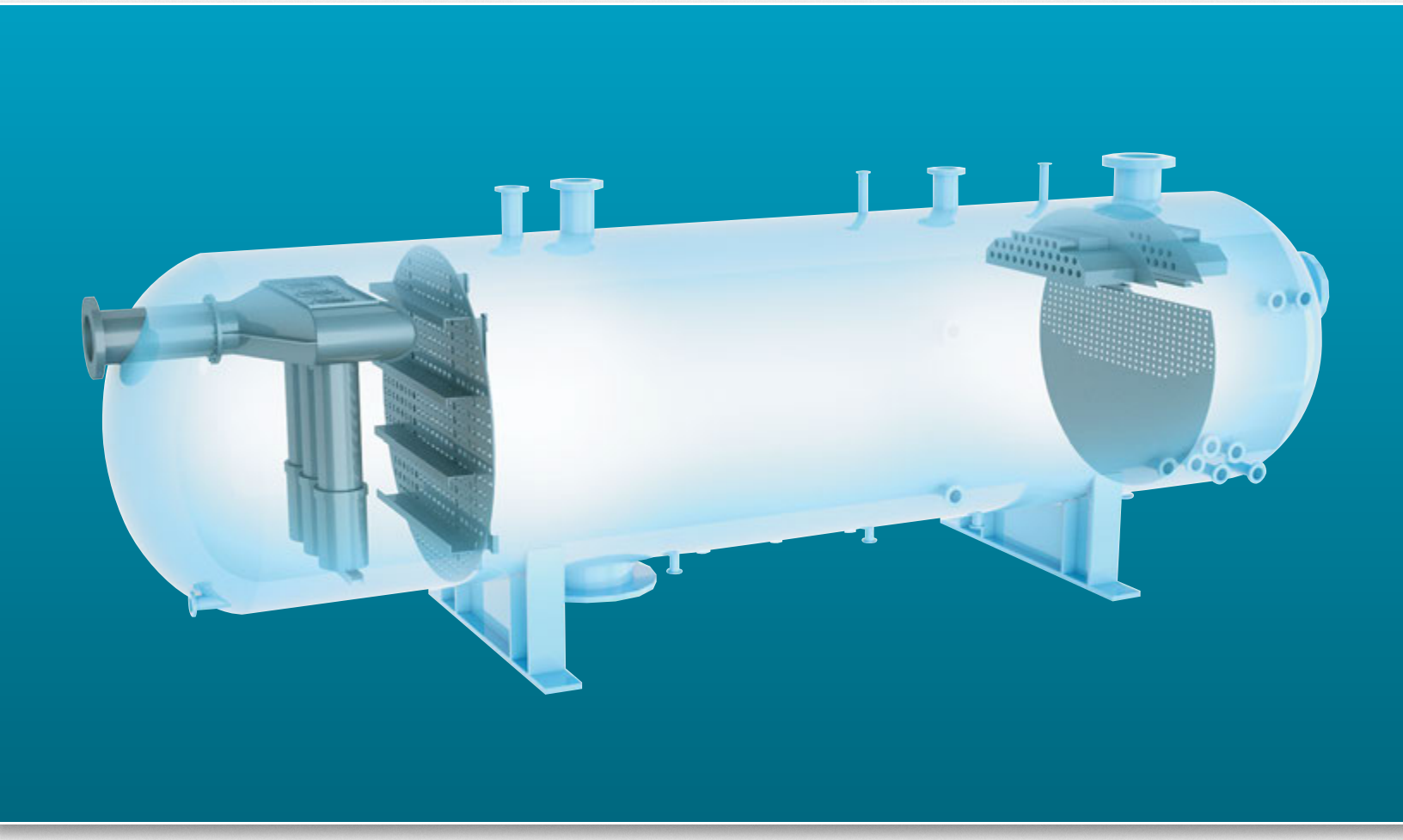
Schlumberger



High-Efficiency Phase Separation Internals

Compact, robust technology for efficient phase separation

One of 16 Ormen Lange receiving scrubbers is assembled at the shop.

Schlumberger has a continuous focus on the development of robust, high-efficiency phase separation internals, which are designed to meet the most stringent performance demands in a compact space.

The documented high separation performance of the internals reduces the risk of operation, ensures that minimal maintenance of downstream equipment is needed, and boasts low life cycle cost. The high-efficiency phase separation internals will reduce the need for chemicals as defoamers and demulsifiers and can help capture the valuable liquid in a gas stream prior to the transport.

They also are valuable for retrofits of existing vessels to achieve increased capacity or to ensure separation for existing vessels and serve as a key element in robust compact systems when pressure is high or space is limited.

Applications

The high-efficiency phase separation internals are used in phase separators for separation of oil, gas, sand and water. These applications include

- scrubber vessels
- two-phase separators
- three-phase separators
- freewater knockout drums
- flare knockout drums
- contactor towers
- slug catchers.

Advantages

High-efficiency phase separation internals reduce the size and weight of the pressure vessel, reduce the footprint, and reduce the need for floor space, thereby lowering the overall cost.

During operation, high-efficiency phase separation internals protect the process system from contamination. They also reduce the operating cost of maintenance to the process system related to

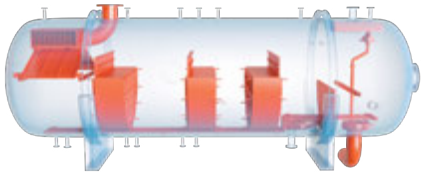
- chemical usage (i.e., defoamers and demulsifiers)
- compressor breakdown
- compressor wear on intake valves
- fouling of downstream heat exchangers
- pump cavitation from free gas in the liquid
- hydrocarbon contamination
- wear of valve trimming
- limited capacity of the existing vessels.

The high-efficiency phase separation system helps protect the process plant from potentially unsafe situations during maintenance or replacement of process equipment and the risk associated with compressor breakdowns. The internals capture the free liquid in the gas stream, ensuring minimal loss of valuable liquid hydrocarbons or glycols.

Product Portfolio

Oil

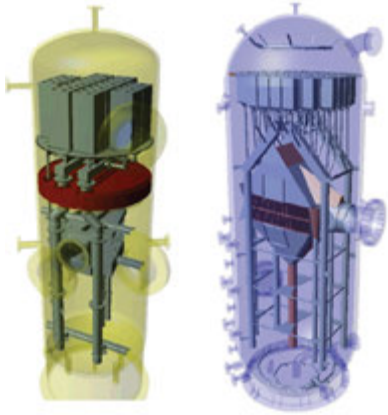
Two- and three-phase separators



Compact three-phase separators

Compact two-phase separators

Gas



Efficient two-stage scrubbers

Compact two-stage scrubbers

Unique dehydration design

Compact in-line scrubber vessels

In-vessel separation

Operators are continuously looking for more efficient and compact separation systems to reduce overall costs. This drives the development of high-efficiency phase separation internals. Our answer to this challenge is to

- decrease separation time by using centrifugal, capillary, or electrostatic forces rather than just gravity forces
- reduce separation distances within the separator vessel by using structured packing or plate packs
- ensure that the intended separator volumes are fully used by using perforated plates in separators and mesh pads in scrubbers.

As an alternative to in-line separation, Schlumberger suggests the use of in-vessel separation, which enables more efficient use of separation volume compared with traditional gravity separation vessels.

Advantages of In-Vessel Separation

- No new tags in the process systems
- No added regulation to the system
- No dirty streams that require additional treatment
- No added blowdown volumes
- No added size or weight
- No need for hot work during installation

CONSEPT ACI axial cyclonic inlet device

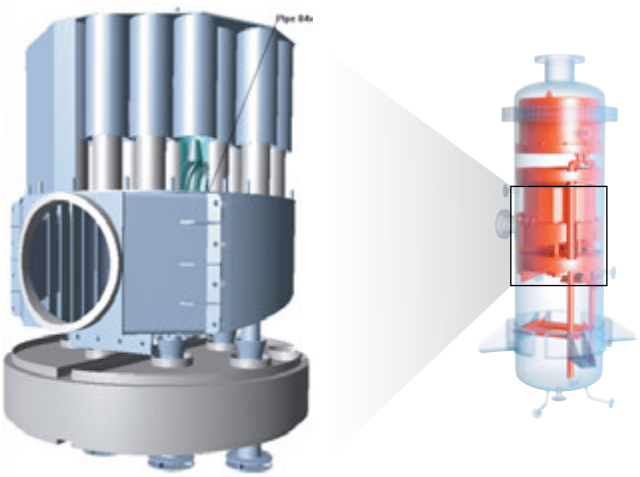
Applications

- High-efficiency centrifugal inlet device for scrubbers
- Bulk separation vessel to be installed as an inlet in scrubbers
- High-pressure applications and compact vessels
- Retrofitting to increase gas load or separation performance
- Retrofitting using only cold work
- Removal of more than 90% of the liquid already in the vessel inlet at K values up to 0.5 m/s

Our CONSEPT ACI* axial cyclonic inlet devices are highly efficient for removing small amounts of liquid from a gas stream, achieving close to 100% efficiency at a wide range of flow rates.

Axial flow cyclone efficiency is important to achieving the stringent separator performance of 0.1 galUS/MMscf that typically is required.

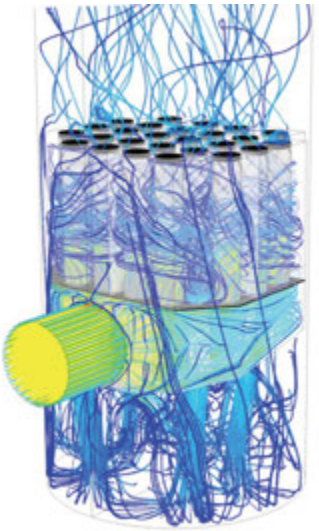
The latest generation of CONSEPT ACI devices incorporates a new element in the existing cyclone, reducing the liquid carryover by a factor of 10. The increased separation efficiency enables vessels to be more compact, which is especially advantageous for high-pressure and subsea applications.



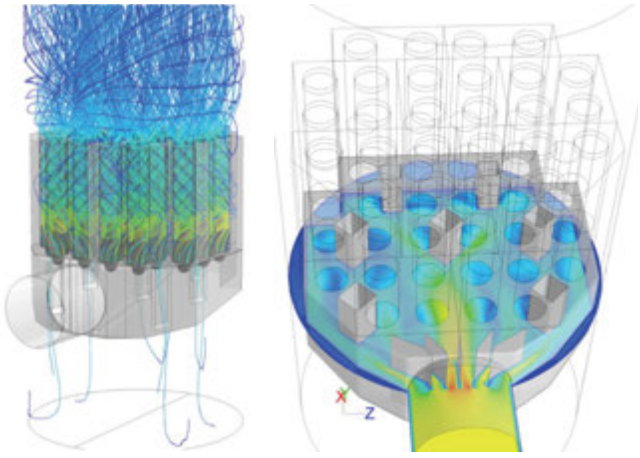
The CONSEPT ACI device is a compact separator for bulk separation of liquid that fits inside the scrubber vessel, considerably increasing the acceptable gas.

Latest-Generation CONSEPT ACI Device

Spin generated through modified spin element core



Droplet tracking D = 10 um



Gas flow distribution

CONSEPT IVD separator inlet vane diffuser

Applications

- Vane inlet used in separators and scrubbers
- Retrofitting and installation using only cold work
- High-pressure applications
- Good hydraulic performance and stable flow in the inlet section
- Enhanced liquid separation inside the vane inlet

The CONSEPT IVD* separator inlet vane diffuser consists of multiple dual-plate vanes that effectively distribute gas and liquid. These vanes are designed to avoid any liquid carryover with gas by providing gradual bend and enough surface area for liquid to separate from gas.

The diffuser vanes are more efficient compared with single-plate vanes, which include a 90° bend and can potentially carry over excess liquid with gas. Installing an CONSEPT IVD diffuser on the inlet section of the separator uniformly distributes gas and liquid to decrease the required residence time for the separator while maintaining the required separation efficiency.

CONSEPT IVD separator inlet vane diffuser for a flare knockout drum assembled in a shop.

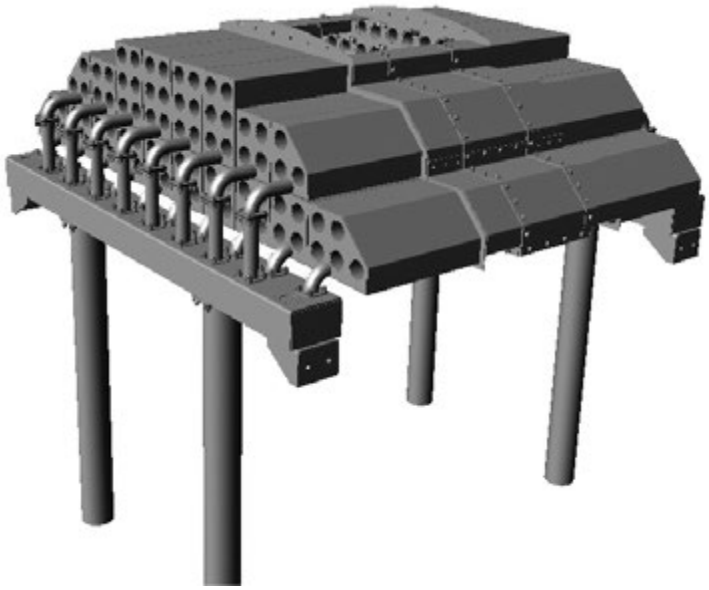
CONSEPT DC demisting cyclones

Applications

- Highly efficient cyclonic demisting
- Operations with scrubbers, separators, and contactor towers
- Operations with high pressures and low surface tensions
- Retrofitting

Schlumberger CONSEPT DC* demisting cyclones are compact cartridges of minicyclones that remove liquids from gas. Each cyclone is designed with internals that set fluids into centrifugal motion to separate liquid from gas. Several of these cyclones are combined and installed on the gas outlet of the separator.

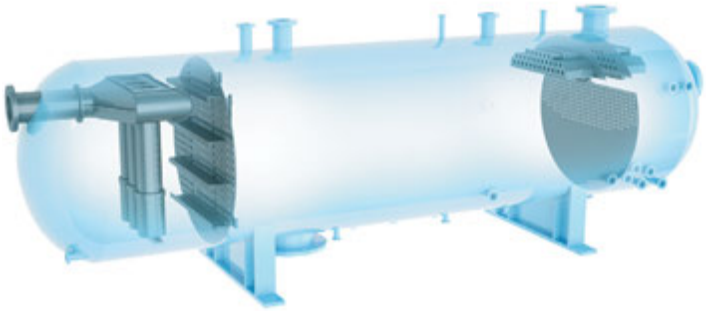
Demisting cyclones provide a higher K value compared with standard demisters or a mesh pad. In combination with other internals, the CONSEPT DC cyclones can increase separation efficiency of the separator to remove 99.99% of 10-um-or-larger liquid droplets or 0.1-galUS/MMscf liquid carryover.



PORTA-TEST REVOLUTION separator internal

Applications

- Cyclonic inlet
- Inlet device for two- and three-phase separators
- Reduction of foam in vessel by separating gas and liquids before inlet momentum reduction
- Accommodation of high inlet momentum in vessels
- Elimination of scaling effects through use of multiple tubes
- Special design for two- and three-phase vessels



PORTA-TEST REVOLUTION separator internal as installed in a three-phase separator.

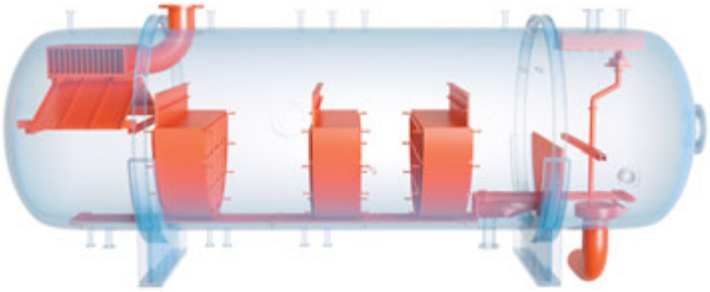
The PORTA-TEST REVOLUTION* separator internal is a unique separator internal inlet device used to eliminate foam and improve fluid management within the separator.

The separator internal can be connected directly to the inlet nozzle during fabrication, or it may be installed as a retrofit through a maintenance hole. It is suitable for use in both vertical and horizontal vessels. With more than 500 installations worldwide, we have the experience and expertise to optimize your separator performance.

Contactor vessels with demister integrated in chimney tray

Our unique contactor design has a built-in inlet and outlet gas scrubbing system, which can potentially eliminate the requirement of scrubbers upstream and downstream of the contactor.

The inlet section of the contactor can be equipped with the CONSEPT IVD separator inlet vane diffuser, which provides uniform distribution of the gas and removes any entrained liquids. The outlet section of the gas, from the top of the contactor tower, uses a CONSEPT DC demisting cyclone as the demisting section, increasing the overall separation efficiency and reducing the solvent losses with outlet gas. The demister for the hydrocarbon scrubber is fitted inside the chimney tray to save space. The pressure drop through these devices is much less compared with individual scrubbers, providing overall capex and opex savings.



Robust three-phase separation with mechanical coalescence

The three-phase separator is designed with various internals for fluid inlet, gas outlet, and liquid outlet to provide higher separation efficiency while potentially decreasing the overall size of the vessel by reducing the overall required residence time. These three-phase separators are designed to handle oil, gas, produced water, and solids. To improve the separation performance, Schlumberger uses its high-efficiency separator internals—CONSEPT IVD diffuser, CONSEPT DC demisting cyclone, PORTA-TEST REVOLUTION separator internal—vortex breakers, or NATCO PERFORMAX* horizontal high-efficiency phase separator to ensure mechanical coalescence and improved separation.

Verification

Verification of the separation performance at real flow conditions using real fluids is essential for utilizing the high-efficiency phase separation internals to their full potential.

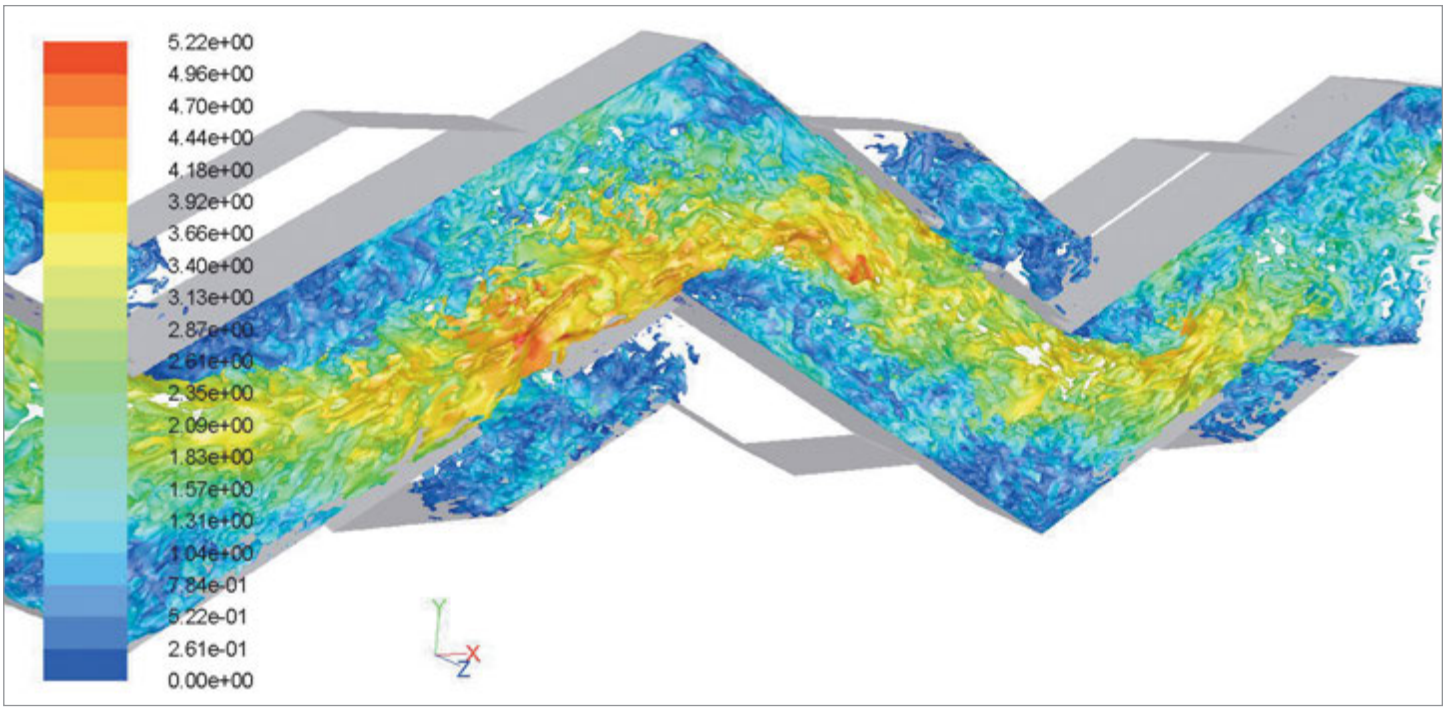
The high-efficiency phase separation internals have been tested with real fluids at high pressures. The demister sections have been tested for liquid and gas mixtures operating close to the critical point with interfacial tension between gas and oil as low as 0.00002 N/cm.

A Schlumberger-designed scrubber is used at the Ormen Lange subsea compression pilot, which is verification of a full-size subsea compressor station in an onshore pit.

Based on the testing, a model for predicting the separation performance is developed based on

- pressure
- liquid and gas densities
- liquid and gas flow rates
- viscosity
- interfacial tension.

The efficiency models enable Schlumberger to accurately predict the actual liquid carryover in real conditions and optimize the vessel size based on the customer requirements for vessel performance.



Turbulent structures in a vanepack as simulated.

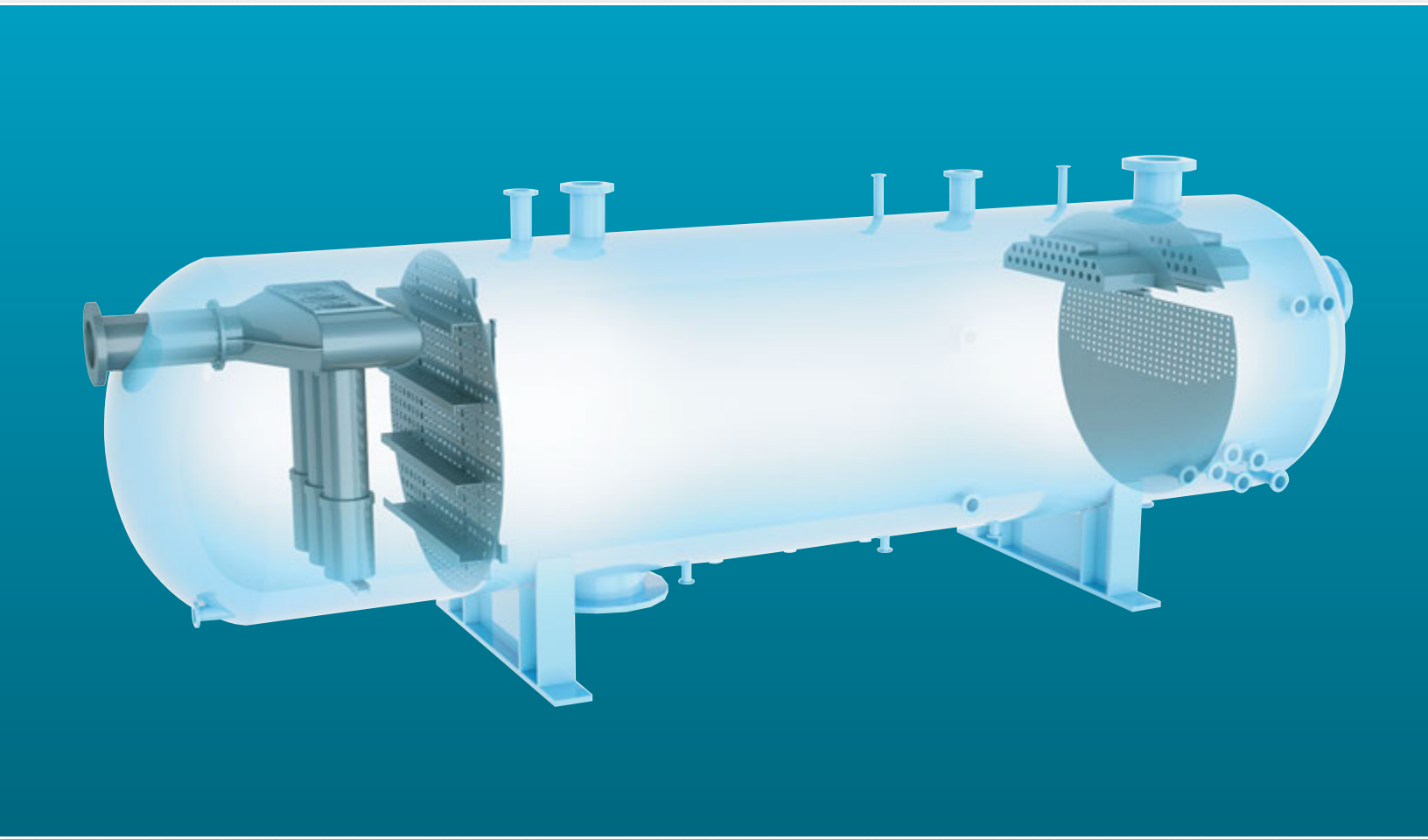
Computational fluid dynamics (CFD) modeling

Applications

- Verification of the flow in the vessel
- Checking volume utilization of vessel volume
- Detection of any maldistribution in the inlet pipes
- Examination of the effect of flow dynamics or slugging, the effect of separator motion, and sloshing of fluids inside the vessel
- Estimation of forces acting on internals in the vessel
- Prediction of separation performance
- Enhancing product development

CFD is an important and integral part of high-efficiency phase separation internals implementation. The CFD calculations assure proper working of internals as designed and their optimal implementation. Schlumberger has extensive experience and dedicated support staff for CFD. Every delivery of the internals is verified with CFD.

High-Efficiency Phase Separation Internals



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