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ABSTRACT & ATTRIBUTES OF
HEAT TRANSFER
Surfaces for ASME Vessels



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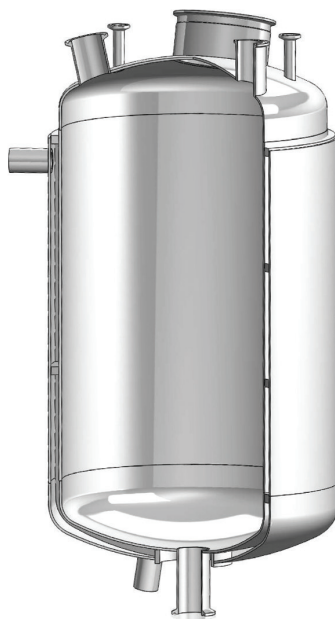
HEAT TRANSFER Surfaces for ASME Vessels

Used in heating and/or cooling applications, thermal heat exchange surfaces control the temperature in the vessel and ultimately the quality of the contents of the vessel. Jacketed vessels are used in many industries and can be used to remove the elevated heat of reaction (heat reactor vessel) or reduce the viscosity of high viscous fluids. There are three basic types of external jacketed heat transfer surfaces: conventional jacket, half pipe jacket and dimple jacket, which is attached to the outside of the vessel by welds. Internal coils can also be utilized and can be used as a stand-alone option or in combination with any of the other types of external jackets.

This white paper serves as an educational and informational reference on heat transfer methods that use steam or fluid, including:

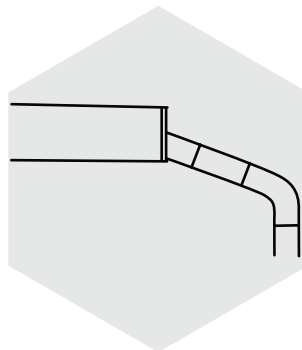
- ▶ Types of heat exchange surfaces
- ▶ General application information and comparison
- ▶ Optional surface treatments
- ▶ Manufacturing terms and definitions
- ▶ Regulatory code review

CONVENTIONAL JACKET



Conventional jackets are an open jacket with an annular space containing the heat transfer media on the exterior surface of the tank. In some instances, internally welded baffles within the conventional jacket control the flow of the heating or cooling agent. In Apache's experience, water, oil or heat transfer fluid is typically used as heat transfer agents for conventional jackets.

Variable coverage areas and pressures are available in conventional jacket designs.



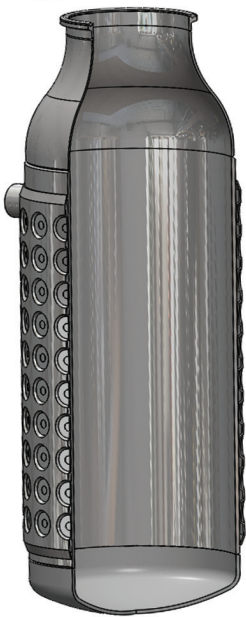
Simple schematic shows conventional jacket construction

Best uses

Conventional jackets are best used for low pressure applications below 50psi. They are also used in high fluid volume applications. The major advantage is that this jacket type allows for the lowest pressure drop. Conventional tank designs are often used in small vessels under 100 gallons.

Note: While the conventional jacket design allows the lowest pressure drop, it can also drive up cost due to the thickness of the material required since there is no reinforcement in the design to accommodate the jacket's external pressure requirements on the vessel wall.

DIMPLE JACKET

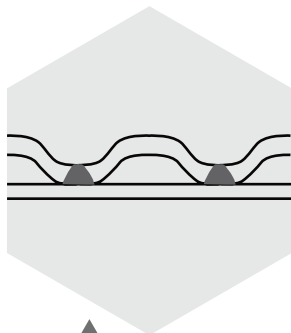


Dimple jackets utilize a thin gauge stainless steel layer that is plug welded to the vessel shell in a regular pattern. The punched and spot welded areas are called dimples, which create turbulence of the heating or cooling fluid flowing through the jacket. The dimple jacket design allows for thinner vessel shell walls than a conventional jacket design due to the strength of the dimple pattern design.

Dimple jackets are manufactured in several different pressures and patterns. Apache fabricates with 12 ga. and 14 ga. material. Each pattern is validated and proof tested per ASME regulations. Apache has proofed and certified designs up to 1 3/4" at 200 psig at 300° F but can go to higher temperatures depending on the application.

Apache provides a CNC punched "pre-formed" sheet. It is MIG and plug welded to the shell.

Inflated dimple laser or resistant spot welded dimple jackets are other technologies available.



▲ Schematic shows plug welds on dimple jacket

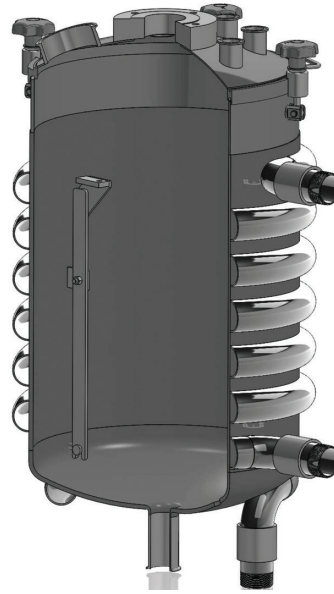
Best uses

The dimple jacket design provides a large heating or cooling transfer area up to 200 psig. Dimple Jackets are very versatile. They can be used to provide heat transfer or cooling for virtually any shape or size of vessel. Dimple jacket technology is not limited to tanks.

On large tanks, dimple jackets have a lower price point and maintain a higher pressure drop compared to conventional jackets. On small vessels, conventional jackets have a lower price point followed by dimple jacket and half pipe solutions.

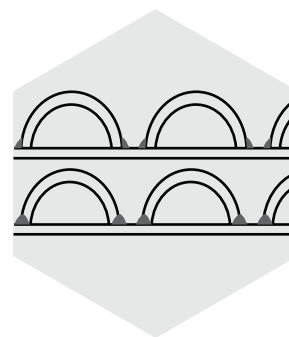
Note: Dimple jackets are not recommended for thermal cycling or when shocking is required. Typically, the stronger half-pipe design is recommended for those applications.

HALF PIPE COIL JACKET



The half-pipe jacketed vessel has a split pipe (split evenly or rolled formed sheet) wound around the vessel and welded into place. This design provides optimal strength and can be rated up to 500 psig. Half-pipe jackets are recommended for high-temperature and liquid heat-transfer applications.

Material used for half-pipe jackets are commonly 304, 304L or 316 and can be welded to a range of alloys. Sound welding practices allow the half pipe to be welded to high alloys.



◀ Standard weld

◀ Full penetration weld

Half pipe heat transfer surfaces can contain the entire vessel or part of the vessel depending on the application.

Other technologies include inflatable half-pipe designs with laser or resistance welded hat sections.

Best uses

Half-pipe jacket designs are often used when the jacket pressure is the determining factor in vessel wall thickness. The cost is dependent on tank size, material thickness and overall application requirements.

Conventional Jacket



CRITERIA

Best used for large volumes of water used to maintain high temperature difference. Conventional jackets are often used in small vessel design.

PRESSURE

Up to 50 psig optimally, but can be evaluated for higher pressure depending on the application.

ASME

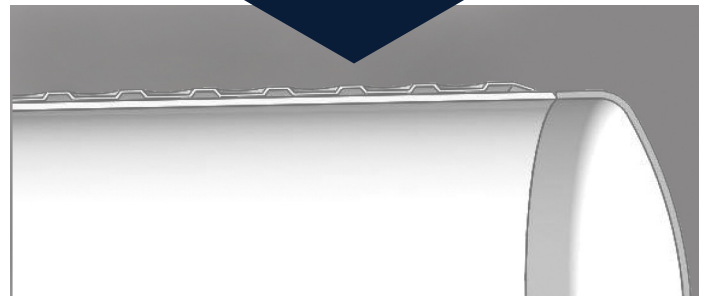
Shells, bottom head, top head or the entire tank can be ASME certified.

CONSIDERATIONS

Conventional jackets require greater shell thickness and expansion joints to eliminate stresses caused by thermal expansion.



Dimple Jacket



CRITERIA

Dimple jackets are well suited to steam applications. High jacket pressures permitted without significant increase of side structure thickness. Efficient heat transfer at low media flow.

PRESSURE

250 psig with temperature limited to 500° F.

ASME

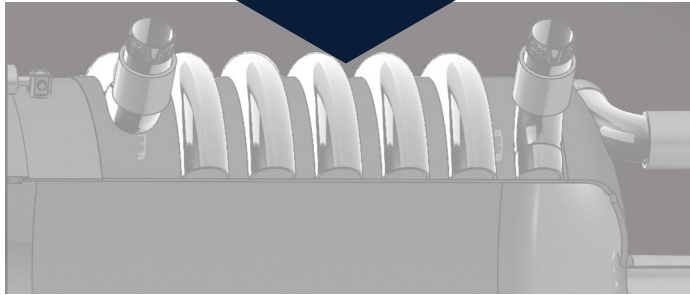
Approved by the National Board of Boiler and Pressure Inspectors up to 250 psig.

CONSIDERATIONS

While dimple jackets are economical, it may not provide drainage required by the steam application.



Half Pipe Jacket



CRITERIA

High jacket pressures attainable without significant increase of side structure thickness
Suitable for steam, water, hot oil and other medias.

PRESSURE

Rated up to 500 psig.

ASME

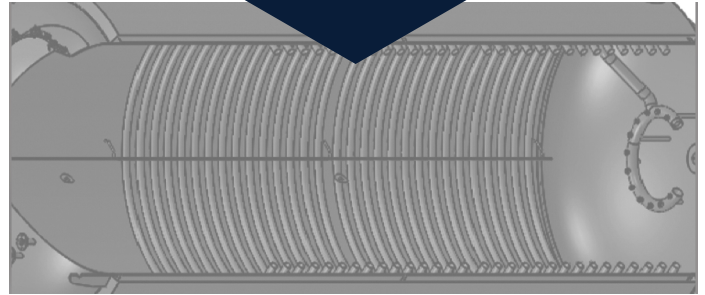
Half pipe coil jackets are not covered in Section VIII, Division 1 of the ASME code.

CONSIDERATIONS

Half pipe may require multiple sections to reduce condensate cover on the heat transfer area. The increased strength and zone capabilities make the half pipe design suitable for hot oil medium.



Internal Coil



CRITERIA

Utilized for heating and cooling surface contact and handling high internal and external pressures.
Efficient heat transfer advantages.

PRESSURE

Rated to 900 psig.

ASME

Internal coils can be included as part of an ASME vessel but aren't required to be code stamped.

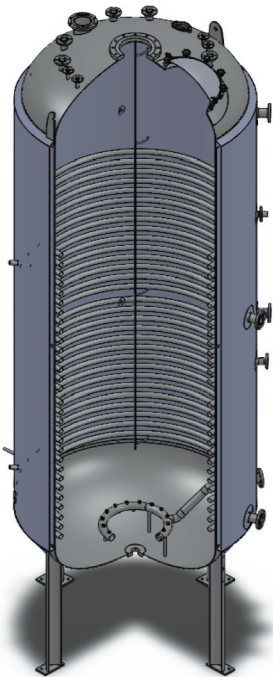
CONSIDERATIONS

Internal coils may be subject to contamination of the vessel contents, especially if contents have corrosive properties.



HEAT TRANSFER SURFACES

INTERNAL COIL



Internal coils are utilized inside vessels for transient heating or cooling of the liquid contained in the tank typically on a batch basis.

Coils provide heating and cooling surface contact and are manufactured as a formed spiral around the inside of the shell or a U-shape in the center of the vessel from the top head down.

Internal coil heat transfer solutions are found in many industries. However, the ability to clean the coil effectively and efficiently may be an issue in industries that require extreme sanitation and / or food safety protocols.

The internal coil design provides high flow, high internal and external pressures and high pipe ratings.

Best uses

Internal coils are often used in industrial or chemical applications where the product is not corrosive to the coil.

Note: Depending on the loads of the application, the required heat transfer may not be attainable.

FINISHING PROCESSES



Pickle Passivation

When required for the application, Apache conducts a full immersion passivation to remove free iron and aid in the formation of the stainless material's passive oxide layer. Full immersion passivation is also an efficient method of color cleaning the exterior welds on a tank. Dimple jackets are often passivated as a by-product of another requirement that was specified for the tank. Passivation also helps Thurmalux adhere to stainless.



Thurmalox

Thurmalox is a high temperature industrial protective coating that is used on conventional, dimple and half-pipe jacket designs.

The product is an air-drying, silicone based heat resistant coating that protects thermally insulated austenitic stainless steel from chloride induced stress corrosion cracking. Apache uses Thurmalox 70, which withstands temperatures to 1000°F (538°C) with peaks to 1100°F (593°C).

It is formulated to contain the minimum amounts of attainable chlorides, halides, sulfides, nitrates and metals that induce external stress corrosion cracking. An independent laboratory for leachable chloride content tests each batch of Thurmalox 70 before it is released.

Agitation

Agitation can be used in jacketed vessels and with internal coils to improve the homogeneity of the fluid properties. Agitation is commonly used in batch applications.

Chemical Reactor

A chemical reactor removes the elevated heat of reaction to reduce the viscosity of high viscous fluids.

Formed Sheet and Plate Header

Apache uses large formed sheet or plate headers to enhance the flow capability of the jacket and maximize the strength of the inlet and outlets of the jacket.

Heat Exchanger

A device used to transfer heat between two or more fluids.

Heat Transfer Media

Media types include water, steam, glycol, hot oils and other fluids.

Thermal Shocking

Thermal shocking introduces alternating low and high temperatures for rapid cooling and / or heating applications.

Wetted Surface

The area of contact between the liquid and the wall of the tank often used to determine the emergency venting capacity required for the tank.

Zones

Heat transfer jacketing can be applied in individually welded zones to allow for separate zones to be thermal controlled individually.



◀ *Small dimple jacketed vessel after pickle passivation descaling process*

Dimple jacketed ASME Vessel Bottom ▼

▶ *Large ASME Vessels with half pipe jacket construction*





About Apache Stainless

Compliance engineering to industries requiring ASME compliance is what we do. Dedicated project engineers provide control over calculations, component selection, compliant designs, approvals, testing and certifications. Apache has the experience and reputation with inspectors, agencies and governing officials for successful and efficient compliance vessel projects.

ASME is a leading developer of codes and standards in the mechanical engineering community. These standards enhance public safety and health as well as promote innovation. Apache has been ASME certified for over 40 years, with decades of experience engineering and manufacturing custom heat transfer vessels.

In addition to ASME, Apache is also accredited in many other global standards. By setting parameters for quality and compliance, we offer greater value for our equipment products.

Apache has a quality assurance team to verify quality conformance, conduct compliance testing, and process certifications including (TOP) Turn-Over-Packet documentation.

As a 100% employee owned company, Apache's culture exemplifies continuous improvement, efficiency, innovation and commitment to our customer.

References:

National Boards of Boiler and Pressure Vessel Inspectors

Apache ASME engineering experts and project library

Marketing/Resources/Heat Transfer Surfaces

