recover acid waste solutions.
In comparison to quencher made of other materials. Graphite quenchers offers several advantages:

- wide range of corrosion resistance to many medias
- enhanced thermal stability
- superior resistance to thermal shock

Accurate construction for a long operation

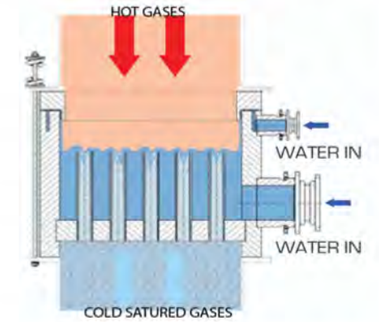
Quencher is not a common process unit, so it is necessary to use graphite grades carefully selected for extreme conditions. **Graphec®** quenchers are made of two possible graphite grades: iSP and iLP. Material selection depends on process media and inlet gas temperature.
CFx (carbon fibre wrapping) around quencher body is suggested as additional safety device, to increase robustness and resistance to thermal shocks.
Each single component is studied to run in severe conditions. Metallic parts are protected by PTFE, ECTFE or ETFE layers. Carbon fiber packing or expanded graphite sheet ensures sealing among components at very high temperatures.

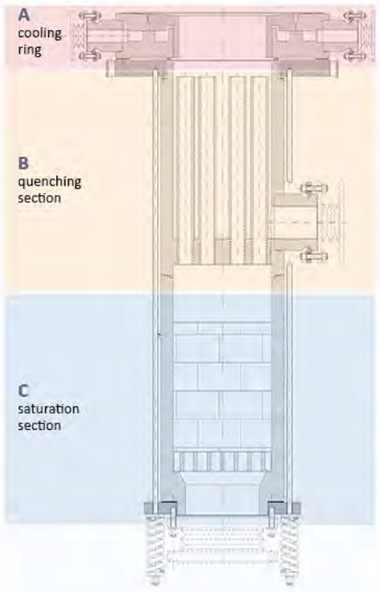
Quencher geometries

Ecarb performs accurate process sizing to define the unit which better fits to specific process condition. **Graphec®** quenchers may handle most challenging process conditions, such as high solid content, low pressure drops availability or flow and pressure fluctuations. Model, material grade, internal configuration, number of sections, diameter, quencher height: we cross all possible geometric parameters to identify the optimal design and minimize the price, respecting specified process parameter. Three geometries of **Graphec®** quenchers are availble.

Graphec PQ: pipe quencher

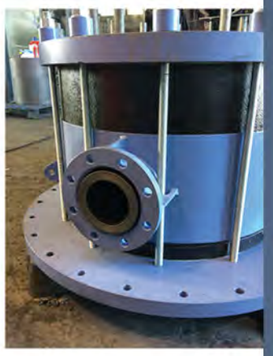
Pipe quenchers PQ is a versatile and universal model. Quenching section (B in the picture aside) consists of a cylindrical column, wherein a bundle of open tubes is installed. Tubes are fixed on a bottom tubesheets only, which is cemented inside the column. The hot gases passes through the tubes inlet upper ends, which are shaped as weir crowns. Quenching liquid overflows inside the tubes and it is suddenly vaporized because of intimate contact with very hot gases at high velocity (spry effect).
Quenched gases flow inside tubes at the saturation temperature. Continuous circulation of a large quenching solution flow must be ensured. Liquid ensures cooling of the graphite quench body. In case of water breakdown, an emergency stream must be immediately activated to avoid overheating.
A continuous film of water is formed along the perimeter of top quencher walls, to protect graphite surfaces.
When inlet gases have a temperature higher than 360°C, a cooling section (A) must be added on top of quenching section. Cooling section is normally a large graphite cooling ring, wherein cooling media flows. Cooling ring geometry offers a wide exchange area to cooling media, so that graphite bulk temperature is not affected by very hot inlet gases.
A third saturation section (C) may be installed below the quenching section, for very hot feed gases to ensure complete outlet saturation.





Graphec MTQ: monotubolar quencher

Graphec MTQ is a long column made of not impregnated graphite protected by carbon fibre wrapping, normally working under aspiration. Hot gases enters through a lateral nozzle, and they are immediately mixed with a stream of fresh water, which is injected from a spry nozzle located at the top of the column.



Not-impregnated graphite resists up to very high temperature so MTQ quenchers have not a severe need of continuous cooling media, and they can resist to occasional dry out conditions. Moreover, since *no continuous recirculation* of large amount of liquid is needed, MT quenchers permit lower energetic and investment cost.

Graphec LRQ: liquid ring quencher

Gas is convoyed in a Venturi conduct made of graphite, where a loophole injects the quenching liquid. Inner part of the quencher is made of not-impregnated graphite to resist to high temperature inlet gases, whilst all wetted parts are made of Graphec impregnated graphite. LRQ are cheaper than pipe quenchers but their versatility and rangeability is limited.

Systems for acid recovery

Quenching may be only the initial step of a more complicated process, aimed to recover acids (normally hydrochloric, sulphuric or hydrofluoric acid), contained in the hot gases. After quenching, gases run through an absorption step, where acids are concentrated, within a isothermal falling film absorber or within an adiabatic columns (with external heat exchanger). Acids may be further concentrated or purified in further distillation or stripping sections.
Ecarb provides turn-key units, for a wide range of processes, including acids distillation, absorption, purification and stripping. Please, consult dedicated brochure for a complete insight on our systems.

Lined steel equipment

Ecarb designs and manufactures ready-to-use engineered process equipment made of steel, protected by polymeric linings or coatings: PTFE, PFA, ECTFE, ETFE, PVDF, ebonite, rubber and phenolic based coatings.
Our know-how in graphite and metals corrosion properties enables us to provide the best technical advice, in order to always select the optimal material. After proper material selection, each item must be accurately sized in order to provide required process performances.
All these valuable advices are carried out for free by our sales specialists, during pre-sale support activities. On the base of required standards and codes, mechanical design is performed always taking care of the specific construction requirements, typical of selected lining material and technique.

Process units typically offered with our lining techniques are:

- Storage tanks
- Process vessels
- Plates columns
- Packed columns
- Reactors with agitators
- Hydraulic guard
- Filters and strainers
- Heat exchangers components as shell and headers.
- Manifolds
- Wide range of accessories and column internals

Material selection:
the best solution in a wide range of possibilities

Material selection is driven by a simple criterion: to identify the best "value for money" solution fully in compliance with process media and working conditions, like temperature and pressure. We investigate in a very wide material portfolio, providing proper warranties to support our technical opinion.

PTFE

Polytetrafluroethylene is ideal plastic lining, being in principle resistant to corrosion up to a temperature of 240°C. PTFE columns and vessels are obtained lining a metallic shell. **Ecarb** offers sheet lining (loose or bonded) and extruded PTFE lining. Selection of lining technology depends on diameter, vacuum grade and process media.
Cylindrical sheet lining is made welding a PTFE sheet, with thickness from 3 to 5 mm. Sheets are manufactured starting from pre-sintered massive PTFE rod, thereby having higher density and resistance to permeation. It is possible to have a large variety of diameters, from 100 mm up to 2500 mm. PTFE sheet may be bonded to the steel, using special adhesives, in order to reduce movements and deformations.
Extruded PTFE lining is applied on the inner surface of metallic sheet directly by past extrusion, providing a seamless liner, with thickness from 4 to 8 mm. Lining is less compact but it adheres perfectly to metallic surfaces, providing superior resistance in case of light vacuum. For this kind of PTFE, standard diameters are imposed by extrusion device availability, from 200mm up to 1450 mm.
Conductive PTFE, enriched with graphite, metals or Silicon Carbide, may be used for special needs (e.g. when required by ATEX area classification or to reduce deformation, which affect PTFE during thermal cycles).
Ecarb provides vacuum systems for PTFE lined columns, in order to avoid lining implosion, when columns work under atmospheric pressure.

- low vacuum grade system: a graphite cylinder (or gage) is installed inside the column to provide mechanical resistance against vacuum.
- high vacuum grade system: the small gap between metallic shell and plastic liner is also kept under vacuum conditions, connecting a vacuum pump to many aspiration pins, located along column surface. This vacuum compensates eventual depression inside column, preventing from implosion.

PFA/ETFE/ECTFE spry coating

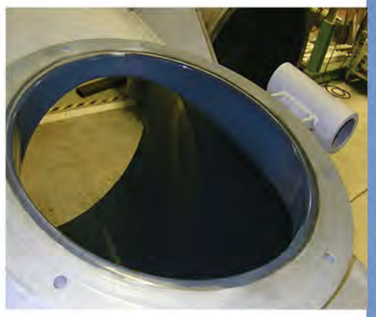
PFA, ETFE and ECTFE are fluropolymers, derivative from PTFE, having different temperature rating and chemical resistance behaviour. They can be applied on the inner surface of metallic shell. Perfect adherence of the coating is due to a thermal treatment which cause intimate contact between metal and plastic coatings. Coating thickness depends on the material (from 800 micron to 1.5 mm). Diameter is limited to 2500 mm due to availability of polymerization ovens.

PFA/ETFE rotolining (rotational lining)

Rotational moulding process is unique plastic forming process, providing indisputable benefits:

- full vacuum resistance
- homogeneous application even on complicated shapes
- seamless liner up to 2200 mm diameter
- higher lining thicknesses versus spry coating techniques.

A metal shell is mounted on a rotational moulding machine and a thermoplastic powder (PFA or ETFE) is then charged into the metal shell.
The machine mounting the steel shell, with the thermoplastic powder inside it, begins to rotate simultaneously about two perpendicular axes. The machine is inserted into the oven and the heating cycle begins.
After adequate time at the right temperature, the inner polymer particles begin to melt and to distribute over the interior surface of the steel shell, forming an uniform layer, up to 4 mm thick.
The heating cycle time is critical since incomplete melting or polymer degradation may result respectively from a too short or excessive heating time. After the cooling stage, the inner layer stays in perfect adherence to the steel shell inner surface and acts as an inner lining.



Dual protection system

Ecarb designs and manufactures metallic columns and vessels with dual protection systems. PTFE sheet lining is applied on a metallic shell already protected by ECTFE, ETFE or PFA coating. This solution is aimed to have an indefinite lifetime, when high aggressive media are processed. Substances like HF or HCl have a strong permeation attitude. They slowly pass trough PTFE liner, in spite of any caution on lining density or thickness. To avoid that acid condensate will than attack and destroy metallic shell, this is protected by a second layer (coating) made of ECTFE, ETFE or PFA. This substances are anyhow quickly removed through venting holes, convoyed to a venting systems, constantly under aspiration.

Rubber and ebonite

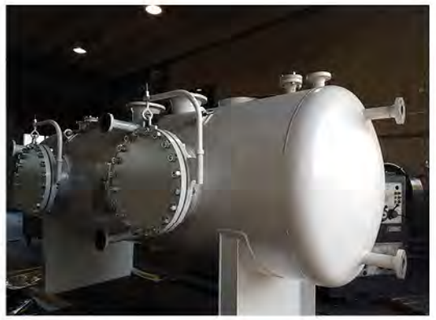
Ecarb produces rubber lined and hard ebonite lined process equipment, like columns, towers, tanks, reactors. Rubber and ebonite are suitable for temperature up to 105°C, and they perfectly work under vacuum conditions. Steel parts produced in our workshop are lined in autoclaves, by long term and reliable partners. **Ecarb** will be responsible for the optimal process design, proper mechanical calculation and perfect execution.

Phenolic based liners

Phenolic liner charged with graphite particles may be applied in autoclave, similarly to ebonite, in order to provide superior chemical resistance to a wide range of substances, even at high working temperature (up to 150°C).

Metallic pressure vessels

Ecarb produces vessels, heat exchangers, autoclaves, columns, towers and other process items made of carbon steel, stainless steel, alloys or exotic metals (Ti, Ni, Cu, Al, Ni-Alloys...).
Every unit is designed by Ecarb according to the most common codes and standards (VSR, AD2000, ASME, CODAP ...) and it is constructed to ensure reliability and long lifetime by qualified welders and skilled workers.



Reactors, tanks and columns

Ecarb offers high-tech reactors and tanks fabricated of exotic metals (Ni-alloys, Ni, Ti, etc.), PTFE lined steel and Stainless Steel, for API and pharma industry.
Explosion clad technology for top and bottom covers and flanges is used to minimise cost, when high pressure rating is requested for noble metals.
Reactors can be equipped with a full range of accessories, like agitators, heating/ cooling jackets, spargers, etc. Separation columns (with packing or trays) can be made of all available metals.

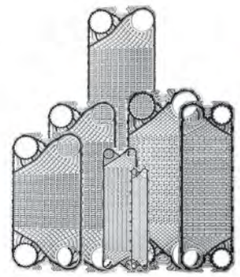
Metallic Heat Exchangers

Shell & Tube heat exchangers are universally used in almost all application where heat transfer is required, because of their flexible and reliable design.
Every heat exchange service can be efficiently and safely performed by shell & tube units: condensation, evaporation, forced circulation, thermo-siphon or kettle reboilers, heating and cooling.
Each Shell & Tubes unit is designed by our engineers in order to fulfil specific requirements of the each service, according to API and GMP standards when required. Full draining and venting of the units are always ensured both for vertical and horizontal installations.
Ecarb produces heat exchangers made of almost every common or exotic metal: carbon steel, AISI 304 L, AISI 316 L, 904L, aluminium, copper, Titanium (gr. 2 and Gr7), Nickel and Ni-alloy, etc..
Shell Size can be produced in a wide range of diameters up to 60" . Max possible length is 240". Almost all most diffused tubes are available: all BWG standard tubes, welded or seamless, straight and U-bend configuration, with special external finishing (i.e. finned) on request;

Cathodic protection devices can be natively implemented in our units, especially in sulphuric acid heating and cooling units.

Ecarb delivers a wide range of **plate and gaskets heat exchangers**.

- Plate surface: from 0,10m2 to 3,5m2
- Product range: 45 different sizes with 2 plate pat- terns
- Plate thickness: from 0,35 mm to 0,8 mm
- Connections sizes: from 25mm to 500 mm
- Gaskets material: Nitril, EPDM, Viton, NBRHT
- Plate materials: AISI 304, AISI 316,Titanium, Ni- Alloy
- Free Flow design (high gap up to 11 mm)
- XXL size available, for very high flow rate.



Silicon Carbide

ProSiC® Silicon Carbide Heat Exchangers are the best solution where other materials (including graphite) reach their limit due to high corrosive process fluids.
SiC is produced by sintering of submicron silicon carbide powder in an extruding process. The sintering process results in a self-bonded, fine grained (less than 10µm), SiC product which is 95% dense.
ProSiC® Shell and Tube heat exchangers with tubesheet and tubes made of silicon carbide are ideal for heating, cooling and condensing of chemically aggressive process streams.
Typical applications include: highly concentrated sulphuric acid, nitric acid, highly concentrated hydrofluoric acid, pickling liquors, caustic soda, solvents from pharma synthesis, etc.
The tubes are made without free silicon and the absence of this substance means that the material can be considered virtually universal corrosion-proof.

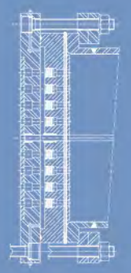
Typical Properties:
- Extreme hardness
- High strength
- High temperature stability
- High thermal conductivity

ECARB can provide SiC heat exchangers with different tubes-tubesheet sealing systems:

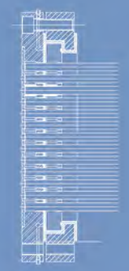
- ALL SiC - Double tube sheets: massive SiC primary sheet (process side) + AISI sheet (service side). Sealing is ensured by a couple of O-rings for each tube/tubesheet joint. O-rings are encapsulated into caves machined into the tube sheets, so to release any stress on the tubes.
- PTFE/PFA - Double tube sheets: massive massive PTFE or PFA lined steel primary sheet (process side) + AISI sheet (service side). O-rings are pushed inside tubesheets caves by threaded bushes.
- Dual tube sheet: each tubesheet is made into two parts, which are coupled to host O-ring set in the middle.

All design are available with separation chamber to segregate process and service fluids.

ALL SiC



PTFE/PFA



Dual tube sheet

After Sales

We are available for every solution can make our Customers' life easier. Our core values are engineering excellence and **customer satisfaction,** so **Ecarb**'s personnel is at full and immediate disposal for any service mission, worldwide.

Our services portfolio includes following jobs:
- Repair of graphite shell & tubes heat exchangers: it is possible to replace damaged tubes in our shop or directly on site. Graphite tubes replacement is a safe, simple and quick job, which allows the full and safe regeneration of a graphite bundle.
- Repair of graphite block heat exchangers: it is possible to repair or to replace damaged blocks, in our shop or on site.
- Repair or modification of graphite columns and quenchers: columns can be easily repaired or modified, installing new column segments or modifying position and orientation of existing nozzles.
- Chemical cleaning of heat exchangers: to remove fouling without mechanical intervention, which may damage graphite components.
- Repair of graphite centrifugal pumps
- Modification or renewal of PED certifications, including revision of mechanical calculation according to new process conditions.
- On site installation and assembly of packages and process items
- Inspections and tests
- Expertise on process may be carried out by our engineers, to identify and remove the root causes of any damage.
- Pre-commissioning, commissioning and start up of our equipment and systems
- Regeneration and repair of metallic process units or components.

Our engineers and technicians have long experience and are able to tackle any problem. Their motivation and availability will surprise you. The added value of our service is the competence which only who designs and manufactures graphite equipments can have.

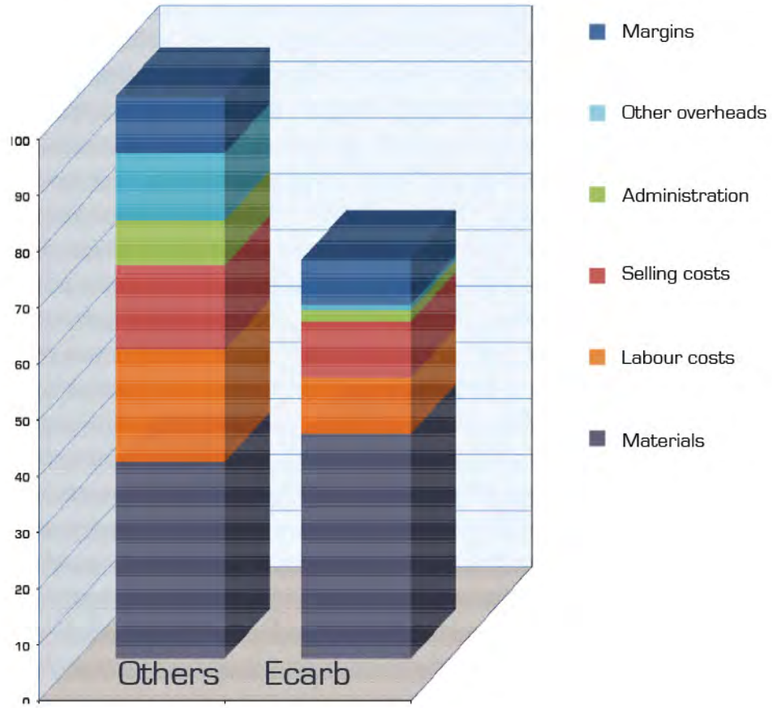
Ecarb's staff is always ready to intervene on site, when plant downtime does not allow maintenance in our shop.

Spare parts

Ecarb is able to deliver a wide range of spare parts, related to its own products or existing units delivered by other suppliers, like complete tube bundles, cylindrical or cubical blocks, graphite nozzles, tubes, fitting, gaskets, nuts & bolts, bolts, tie-rods, springs, bellows, column segments, column internals, headers, baffles, metallic plates, steel shells, graphite cement.
Every component of your process units is replicated with accurate reverse engineering techniques, using high quality materials from western suppliers, equivalent to original grades.

Unique convenience

Premium products at a smart price: this is possible because Ecarb is a dedicated task force, aimed only to deliver process equipment. Our price does not include any adder which is not strictly connected to the quality of our product, as blazoned multinational companie must do.



What you pay:
direct costs (material + labour), design office, marketing and sales, administration, R&D, quality management system.

What you do not pay:
costs of corporate structures, international management, investments in Far East, IT, HR, IPO charges, finance, controlling, trademark fees, advertising, SOX, irrelevant certifications ...

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