# **INDUSTRIE MECCANICHE DI BAGNOLO**







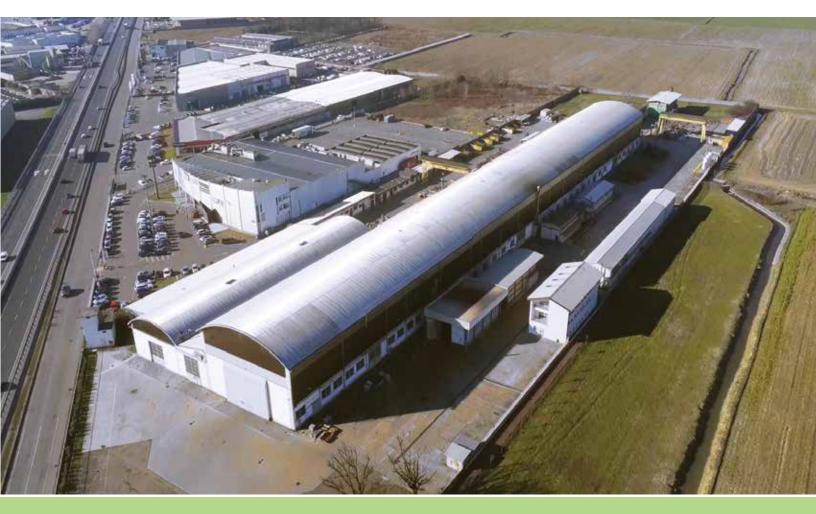
Industrie Meccaniche di Bagnolo (IMB) was established in 1961 to design and manufacture specialty heat exchangers for the refining, chemicals and petrochemicals sector.

We have remained at the heart of our community ever since and are proud of the thousands of units carrying the IMB name providing reliable support in the most demanding services and critical applications in plants around the world.



IMB was acquired by Chart Industries, Inc., (NYSE:GTLS) in 2018 and is incorporated into the Heat Transfer Solutions segment . Chart's product portfolio, strong aftermarket focus and global presence represent an exciting new chapter for our company's continued development.

Similarly, it bears testament to the quality and reliability of our equipment that Chart chose IMB to diversify out of its traditional cryogenic processing sectors.



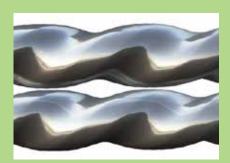
#### LUMMUS ADVANCED BREECH-LOCK EXCHANGER® (LABLEX®)

HAIRPIN Type Multi-Tube / Double-Pipe HEx

## SPINTUBE™ Replacement Bundles





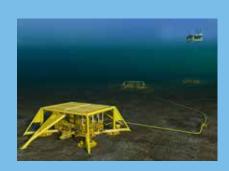


#### SPECIAL ENGINEERED S&T HEx.s

#### HEx.s FOR OFFSHORE APPLICATIONS

#### **SERVICE & MAINTENANCE**







700+ IMB-built LABLEX<sup>®</sup> units in service representing 50%+ of the world's installed database.

LUMMUS ADVANCED BREECH-LOCK EXCHANGER<sup>®</sup> (LABLEX<sup>®</sup>) Heat Exchanger

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LUMMUS ADVANCED BREECH-LOCK EXCHANGER® is a registered trademark of Lummus Technology, Inc.

LUMMUS ADVANCED BREECH-LOCK EXCHANGER® (LABLEX®) Heat Exchanger is typically used in hydrocracking, hydro-treating, gas compression, ammonia/urea synthesis, methanol and other high-temperature and high-pressure applications with rich hydrogen streams.

It is suitable for services where both the shell and tube sides are at high pressure (H/H type) and those with high pressure only on the tube side (H/L type).

The IMB solution features a special threaded ring to hold the channel cover and contain channel pressure. This unique and innovative technology eliminates the large channel cover flange and bolting of other conventional high-pressure exchanger designs and delivers significant reduction in heat exchanger size and weight.

- · hydrostatic pressure load is taken by the channel body
- eliminates heavy bolting (bolts are only sized for gasket compression loading)
- · permits optimized channel design by eliminating risk of distortion due to bolting



1 High/High LUMMUS ADVANCED BREECH-LOCK EXCHANGER® Heat Exhanger type

<sup>2</sup> Installation for Hydrocracking Unit



Advantages of the LABLEX® Heat Exchanger design compared with a conventional welded diaphragm design include:

- · More economical across a certain combination of exchanger sizes and design conditions
- The overall exchanger is lighter with a thinner channel and is easier to handle
- · No internal threaded holes in the channel-forging or in the cladding
- The internal tubesheet-to-shell gasket can be tightened from the outside during operation
- No cutting and/or grinding of welded parts (i.e. channel diaphragm weld) is required to open the channel for maintenance
- No welding is required to close and seal the channel after maintenance; there is no need for line flushing, welding permits, skilled qualified welders, PWHT's and country boiler authority supervision and inspection during maintenance
- There is no need for hydraulic bolt tensioning devices to remove the channel cover and reassemble the exchanger, thus eliminating the number of tightening cycles and straining of gauge measurements.

Bolt size - Comparison between conventional design and LABLEX® Heat Exchanger

These advantages allow much easier operation and maintenance of the LABLEX® Heat Exchanger closure.

These exchangers are easy to operate and comparatively easy to dismantle and reassemble, which results in more reliable operation and shorter shutdown time.

## LOWER CAPITAL EXPENDITURE EASIER MAINTENANCE SHORTER SHUTDOWN TIME

## **HIGHER PLANT RELIABILITY + LOWER TOTAL LIFE-CYCLE COST**

3 LUMMUS ADVANCED BREECH-LOCK EXCHANGER® Design Reduced Bolt Size Design Pressure: 200 barg (2,900 PSI) Design Temperature: 450°C (842°F) Shell ID: 1,730 mm (68") Bolt size: 1" ½ (# 72) Bolt weight: 1.1 Kg./each 4 CONVENTIONAL Design Design Pressure: 168 barg (2,437 PSI) Design Temperature: 345°C (653°F) Shell ID: 1,470 mm (58") Bolt size: 5" <sup>3</sup>/<sub>4</sub> (# 20) Bolt weight: 120 Kg/each



## LUMMUS ADVANCED BREECH-LOCK EXCHANGER® IS NOT JUST ANOTHER SCREW-PLUG EXCHANGER

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Industrie Meccaniche di Bagnolo can demonstrate, over hundreds of successful applications, a product that is designed and manufactured with the closest tolerances and highest attention to detail for reliability, easy maintenance and enhanced safety.

The unique design of the LABLEX<sup>®</sup> Heat Exchanger internals offers exceptional maintenance advantages over competitors' Screw-Plug exchanger closures:

- Minimal tolerance for channel & lock ring threads for safer operation
- · Internal bolts are not prone to deformation or to overstressing
- The seal gasket, thanks to the advanced design, follows the relative movement of the diaphragm with respect to the channel due to differential thermal expansion, thus guaranteeing the sealing even during critical transient conditions
- Detailed design has been improved and optimized over the years, with specific focus even on minor details that can substantially affect reliability and maintenance and that are provided and regularly updated to assist our Customers worldwide.
- Effective operations and maintenance manual including a detailed plan for preventive maintenance
- Dedicated team with extensive experience for training, site support and technical assistance during LABLEX<sup>®</sup> Heat Exchanger shutdown and maintenance.

5 One of the Biggest Ever Built Design Pressure:
179 bar shell side – 200 bar tube inside
2596 PSI shell side – 2,900 PSI tube side
Design Temperature:
454 °C shell side – 427 °C tube side
850 °F shell side – 800 °C tube side
Shell ID: 1,981 mm. (78")
Weight: 180 tons each
Assembled at Cremona river port and shipped to the site in stacked condition

6 Stacked exchangers for Saudi Arabia



#### LUMMUS ADVANCED BREECH-LOCK EXCHANGER® (LABLEX®)

#### New IMB LABLEX®

Based on our long experience with site technical assistance all over the world, we have introduced the New IMB LABLEX® design incorporating a number of improvements which make site maintenance even easier, quicker and safer.

Threaded lock ring and cover disc are now bolted together thus rotating as a single piece during assembly/ disassembly making these operations much easier. Typical bugs affecting all Screw-Plug exchangers, such as the push bolts getting stuck and the internal stuck push bolts difficult to be cut, have also been definitely fixed.

New IMB LABLEX<sup>®</sup> advantages are available also for the Aftermarket so that existing IMB LABLEX<sup>®</sup> Heat Exchangers can be upgraded to the New IMB LABLEX<sup>®</sup> technology by simply replacing a few components and carrying out simple modifications.



7 Hydrocracking Unit with VERTICAL LABLEX® Heat Exchangers - courtesy of SHELL PERNIS, NL

# Easy installation- Special Proprietary IMB PREMIUM JIG

IMB has developed unique, proprietary IMB PREMIUM JIGS designed to facilitate dismantling and reassembly operations of the LABLEX<sup>®</sup> Heat Exchangers. With our hydraulically operated IMB PREMIUM JIG it is possible to open the channel, remove the internals, and then reassemble and reclose the LABLEX<sup>®</sup> Heat Exchanger in a very short time with no need for continuous cranage assistance.

The IMB PREMIUM JIG is adjustable so that one Jig can be used for different exchangers and threaded ring sizes.

The new simplified IMB PREMIUM JIG 3.0 and 4.0 (this one operated with no need for a beam bolted to the exchanger) have been developed for the use with the New IMB LABLEX<sup>®</sup> exchangers.

IMB LOCK-BREAKING KIT is also supplied to facilitate breaking of the initial lock of the threaded lock ring into the channel thread.



HAIRPIN

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## HAIRPIN TYPE MULTI-TUBE/DOUBLE PIPE HEAT EXCHANGER

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BENDECK 330elb

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RHU Reactor Feed Preheater 20" Horizontal Hairpin High Pressure H2 Service

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HAIRPIN HEAT EXCHANGERS -AN EFFICIENT ALTERNATIVE TO CONVENTIONAL SHELL & TUBE HEAT EXCHANGERS 10 Non removable bundle - HAIRPIN all welded

HAIRPIN Heat Exchangers use true counter-current flow. Unlike multipass shell-and-tube designs where correction factors are used to account for inefficiencies resulting from co-current passes, this process maximizes temperature differences between shellside and tubeside fluids. Owing to its fewer sections and less surface area, a HAIRPIN Heat Exchanger is the most efficient design, when a process requires a temperature cross (hot fluid outlet temperature is below cold fluid outlet temperature).

Double-pipe Heat Exchangers utilize a single pipe-within-a-pipe design and are commonly used for high fouling services such as slurries where abrasive materials are present, and for smaller duties. Standard shell diameters range from 2" to 6". Multi-tube Heat Exchangers are used for larger duties with standard designs for shell diameters up to 30" and surface areas in excess of 10,000 square feet per section.

#### When to use HAIRPIN Heat Exchangers:

- The process results in a temperature cross
- High pressure tubeside application
- · Cyclic service
- High flowrate ratios between shellside and tubeside fluids
- High terminal temperature differences (300°F/149°C or greater)
- The exchanger is subject to thermal shock
- · Heating or cooling vapors
- Complete vaporization is required
- · Solids are present in the process stream

#### Why HAIRPIN should be preferred:

- Separate tubesheets: Handle high temperature differences and cycling more effectively than shelland-tube exchangers
- Durable baffle cage construction: Welded to the tie rods without the need for "sleeves" or internal nuts
- Moveable support brackets: Allow shell expansion and contraction and eliminate the need for sliding plates commonly used for fixed supports. Brackets are slotted for anchor bolts on all four sides for flexibility in installation, and offer the ability to add sections in the future
- Easy installation and piping, as tubeside and shellside connections on the same end
- No internal bolting
- Double-pipe exchangers utilize pipe instead of thin wall tubing to enhance integrity

11 Removable bundle - Separated Head Closure



#### **Closure Design**

Our closure designs offer an effective means of providing a removable tube bundle for a variety of design conditions and applications. All of our closures have the following features:

- External Split rings Split rings are used to lock the bundle to the shell. On outdated models these rings were internal and came into contact with the shellside fluid. Internal split-rings are still used by others.
- Better gasketing Our gaskets do not seat on the tubesheet face where misalignment easily can occur and the potential for erosion exists. Our shellside gaskets are easier to remove than wedge gasketing used by competitors.

Separate tubeside and shellside gaskets - Prevent interstream leakage.

• Round flanges - More effective gasket seating than square flanges.

#### **HAIRPINS** with finpipes

Double pipe exchangers and multitube hairpin exchangers with longitudinal fin pipes and fin tubes provide augmented heat transfer area in a compact arrangement, allowing effective space savings for applications where shell side heat transfer coefficient is limiting, as with low pressure gases and high or very high viscous fluids.

The adoption of IMB periferal baffles can further enhance extended surface effectiveness, while keeping pressure drop very limited.



12 Double Pipe Heat Exchanger

- 13 Among our references in Solar Thermal Power, IMB HAIRPIN design turned out to be a convenient and compact configuration for the Steam Reheater unit.
- 14 IMB compact HAIRPIN exchangers are ideally suited to meeting the challenge of ever increasing capacity requirements for gas processing and storage.





**15** Hairpin with extended tubesheet - Non removable bundle



HAIRPIN



16 Removable bundle - Single bolt closure

17 Removable bundle - Separated head closure



**SPINTUBE**<sup>™</sup>

SPINTUBE™ REPLACEMENT BUNDLES Enhance the performance of your Shell and Tube Heat Exchanger (S&T HEx) with SPINTUBE<sup>™</sup> Replacement Bundles by Chart IMB - Industrie Meccaniche di Bagnolo.

SPINTUBE<sup>™</sup> replacement bundles can be retro-fitted to any TEMA type S&T HEx and provides increased thermal performance and reduced pressure drop.

The construction of SPINTUBE<sup>™</sup> bundles allows inspection and cleaning with the same methods and techniques used for conventional S&T HEx's. Flow induced vibrations are completely eliminated.

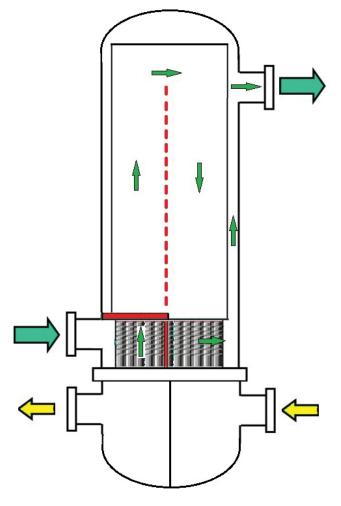
SPINTUBE<sup>™</sup> bundles are particularly beneficial in plant upgrades and debottlenecking and are compatible with any cross-flow or longitudinal bundle configuration.

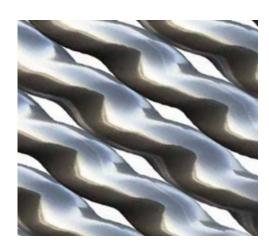
#### Shell-side Longitudinal vs. Cross Flow

- Shell-side geometry that minimizes recirculating eddies, bypassing and leakage, providing the most effective use of pressure drop.
- The amount of recirculation and back-mixing that occurs in cross-flow segmental baffle bundles penalizes the effective MTD more than it does in longitudinal shell-side flow in SPINTUBE™ bundles.
- Compared to conventional segmental baffle heat exchangers, for the same pressure drop, shell-side heat transfer coefficients are higher, or shellside pressure drop is lower for the same heat transfer coefficient.

#### Shrouded E to F Conversion

- Shroud allows installing a SPINTUBE™ "F" bundle in "E" shell with no changes in existing nozzle locations.
- TEMA "F" shell performance is achieved without long leaf seals between long baffle and shell ID.
- For 2 tube side passes, true counter-current flow.



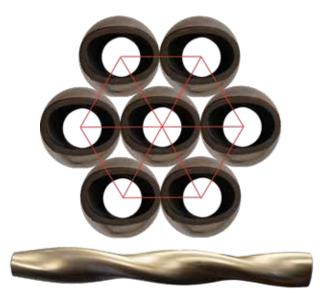


#### SPINTUBE<sup>™</sup> Tube-side Flow

The round tube of a conventional S&T HEx has a uniform crosssection that tends to be less effective in terms of heat transfer performance.

Because of the tangential velocity component, a SPINTUBE<sup>™</sup> Replacement Bundle introduces additional turbulence. In the SPINTUBE<sup>™</sup> bundle, tubes are closer to each other (in direct contact) so that the number of tubes per shell diameter is increased.

As a consequence of the increased heat transfer coefficient and surface area, SPINTUBE bundle may improve thermal performance by 20 to 40% versus a traditional tube bundle in the same shell.



#### SPINTUBE<sup>™</sup> Parameters

- No tube material and thickness limitations
- Tube diameter from 3/8" to 1 <sup>1</sup>/<sub>4</sub>"
- Tube spin adjusted to particular service

#### SPINTUBE<sup>™</sup> Bundles

- Tubes in direct contact with each other provide a tighter tube pitch (more tubes per shell)
- Retro-fitting an existing shell with a SPINTUBE bundle may increase heat transfer surface area by 20 to 40%
- Tubes in direct contact with each other and firmly wrapped in a bundle are self-supporting, thus eliminating the need for baffles

#### Maintenance

• Due to cleaning lanes between tubes, SPINTUBE™ bundles can be cleaned with conventional water-jet methods

#### **Flow Induced Vibrations**

• SPINTUBE™ heat exchangers eliminate potentially damaging flow induced vibrations

#### Applications

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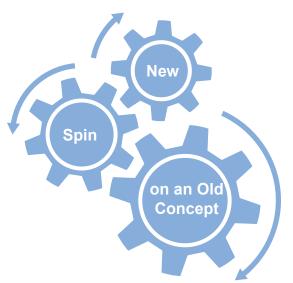
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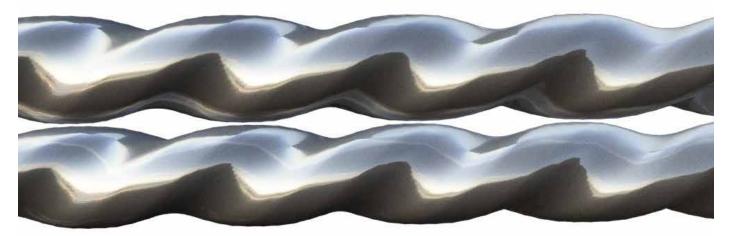


#### Benefits

Retro-fitting a conventional tube bundle with a SPINTUBE™ Replacement Bundle is the most cost effective and simplest way of improving thermal performance of your existing heat exchanger fleet.

- 20 to 40% improved thermal performance (compared with conventional)
- · Improved hydraulic performance (reduced shell-side pressure drop)
- Custom designed solutions
- Minimized project scope
- · Improved efficiency and throughput (compared with conventional)
- · Vibration problems eliminated
- Easy cleaning





SPECIALLY ENGINEERED SHELL & TUBE HEAT EXCHANGERS

18 Fountain bundles for Solar Plant - Kettle Special design heat exchanger



IMB understands the challenges of the oil and gas industry, which is why our engineers are always striving to deliver optimized heat exchanger solutions and lowest total lifecycle cost. Choose IMB for thermal design optimization, enhanced mechanical features, specialty materials and construction of proprietary equipment under licensed design. To supplement our in-house advanced mechanical and thermal design capabilities we routinely partner with laboratories, material test houses, universities and professional institutions.



 19 Styrene plant – 3 car Garage Vert. HEx.

 20 Reactor Reheater



21 TEXAS TOWER, Vertical TEMA CES type HEx. for a Catalytic Reforming Unit, Gr.22 Cl.3 low-alloy steel - 19 meters long Tp.321 stainless steel tubes

22 23 Pre-Cooling Cycle Compressor Condenser: 11,000 fine finned Titanium Gr.2 tubes Weight 165 tons I.D. 3,800 x Length 22,000 mm HELIXCHANGER® Heat Exchanger



## SPECIALLY ENGINEERED S&T HEx.s - HELIXCHANGER<sup>®</sup>

IMB's HELIXCHANGER® references include the large HELIFIN® and 'Texas Tower' heat exchangers.

#### Applications

The HELIXCHANGER® heat exchanger uses LUMMUS Technology's industry-proven, enhanced heat transfer technology to provide solutions for common issues such as shell-side fouling, high-pressure drop and vibration. In the HELIXCHANGER® heat exchanger, quadrant shaped baffle plates are placed at an angle to the tube axis in a sequential arrangement to create a helical flow pattern. Whether the need is to extend the operating period between cleaning campaigns of crude preheat exchangers, reduce capital costs in a petrochemical plant or improve energy efficiency of feed/ effluent towers, HELIXCHANGER® advanced heat exchanger technology offers a lower life-cycle cost solution. HELIXCHANGER® heat exchanger is adopted in refining, power and petrochemical facilities worldwide.

HELIXCHANGER<sup>®</sup> Heat Exchanger is a registered trademark of Lummus Technology, Inc. 23

From large HAIRPIN installations to SUB-SEA COOLERS and EXOTIC METALLURGY, IMB's expertise in delivering the perfect customized solution is highly prized by our many satisfied clients

We supplied critical equipment to the first Subsea Gas Compression Plant in the World.

Minimizing plot plan and weight are the most critical aspects of every offshore installation. IMB understands this and has a demonstrable track record of providing the optimum solution that meets process specifications while occupying the least space. HEAT EXCHANGERS FOR OFFSHORE APPLICATIONS

ARREST, CREETER

#### **Subsea Coolers**

Since the very beginning in early 2000, IMB participated in the study and pilot phases for subsea coolers equipment for the North Sea, from engineering to manufacturing.

IMB is proud of being part of the Åsgard Subsea Compression Project completed in 2015, as the first of its kind in the world. Compressors are installed on the seabed, instead of on a platform. This improved recovery from the Mikkel and Midgard reservoirs by around 280 million barrels of oil equivalents.

Total project scope, from preliminary modelling to the sinking yard off the coast of Norway.

24 Subsea Discharge Cooler 25 Typical SMO254 Weldolet Details





#### **Exchangers For Offshore Applications**

IMB has a proud history of developing ever more efficient heat transfer technologies and offer the industry's most comprehensive selection of tubular heat exchanger products and solutions.

From thermal and mechanical design, through bestin-class manufacturing, technical consultancy, training and aftermarket service, our engineers help you optimize your heat transfer systems to make your operations more efficient and productive. 26 Platform Glycol Cooler



27 Offshore Oil & Gas Steam Heater



IMB technological team is always focused on looking for more effective materials selection and cooperation with metallurgy specialists, frequently adopted to provide a consistent solution to our customers.

Materials we routinely fabricate:

- · Stainless steel, all grades
- · Super austenitic stainless steels (e.g. 254 SMO)
- $\cdot$  Duplex and superduplex stainless steels
- · Titanium all grades
- $\cdot$  Inconel, Incoloy, Hastelloy, all grades
- · Carbon Steel

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- · Low-Alloy Steels (1¼Cr, 2¼Cr, 2¼CrV, 3Cr, 5Cr, 13Cr)
- · Low Temperature Steels (3<sup>1</sup>/<sub>2</sub>Ni, 9Ni)
- · Monel and Cu-Ni alloys

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28 Solid Titanium Heat Exchangers for Offshore Platform29 Offshore Installation





SERVICE/MAINTENANCE



IMB is accredited in accordance with relevant international ISO standards and our commitment to integrity, sustainability and engagement with the local community is enshrined in our company culture.

Our employees are the key to turning your challenges into solutions.

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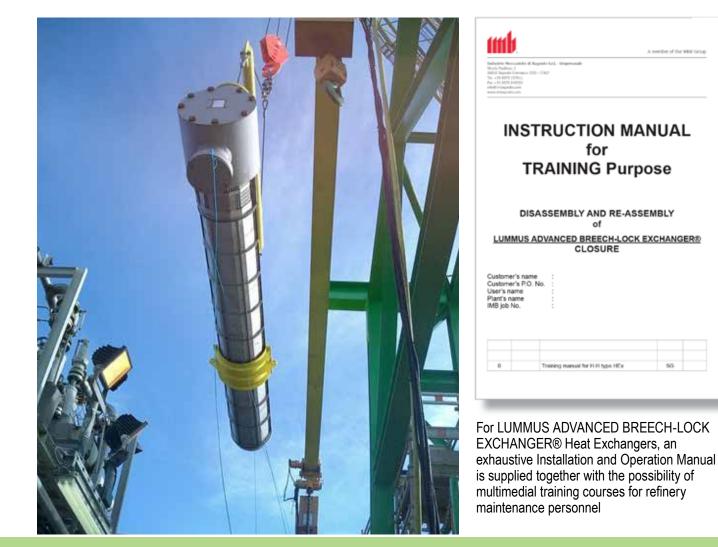
We pride ourselves on a highly motivated, highly skilled workforce equipped with the highest standards of training, technology and tools to get the job done to the best of their ability and your total satisfaction.

IMB follows up its clients from very early engineering phases to after-sale activities, with the aim to satisfy customer in all phases of process. IMB can be relied on to provide the highest level of support throughout the product lifecycle. Services include:

- Engineering consultancy
- Thermal and mechanical design optimization
- Operator training can be site and/or classroom/virtual based
- Installation and commissioning
- Site assistance
- Spare parts

IMB invests its best professional resources to assist Customers with consultancy service, training and site assistance when requested, always in a view of full cooperation and with unique attitude to offer them an outstanding satisfactory experience.

Our focus is to fully satisfy our Customer by offering a superior level of service and reliability from the start of a project, i.e. in the design phase where we can help optimizing the design through our thermal and engineering departments, through fabrication and after delivery of the equipment to site. Our technical skills and long experience in this market (a large number of interventions carried out in refineries all over the world) allowed us to have a dedicated team that can support and satisfy all Customer's needs offering technical consultancy, training, enhanced replacement, spare parts and onsite technical assistance activities. This has always shown our Customers that we are interested in building a long-term relationship, so to earn their loyalty for a mutual growth of business profit.





## **INDUSTRIE MECCANICHE DI BAGNOLO**

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