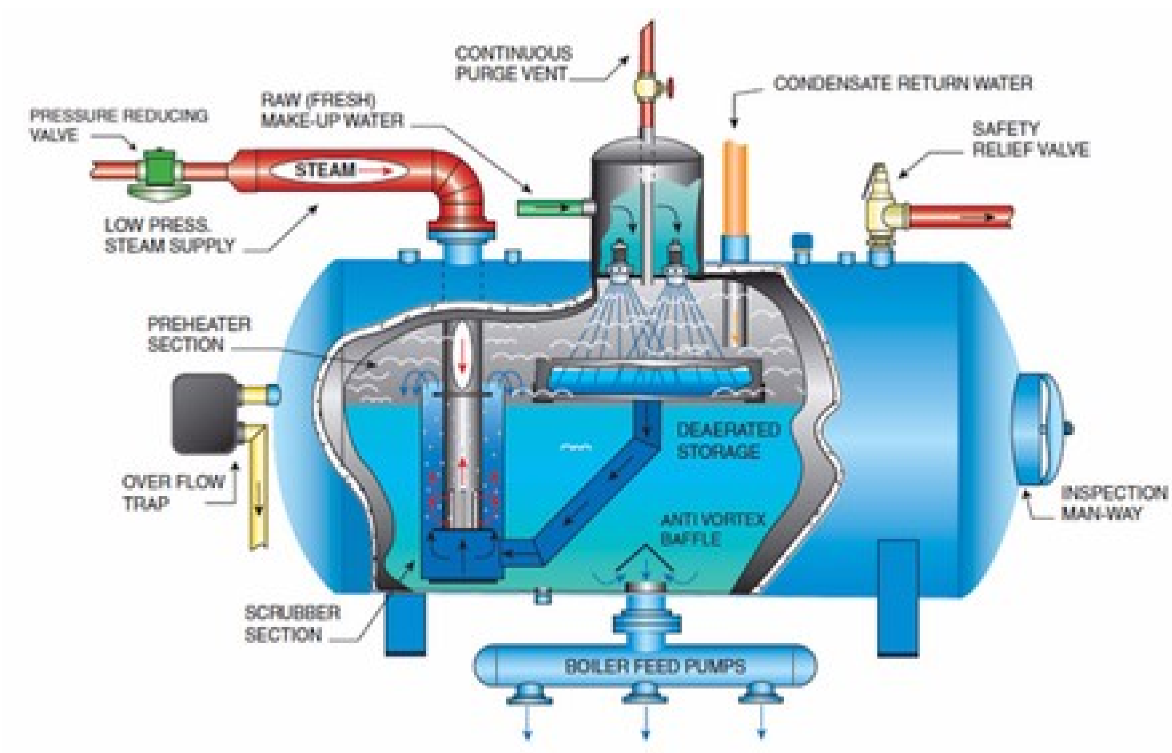
Pressure Vessel Newsletter

Volume 2017, October Issue



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From The Editor's Desk:

Immediately after the hurricane Harvey that devastated large parts of Houston a few weeks ago, Associated Press ran a story highlighting vulnerabilities in storage tank installations along the gulf coast during a hurricane. According to the report, more than two dozen storage tanks holding crude oil and petroleum products failed during the hurricane and spilled at least 145,000 gallons of fuel and released toxic pollutants in the atmosphere.

It is known fact that storage tanks are prone to float and break during floods. Harvey's unprecedented rainfalls revealed a new vulnerability – floating roofs of some of the storage tanks sank under the weight of so much water. Yet, although the federal and state laws require companies to prepare for spills, they mandate no measures to secure storage tanks at refineries, chemical plants and oil production sites. And they don't require companies to incorporate design to safely discharge rainwater from atop the floating roofs during excess rainfall.

The refineries were able to fill the larger storage tanks prior to the hurricane to make them less buoyant; however, they couldn't prevent the smaller tanks from floating as even when completely filled they were not able to overcome the buoyancy forces. Regarding the accumulation of rainwater on the floating roofs, the currently industry standard from American Petroleum Institute calls for storage tanks to be able to drain at a minimum 10 inches of rain over a 24-hour period. Rain was however falling at more than twice that rate during the hurricane Harvey.

Most states have rules governing protections for underground storage tanks during floods. There should now be mandatory rules to govern the protection of aboveground tanks too – at least for those tanks that have floating roofs and are located in a hurricane zone.

Ramesh K Tiwari

In this issue…

An advertisement is about self blah blah right?

Well, for a change we decided to let others do the talking

"We are pleased to observe that M/s KEVIN Enterprises were fully supportive to meet the quality standards, delivery commitments and the documentation requirements, during the execution of the Project." **AKER KVÆRNER**

"KEVIN has completed design & supply of vessel internals comprising of structured packing, trays and associated internals. The equipments are commissioned at Reliance Industries Ltd., Jamnagar and have met our desired criteria. We would be glad to do business with them again."

BLACK & VEATCH

"For our grass root Naptha Cracker Associated Units, KEVIN's engineering & drawings were evaluated by respective licensors and the supplies were inspected by Lurgi. We hereby con rm our satisfaction with the performance of items engineered and supplied by KEVIN Enterprises." **Lurgi**

"KEVIN Enterprises has supplied a huge quantity of equipment like Medal-Pak packings, Tower Internals & Trays. KEVIN's technical offer and post order engineering was evaluated by Giammarco Vetricoke, Haldor Topsoe and ourselves."
We are very satis ed with quality of service and goods as produced at KEVIN which are already installed in the towers."

Eni
Snamprogetti

"KEVIN has supplied metal packing and other column internals for CO_2 Removal Unit for Ammonia feedstock changeover project being setup by us for National Fertilizers Ltd., Nangal.
The PO has been executed as per schedule. M/s. KEVIN's support during the execution of PO is well appreciated."

Tecnimont ICB

"KEVIN Enterprises have supplied equipments to various projects through us, we being LSTK contractors. They have executed the job timely and to our entire satisfaction. We would like to continue our partnership for our future projects."

TOYO ENGINEERING INDIA LTD

"KEVIN Enterprises have worked with us on several projects since 1994, involving various clients. KEVIN's approach is professional and their supplies and services are consistent in quality & delivery." **Uhde India**

ThyssenKrupp

"KEVIN Enterprises have supplied Mass Transfer Equipments for several of our prestigious projects for past many years. We found KEVIN Enterprises quality, delivery and services entirely to our and our client's satisfaction." **JACOBS**

"Stone & Webster remains very satisfied with all the products we have received from KEVIN Enterprises and trust our future projects with them."

Shaw Stone & Webster, Inc.

"KEVIN did a good job on Canadian NRL HORIZON OIL SANDS project and we are satisfied with their performance"

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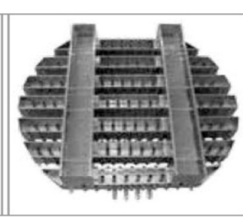
Random Packings



Tower Internals

Fractionation Trays

Structured Packings

Mist Eliminators

DEAERATORS

DEAERATORS IN INDUSTRIAL STEAM SYSTEMS

A deaerator is a device that is widely used for the removal of oxygen (O2) and other dissolved gases from the feedwater to steam generating boilers. Deaeration protects the steam system from the effects of corrosive gases. In particular, dissolved O_2 in boiler feedwaters will cause serious corrosion damage in steam systems by attaching to the walls of the metal piping and other metallic equipment and forming oxides (rust). Dissolved carbon dioxide (CO_2) combines with water to form carbonic acid that causes further corrosion. Most deaerators are designed to reduce the concentration of dissolved O_2 and CO_2 to a level where corrosion is minimized. A dissolved O_2level of 5 ppb or lower is needed to prevent corrosion in most high pressure (> 200 psi) boilers. While oxygen concentrations of up to 43 ppb may be tolerated in low-pressure boilers, equipment life is extended at little or no cost by limiting the O_2 concentration to 5 ppb. Dissolved CO_2 is essentially completely removed by the deaerator.

How They Work

The design of an effective deaeration system depends on the amount of gases to be removed and the final O_2 concentration desired. This in turn depends upon the ratio of boiler feedwater makeup to returned condensate and the operating pressure of the deaerator.

Deaerators use steam to heat the water to full saturation temperature corresponding to the steam pressure in the deaerator, and to scrub out and carry away the dissolved gases. Steam flow may be parallel, cross or counter to the flow of water. The deaerator consists of a deaeration section, a storage tank, and a vent. In the deaeration section, steam bubbles through the water, both heating and agitating it. Steam is cooled by incoming water and condensed at the vent condenser. Non-condensable gases and some steam are released through the vent.

Steam provided to the deaerator provides physical stripping action and heats the mixture of returned condensate and boiler feedwater makeup to saturation temperature. Most of the steam will condense, but a small fraction (usually 5% to 14%) must be vented to accommodate the stripping requirements. Normal design practice is to calculate the steam required for heating and then make sure that the flow is sufficient for stripping as well. If the condensate return rate is high (> 80%) and the condensate pressure is high in comparison to the deaerator pressure, then very little steam is needed for heating and provisions may be made for condensing the surplus flash steam.

Deaerator Steam Consumption

The deaerator steam consumption is equal to the steam required to heat incoming water to its saturation temperature, plus the amount vented with the non-condensable gases, less any flashed steam from hot condensate or steam losses through failed traps. The heat balance calculation is made with the incoming water at its lowest expected temperature. The vent rate is a function of deaerator type, size (rated feedwater capacity), and the amount of makeup water. the operating vent rate is at its maximum with the introduction of cold, O_2-rich makeup water.

TYPES OF DEAERATORS

There are two basic types of deaerators, the tray-type and the spray-type. The tray-type (also called the cascade-type) includes a vertical domed deaeration section mounted on top of a horizontal cylindrical vessel which serves as the deaerated boiler feedwater storage tank. The spray-type consists only of horizontal (or vertical) cylindrical vessel which serves as both the deaeration section and the boiler feedwater storage tank.

Tray-type Deaerator

The typical horizontal tray-type deaerator in Figure 1 has a vertical domed deaeration section mounted above a horizontal boiler feedwater storage vessel. Boiler feedwater enters the vertical deaeration section above the perforated trays and flows downward through the perforations. Low-pressure deaeration steam enters below the perforated trays and flow upward through the perforations. Some designs use various types of packed bed, rather than perforated trays, to provide good contact and mixing between the steam and the boiler feedwater.

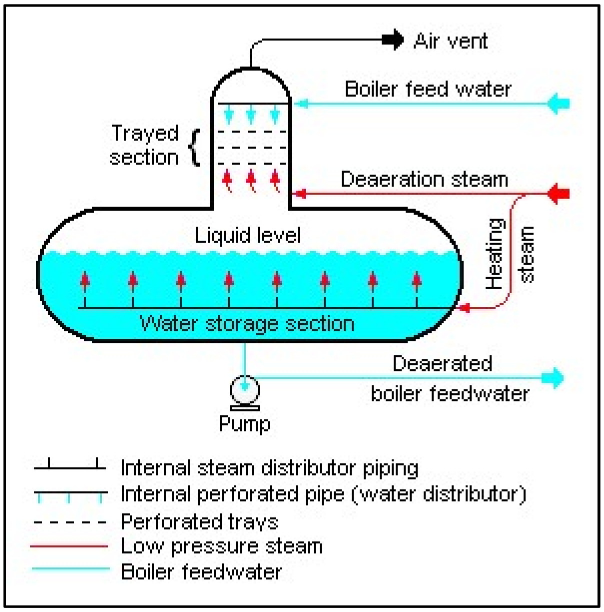


Figure 1: Schematic Diagram of Typical Tray-type Deaerator

The steam strips the dissolved gas from the boiler feedwater and exits via the vent valve at the top of the domed section. Should this vent valve not be opened sufficiently, the deaerator will not work properly, causing high O_2 content in the feedwater going to the boilers. Should the boiler not have an O_2-content analyzer, a high level in the boiler chlorides may indicate the vent valve not being far enough open. Some designs may include a vent condenser to trap and recover any water entrained in the vented gas. The vent line usually includes a valve and just enough steam is allowed to escape with the vent gases to provide a small and visible telltale plume of steam.

The deaerated water flows down into the horizontal storage vessel from where it is pumped to the steam generating boiler system. Low-pressure heating steam, which enters the horizontal vessel through a sparger pipe in the bottom of the vessel, is provided to keep the stored boiler feedwater warm. External insulation of the vessel is typically provided to minimize heat loss.

Spray-type Deaerator

As shown in Figure 2, the typical spray-type deaerator is a horizontal vessel which has a preheating section (E) and a deaeration section (F). The two sections are separated by a baffle (C). Low-pressure steam enters the vessel through a sparger in the bottom of the vessel.

The boiler feedwater is sprayed into section (E) where it is preheated by the rising steam from the sparger. The purpose of the feedwater spray nozzle (A) and the preheat section is to heat the boiler feedwater to its saturation temperature to facilitate stripping out the dissolved gases in the following deaeration section. The preheated feedwater then flows into the deaeration section (F), where it is deaerated by the steam rising from the spargersystem. The gases stripped out of the water exit via the vent at the top of the vessel. again, some designs may include a vent condenser to trap and recover any water entrained in the vented gas. Also again, the vent line usually includes a valve and just enough steam is allowed to escape with the vent gases to provide a small and visible telltale plume of steam.

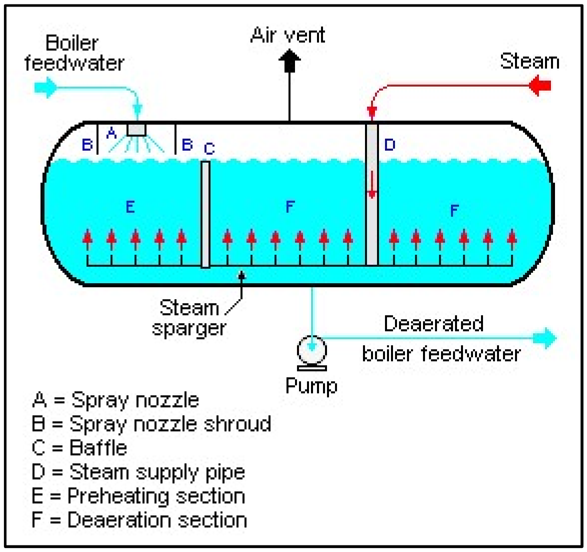


Figure 2: Schematic Diagram of Typical Spray-type Deaerator

The deaerated boiler feedwater is pumped out from the bottom of the vessel to the steam generating boiler system.

THE DEAERATING PRINCIPLE

The removal of dissolved gases from boiler feedwater is an essential process in a steam system. The presence of dissolved oxygen in feedwater causes rapid localized corrosion in boiler tubes. Carbon dioxide will dissolve in water, resulting in low pH levels and the production of corrosive carbonic acid. Low pH levels in feedwater cause severe acid attack throughout the boiler system. While dissolves gases and low pH levels in feedwater can be controlled or removed by the addition of chemicals, it is more economical and thermally efficient to remove these gases mechanically. This mechanical process is called deaeration and increases the life of steam system dramatically.

Deaeration is based on two scientific principles:

1. Henry's law: This law asserts that gas solubility in a solution decreases as the gas partial pressure above the solution decreases.
2. Relationship between gas solubility and temperature: Gas solubility in a solution decreases as the temperature of the solution rises and approaches saturation temperature.

A deaerator utilizes both of these natural processes to remove dissolves oxygen, CO_2 and other non-condensable gases from boiler feedwater. The feedwater is sprayed in thin films into a steam atmosphere allowing it to become quickly heated to saturation temperature. Spraying feedwater in thin films increases the surface area of the liquid in contact with the steam, which results in more rapid oxygen removal and lower gas concentrations. This process reduces the solubility of all dissolved gases and removes them from the feedwater. The liberated gases are then vented into the atmosphere.

BENEFITS

Deaerators provide many benefits to a steam plant system, including:

- Serving as a surge collection tank for process condensate return
- Blending hot return condensate and cold make-up water
- Preheating feedwater uniformly to improve boiler efficiency
- Removing oxygen (O_2) and carbon dioxide (CO_2) from feedwater to mitigate corrosion
- Holding 13 to 15 minutes of treated hot water in reserve storage for load change
- Providing a location for feeding and blending chemicals and testing protocols
- Providing a constant pressurized supply of water to boiler feed pumps
- Providing a convenient location for instrument controls and feedwater test data
- Helping to ensure precise drum water level and pressure inside of a boiler

DEAERATOR CONSTRUCTION

Deaerators are large, insulated tank-car-shaped pressure vessels. They produce preheated boiler feedwater to help ensure efficient steam plant operation. Deaerators come in numerous shapes and sizes, depending on the boiler plant design, capacity and system pressure rating. The units are produced in spray, tray, vacuum and atmospheric pressure design.

Most deaerators are ASME certified pressure vessels that operate at 5 to 15 psig by utilizing a low-pressure stean supply. A safety valve must be installed to ASME Code requirements. Quality pressure and temperature sensors are essential to ensuring precise pressure control and achieving a water temperature of 225^{o}F (the minimum temperature required to remove dissolved O_2 and CO_2 from feedwater) in the deaerator's storage section through mechanical evaporative scrubbing. At this elevated temperature, feedwater pumps, piping and economizers are subject to severe O_2 corrosion attacks even though a minute level of O_2 is dissolved in the water. When properly operating, a deaerator should be able to scrub O_2 to 5 to 10 ppb residual.

Typically, a ½-in vent in a deaerator's stainless steel dome degassing chamber removes non-condensable gases. A steam plume of 18 to 24-in should be visible at the end of the vent pipe.

The addition of sulfite or hydrazine chemically ensures a "zero" level of dissolved gas in the feedwater. A ¼-in stainless steel pipe should be used to distribute the liquid sulfite or hydrazine inside the deaerator storage section about 6 to 12 inches below the normal water level. Daily testing of boiler blowdown water should confirm a sulfite residual of 25 to 40 ppm, ensuring zero O_2 residual in the feedwater system.

OPERATIONAL CHECKLIST

A checklist can be used to evaluate the operational integrity of a deaerator unit. Checklist items should include:

- Storage suction volume for 13 minutes of water (from normal operating water level to pump low level trip)
- Normal pressure of 5 psig, ensuring a minimum temperature of 225^{o}F
- Readily accessible utility-grade pressure and temperature gauges and/ or sensors
- ½-in vent gas purge pipe of 18 to 24 inch
- Stainless steel sulfite chemical feed line inside of the vessel storage section
- Sulfite line (quill) located 6 to 12 inch below the normal operating water level
- Evaluation of daily sulfite use (Large change can indicate a spray-valve or tray-box malfunction)
- Semi-annual testing of unit performance/ dissolved O_2 without chemical feed
- Quality liquid level gauge glass easily visible by operators to monitor and confirm water level
- Well-insulated tank, including valves and man-heads
- Unrestricted discharge pipe to ensure adequate net positive suction head available for feed pumps
- Annual internal inspection for debris, corrosion, or defective components
- Annual planned maintenance and calibration of all instruments
- Nondestructive tests of all vessel welds on a five-year basis

CONCLUSION

A deaerator is not only an essential auxiliary component of a reliable feedwater system, but the heart of a boiler mass-flow and thermal-energy database that can be used to critique plant operations and identify energy-savings opportunities. Whether a deaerator is for a large 80,000-pph watertube boiler system, or a small 300-hp firetube unit, significant energy savings may be possible in plants that do not monitor feedwater system performance closely. If the boiler efficiency is not at its peak (and the cause of inefficiency cannot be identified), a critique of the feedwater system may be revealing.

Many facilities use steam and fuel meters to determine boiler efficiency. Frequently, these meters are not accurate and utility staff members may have a false sense of boiler efficiency. If a facility spends more than $50,000 per month on boiler fuel, a 5- or even a 10-percent efficiency improvement may be possible.

An unscheduled deaerator outage can be serious issue, affecting process operations, energy costs, maintenance budgets, and the long-term integrity of the entire boiler system. **Get to know and respect this unit as a boiler plant's major auxiliary system.**

References:

Evaluating Deaerator Operation by Gary Wamsley

Deaerator – Wikipedia

Deaerators in Industrial Steam Systems – US Department of Energy

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PRESSURE VESSELS FABRICATED BY LAYERED CONSTRUCTION

Cylindrical vessels can be reinforced by shrinking an outer cylinder so that a contact pressure is produced between the two. This is usually done by making the inside radius of the outer cylinder smaller than the outside radius of the inner one and assembling the two after heating the outer one. (The reverse procedure of cooling the inner cylinder with dry ice or liquid gases also has been used). A contact pressure is developed after cooling dependent upon the initial interference of the two cylinders. Its magnitude and the stress it produces can be calculated by equating the increase in the inner radius of the outer cylinder to the decrease in the outer radius of the inner cylinder.

If such a built-up cylinder is now subjected to internal pressure, the stresses produced by this pressure are the same as those in a solid wall cylinder of thickness equal to the sum of the individual cylinders (designated as pressure bearing). These stresses are superposed on the shrink-fit stresses discusses in the previous paragraph. The latter are compressive at the inner surface of the cylinder which reduces the maximum tangential tensile stress due to the internal pressure at this point, thereby creating a more favorable stress distribution than in the case of a solid wall cylinder. See Figure 1 for the shrink-fit tangential stresses in a cylinder.

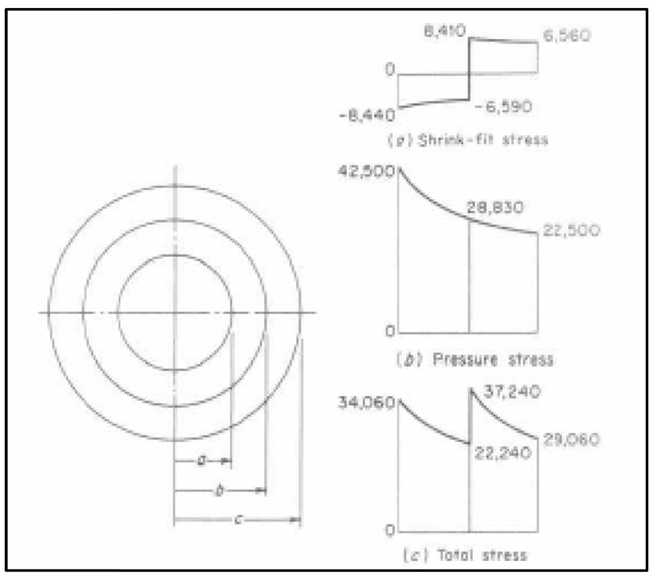

Figure 1: Shrink-Fit Tangential Stresses in a Cylinder

MAIN COMPONENTS IN A MULTILAYER PRESSURE VESSEL

Multilayered pressure vessels are those having the shell and heads made up of two or more separate layers. Cylindrical portion of multilayer vessels consist of an inner liner made of corrosion resistant material, over which shell layers formed from plates or sheets are added. Dummy layer is provided between inner shell and shell layers, to function as a secondary containment, to protect the carbon steel shell layers. Leak detection system helps in early detection of any leak. Outer protective layer is provided over the shell layers. Heads of the vessel are constructed from single wall forgings with an inner lining, or as a layered construction which is comparatively more difficult to construct. Dummy layer and leak detection system are provided for the heads also.

ADVANTAGES OF LAYERED CONSTRUCTION COMPARED TO SINGLE WALL CONSTRUCTION

When the thickness of a cylindrical vessel is very large, the variation in the stress from the inner surface to the outer surface becomes appreciable, and the ordinary membrane or average stress formulas are not a satisfactory indication of the significant stress. Major advantage of multi-layer construction is the possibility to achieve uniform shell properties and stress distribution which is difficult to achieve for thick single wall. Thin plates exhibit superior mechanical properties (strength as well as notch toughness) compared to thick plates. When thin plates are wrapped gap-less, the layered section forms a virtually solid wall with uniform properties. In addition, the compression stress induced by the tight wrapping is distributed throughout the inner two-thirds of shell courses. The tensile stress resulting from operating pressure is superimposed over this pre-stress to provide an almost uniform tensile stress over the entire thickness. Materials of different properties can be used for the layers, if required, to enhance the strength characteristics.

Multiwall vessels can be easily fabricated to any desired thickness and diameter, whereas single wall construction is limited by the available plate thickness and fabrication facilities.

By suitably selecting the materials and thickness of layers, PWHT can be avoided. Therefore, the inner layer can be made from titanium or any other material, without fear of any degradation due to PWHT. Whereas, PWHT is mandatory for thick-walled construction which can degrade the inner lining.

Lighter weight is achieved for layered shell sections by using high tensile thin plate materials. It can result in savings of overall costs.

The rupture mode of layered construction is only by tearing without fragmentation; the propagation of any brittle fracture/ crack will stop at layer interface. Single wall construction has the risk of brittle fracture and hence may fragment to small pieces during a rupture which can fly off in all directions.

Repair of leak in single thick walled vessels is a difficult task because any corrosion cavities formed in the wall has to be repaired only by weld build-up which is time-consuming and needs PWHT. This affects the metallurgy and corrosion resistance of inner liner. Cavities formed in multiwall vessels can be filled up by installing thin plate segments without any PWHT.

LIMITATIONS OF MULTILAYER CONSTRUCTION

In the multilayer vessels, high local discontinuity stresses can occur at nozzles, supports etc. This is due to reduced rigidity of a collection of thin plates as opposed to a solid wall. This problem can be resolved by putting additional layers at these locations or by employing solid wall construction in these local areas. For instance, flared insert type thick walled nozzles can be used and the layers can be welded to the solid body. Also, solid ring can be used for connecting layered shell to layered heads and supports. Or, use the thickest plate permissible without the need for PWHT.

Rapid internal cooling or heating must be avoided to prevent the inner layer from getting overstressed which will result in weld cracks or buckling. Liner stress analysis and buckling analysis should be carried out to establish the optimum heating and cooling rates.

Vacuum rating of multiwall vessel is less compared to that of the thick-walled construction because the vacuum is to be withstood by the inner liner only. In order to alleviate this problem, the inner liner is designed for expected vacuum condition

DESIGN OF MULTILAYER PRESSURE VESSELS

General Design Consideration

The corrosion resistant inner liner (which is considered sacrificial layer), dummy layer and the outer shell are not considered part of the required minimum shell thickness. When attachments (nozzles, supports etc.) are welded to vessel shell, provisions shall be made to transfer the load to all shell layers. If not, only the thickness of layer to which the attachment is welded shall be considered in calculating the stress near the attachment. Torispherical layered heads are not permitted for layered vessels. Usually, the heads are carbon steel and hemispherical. Dummy lining of heads can be weld overlay or cladding with the same material as that of inner layer. The inner liner shall be designed for vacuum condition. Strength calculations for all parts shall be checked for testing and as-erected conditions also.

Thickness Design of Inner Liner

Specific code requirements are not available for liner thickness calculation. Major factor for selecting the liner thickness is the acceptable corrosion rate for the selected material under the operating conditions. Second factor is the possibility of liner buckling due to differential thermal expansion of the liner compared to the shell layers. While calculating the differential expansion, it should be realized that the temperature seen by liner will be higher than the shell layers due to its proximity to the operating fluids. This temperature difference has to be calculated and accounted for by carrying out a detailed buckling analysis. Third factor is the maximum vacuum condition that the inner layer will have to withstand. The fabrication sequence and fabrication stresses induced by the wrapping process of shell layers over the liner also are to be considered.

Buckling analysis done to study the strength of the inner liner to withstand differential thermal expansion. It is assumed in the analysis that the liner deformation due to buckling shall only be inwards since any movement outward is prevented by the shell. FEA is used for buckling analysis. Internal pressure, temperature difference between liner and shell, and residual compressive stress due to the fabrication process are the loading conditions to be assumed in the FEA. Both ends of the analytical model are assumed as fixed because the liner and the shell are welded at these locations. Gap is considered between liner and shell whereas no gap is considered between the shell layers; the shell is modelled as a solid wall.

Design of Shell Layers and Other Pressure/ non-Pressure Parts

Design calculations for shell layers, pressure parts like nozzles etc., are carried out using formulas and rules in the applicable design codes. The design basis shall consist of operating conditions (internal pressure, external pressure, temperature etc.) and other loading conditions (support stresses, wind loads, self-weight etc.). It shall be assumed that the total stress induced on the shell or head shall be shared by each layer used for its construction, in proportion to the thickness of plates used for the layer. Total minimum thickness calculated for the layered pressure parts shall be divided by the thickness of layered plates to be used, in order to arrive at the number of layers. Selection of layer plate material and thickness shall be based on availability and ease of fabrication. If plates with higher allowable stress is used, the wall thickness and the weight of the vessel can be reduced. Minimum thickness of any layer shall be 1/8 in. (3 mm), and the maximum thickness should be ¾ in. (19 mm).

Leak Detection System

Leak detection holes with piping are provided for early detection of leaks from liners. Leak detection tubes (usually ½” nominal size) 2 each at 180^{o} apart are provided above and below each circumferential shell weld. That means that for every shell course there shall be a minimum of four leak detection points. All the leak detection tubes in a shell course are to be connected to a header by means of stainless tubes. Separate header is provided for each shell course. This will help to identify which shell course is leaking. A carrier gas, usually dry air at about 1 psi pressure, shall be connected to one end of the header and the other end shall be connected to a bottle containing leak detection solution. The carrier gas flow is to be maintained at all times, and the solution is to be topped up as and when required.

CONCLUSION

Multiwall construction is best suited for pressure vessels with extra heavy wall thickness required in process applications. Multilayer construction has definite advantages compared to single wall construction. Their in-service maintenance and repair are easier, if handled with care and skill. The disadvantages attributed to multiwall construction can be easily alleviated by simple techniques described in this article.

References:

Multilayer Pressure Vessels *by* P.V. Thomas

Theory and Design of Modern Pressure Vessels *by* John F. Harvey

MAJOR CHANGES IN 2017 EDITION OF ASME SECTION VIIICODE

The following is a list of the major, but not all, changes in the 2017 Edition of the ASME Section VIII, Division 1 Code:

Appendix 1-9 and 1-10

Alternative rules for reinforcement of openings under internal pressure (1-9) and Alternative methods for design of reinforcement for openings in cylindrical and conical shells under internal pressure (1-10) have been removed and transferred to Part 4.5 of the ASME Section VIII, Division 2 Code.

UG-36: Openings in Pressure Vessels

Values are a little modified.

- For vessel ID 1520 mm (changed from 1500) and less than half the vessel diameter but not to exceed 510 mm (changed from 500 mm)

This is too match the OD of pipe size in mm.

UG-66 Curve B

A new material SA-299 is added. In Appendix 5 for expansion joint, extra figures are added.

Division 2

Now there are two classes of vessels. For both classes, the toughness, material, design, fabrication and examination requirements are essentially the same. The differences are as follows:

Class 1 Vessels:

Design margin	3.0
UDS	Certification only required if fatigue analysis is necessary
MDR	Certification only required if Part 5 Design-by-Analysis is used to determine pressure vessel thickness of a component not covered by Part 4 Design-by-Rule, or if a fatigue analysis is required.
Allowable Stresses	Taken from ASME Section II, Part D, Subpart 1, Table 2A S is lower of $\{\mathrm{UTS}/3, \mathrm{Yield}/1.5\}$

Class 2 Vessels:

Design margin	2.4
UDS	Certification of UDS is required.
MDR	Certification of MDR is required.
Allowable Stresses	Taken from ASME Section II, Part D, Subpart 1, Table 5A S is lower of $\{\mathrm{UTS}/2.4, \mathrm{Yield}/1.5\}$

For example, for SA 516-70, UTS = 70,000 psi and Yield Stress = 38,000 psi. For Class 1, S is lower of {70,000/3, 38,000/1.5} = 23,3333 psi. For Class 2, S is lower of {70,000/2.4, 38,000/1.5} = 25,333 psi.

The introduction of Class 1 vessels in ASME VIII-2 will allow U2 Certificate holders to design and construct an ASME vessel with a U2 Certification designator that is lighter than a ASME VIII-1 vessel but without all the additional requirements of a U2 Class 2 vessel.

Quick-opening and Quick-actuating Closures

UG-35.2 was revised to specifically address quick actuating closures.

UG-35.3 was added to address quick opening closures.

Appendix FF was revised to address the needs of both quick actuating and quick opening closures.

The safety improvements include:

- Clear definitions of quick actuating and quick opening closures
- Consistency on usage of holding and locking elements
- Requirement to have a pressure release device (or allowance for opening and maintenance procedures) for a quick opening closure
- Requirement for a partial data report when a closure is provided as a part

Manual UT Examinations

UW-11(a)(8), UW-11(d), UW-12, UW-51(a)(4), and UW-53 were revised to clarify when manual and automated UT examination methods are acceptable.

New PRT Certificate of Authorization and Certification Program for Organizations Fabricating Parts without Design Responsibility

Organizations fabricating parts are currently required to demonstrate design capabilities and are also required to obtain a separate Certificate of Authorization for fabricating parts under each section of the boiler code. This program will permit organizations that fabricate parts and do not take design responsibility to obtain an ASME certificate. The new program will also enable a manufacturer who holds a PRT stamp to fabricate parts for multiple code sections based on demonstrated capabilities. This change has also been made in other sections of the code.

Paragraph 4.15.3.4(e) - Acceptance Criteria for Shear Stresses

The current basis for determining the acceptance criteria is based on whether a material is ferritic material or not; however there is no strict definition of what constitutes a ferritic material. A revised acceptance criteria is being introduced based on if the material carries Note G2 in Table 5B of Section II Part D.

[*Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short–time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 662/3% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. Table Y–2 lists multiplying factors that, when applied to the yield strength values shown in Table Y–1, will give allowable stress values that will result in lower levels of permanent strain.] in Table 5A or Note G1 [Due to the relatively low yield strength of these materials, these higher stress values were established at temperatures where the short–time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. The stress values in this range exceed 662/3% but do not exceed 90% of the yield strength at temperature. Use of these stresses may result in dimensional changes due to permanent strain. These stress values are not recommended for the flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction. Table Y–2 lists multiplying factors that, when applied to the yield strength values shown in Table Y–1, will give allowable stress values that will result in lower levels of permanent strain*.]

Adoption of ASME CA-1 Standard on "Conformity Assessment Requirements"

Various paragraph were revised to replace conformity assessment requirements with a reference to CA-1.

- Added reference to CA-1 (Latest Edition) to Table U-3
- Replaced Conformity Assessment requirements in UG-117 and UG-131 with reference to CA-1
- Replaced definitions in Appendix 3 with reference to CA-1
- Deleted Appendix 25 (Rules for Acceptance of Testing Labs)
- CA-1 now covers the conformity assessment requirements formally covered by the deleted Appendix

Axial Compressive Stress and Hoop Compression

Code Case 2286-5 was previously incorporated into Section VIII, Division 2. Paragraphs 4.4.12.2 (b) and (e), 4.4.12.4 (b) and (c), and 4.4.15 were revised to correct the limits for the compressive stress factors.

Correct Equation 4.4.126 in Paragraph 4.4.12.4

Equation 4.4.126 correctly bounds the stress when both stresses are compressive and equal (pressure stress) but diverges in a different path when the stress tends towards uniaxial with certain bounding stresses. This change corrects Equation 4.4.126.

References:

Key Changes for the 2017 Edition of the ASME BPVC

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RADIOGRAPHIC EXAMINATION OF WELDED JOINTS

This article explores paragraphs UW-51 and UW-52 of ASME Section VIII, Division 1, and the radiographic requirements for pressure vessels.

When can butt-welded joints in pressure vessels that are required to be radiographed be examined using ultrasonic method as an alternate to radiographic examination?

Paragraph UW-51(a)(4) states, "As an alternate to the radiographic examination requirements, all welds in material ¼-in. (6 mm) and greater in thickness may be examined using the ultrasonic method per the requirements of 7.5.5 of section VIII, Division 2".

The ultrasonic examination areas shall include the volume of the weld, plus 2-in. (50 mm) on each side of the weld for material thickness greater than 8-in. (200 mm). For material thickness 8-in. (200 mm) or less, the ultrasonic examination area shall include the volume of the weld, plus the lesser of 1-in. (25 mm) or t on each side of the weld. Alternatively, examination volume may be reduced to include the actual heat affected zone (HAZ) plus ¼-in. (6 mm) of base material beyond the HAZ on each side of the weld.

What indications on radiographs of welds characterized as imperfections are unacceptable?

Paragraph UW-51(b) states that the indications shown on radiograph of welds and characterized as imperfections are unacceptable under the following conditions:

1. Any indication characterized as a crack or zone of incomplete fusion or penetration;
2. Any other elongated indication which has length greater than
    a. ¼-in. (6 mm) for t up to ¾-in. (19 mm)
    b. (1/3)t for t from ¾-in. (19 mm) to 2¼-in. (57 mm)
    c. ¾-in. (19 mm) for t over 2¼-in. (57 mm)

    wheret is the thickness of the weld excluding any allowable reinforcement. For a butt-weld joining two members having different thicknesses at the weld, t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included in t;
3. Any group of aligned indications that have an aggregate length greater than t in a length of 12t, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group;
4. Rounded indications in excess of that specified by the acceptance standards.

How does spot radiography help in improving weld quality in a pressure vessel?

Spot radiography rules are considered to be an aid to quality control. Spot radiographs made directly after a welder or an operator has completed a unit of weld proves that the work is or is not being done in accordance with a satisfactory procedure. If the work is unsatisfactory, corrective steps can then be taken to improve the welding in the subsequent units, which unquestionably will improve the weld quality.

Spot radiography will not ensure a fabrication product of a predetermined quality level throughout. It must be realized that an accepted vessel under these spot radiography rules may still contain defects which might be disclosed on further examination. If all radiographically disclosed weld defects must be eliminated from a pressure vessel, then 100% radiography must be employed.

Can radiographs required at specific locations to satisfy the rules of other paragraphs in the ASME code be used to satisfy the requirements for spot radiography?

Paragraph UW-52(b)(4) states that radiographs required at specific locations to satisfy the rules of other paragraphs shall not be used to satisfy the requirements for spot radiography. Some examples of such rules are:

UW-9(d): Except when the longitudinal joints are radiographed 4-in. (100 mm) each side of each circumferential welded intersection, vessels made up of two or more courses shall have the centers of the welded longitudinal joints of adjacent courses staggered or separated by a distance of at least 5 times the thickness of the thicker plate.

UW-11(a)(5)(b): The following welded joint shall be examined radiographically for their full length – all category A and D butt welds in the shell and the heads of vessel where the design of the joint is based on a joint efficiency permitted by UW-12(a); in which case, category B and C butt welds [but not including those in nozzles and communicating chambers except as required in UW-11(a)(4)] which intersect the category A butt welds in the shell or heads of vessel or connect seamless shell or heads shall, as a minimum, meet the requirements for spot radiography.

UW-14(b): Single openings may be located in head-to-shell, or category B or C butt welded joints, provided the weld is radiographed for a length equal to three times the diameter of the opening with center of the hole at the mid-length.

What is the minimum extent of spot radiographic examination required by the ASME Code?

1. One spot shall be examined on each vessel for each 50-ft (15 m) increment of weld or fraction thereof.
2. For each increment of weld to be examined, a sufficient number of spot radiographs shall be taken to examine the welding of each welder or welding operator. Under conditions where two or more welders or welding operators make weld layers in a joint, or on the two sides of a double welded butt joint, one spot may represent the work of all welders or welding operators.
3. Each spot examination shall be made as soon as practicable after completion of the increment of weld to be examined. The location of the spot shall be chosen by the inspector.
4. Radiographs required at specific locations to satisfy rules of other paragraphs shall not be used to satisfy the requirements for spot radiography.

How are spot radiographs of butt-welds in a pressure vessel evaluated?

1. When a spot radiograph is found to be acceptable, the entire weld increment represented by this radiograph is acceptable.

2. When a spot has been examined, and the radiograph discloses welding which does not comply with minimum quality requirements, two additional spots shall be radiographically examined in the same weld increment at locations away from the original spot. The locational of these additional spots shall be determined by the inspector.
    a. If the two additional radiographs are found to be acceptable, the entire weld increment represented by the three radiographs is deemed acceptable provided the defects disclosed by the original spot are removed and the area repaired by welding. The weld repaired area shall be radiographically examined and found to be acceptable.
    b. If either of the two additional spots shows welding which does not comply with minimum quality requirements, the entire increment of weld represented shall be rejected. the entire rejected weld shall be removed and the joint shall be rewelded; or the entire increment shall be completely radiographed, and only defects need to be corrected.

References:

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1: Edition 2015

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COPING WITH STRESS AT WORK

Everyone who has ever held a job has, at some point, felt the pressure of work-related stress. Any job can have stressful elements, even if you love what you do. In the short-term, you may experience pressure to meet a deadline or to fulfill a challenging obligation. But when work stress becomes chronic, it can be overwhelming — and harmful to both physical and emotional health.

Unfortunately such long-term stress is all too common. In 2012, 65 percent of Americans cited work as a top source of stress, according to the American Psychological Association's (APA) annual Stress in America Survey. Only 37 percent of Americans surveyed said they were doing an excellent or very good job managing stress.

A 2013 survey by APA's Center for Organizational Excellence also found that job-related stress is a serious issue. More than one-third of working Americans reported experiencing chronic work stress and just 36 percent said their organizations provide sufficient resources to help them manage that stress.

You can't always avoid the tensions that occur on the job. Yet you can take steps to manage work-related stress.

COMMON SOURCES OF WORK STRESS

Certain factors tend to go hand-in-hand with work-related stress. Some common workplace stressors are:

- Low salaries.
- Excessive workloads.
- Few opportunities for growth or advancement.
- Work that isn't engaging or challenging.
- Lack of social support.
- Not having enough control over job-related decisions.
- Conflicting demands or unclear performance expectations.

EFFECTS OF UNCONTROLLED STRESS

Unfortunately, work-related stress doesn't just disappear when you head home for the day. When stress persists, it can take a toll on your health and well-being.

In the short term, a stressful work environment can contribute to problems such as headache, stomachache, sleep disturbances, short temper and difficulty concentrating. Chronic stress can result in anxiety, insomnia, high blood pressure and a weakened immune system. It can also contribute to health conditions such as depression, obesity and heart disease. Compounding the problem, people who experience excessive stress often deal with it in unhealthy ways such as overeating, eating unhealthy foods, smoking cigarettes or abusing drugs and alcohol.

TAKING STEPS TO MANAGE STRESS

- **Track your stressors**

  Keep a journal for a week or two to identify which situations create the most stress and how you respond to them. Record your thoughts, feelings and information about the environment, including the people and circumstances involved, the physical setting and how you reacted. Did you raise your voice? Get a snack from the vending machine? Go for a walk? Taking notes can help you find patterns among your stressors and your reactions to them.

- **Develop healthy responses.**

  Instead of attempting to fight stress with fast food or alcohol, do your best to make healthy choices when you feel the tension rise. Exercise is a great stress-buster. Yoga can be an excellent choice, but any form of physical activity is beneficial. Also make time for hobbies and favorite activities. Whether it's reading a novel, going to concerts or playing games with your family, make sure to set aside time for the things that bring you pleasure. Getting enough good-quality sleep is also important for effective stress management. Build healthy sleep habits by limiting your caffeine intake late in the day and minimizing stimulating activities, such as computer and television use, at night.

- **Establish boundaries.**

  In today's digital world, it's easy to feel pressure to be available 24 hours a day. Establish some work-life boundaries for yourself. That might mean making a rule not to check email from home in the evening, or not answering the phone during dinner. Although people have different preferences when it comes to how much they blend their work and home life, creating some clear boundaries between these realms can reduce the potential for work-life conflict and the stress that goes with it.

- **Take time to recharge.**

  To avoid the negative effects of chronic stress and burnout, we need time to replenish and return to our pre-stress level of functioning. This recovery process requires “switching off” from work by having periods of time when you are neither engaging in work-related activities, nor thinking about work. That's why it's critical that you disconnect from time to time, in a way that fits your needs and preferences. Don't let your vacation days go to waste. When possible, take time off to relax and unwind, so you come back to work feeling reinvigorated and ready to perform at your best. When you're not able to take time off, get a quick boost by turning off your smartphone and focusing your attention on non-work activities for a while.

- **Learn how to relax.**

  Techniques such as meditation, deep breathing exercises and mindfulness (a state in which you actively observe present experiences and thoughts without judging them) can help melt away stress. Start by taking a few minutes each day to focus on a simple activity like breathing, walking or enjoying a meal. The skill of being able to focus purposefully on a single activity without distraction will get stronger with practice and you'll find that you can apply it to many different aspects of your life.

- **Talk to your supervisor.**

  Healthy employees are typically more productive, so your boss has an incentive to create a work environment that promotes employee well-being. Start by having an open conversation with your supervisor. The purpose of this isn't to lay out a list of complaints, but rather to come up with an effective plan for managing the stressors you've identified, so you can perform at your best on the job. While some parts of the plan may be designed to help you improve your skills in areas such as time management, other elements might include identifying employer-sponsored wellness resources you can tap into, clarifying what's expected of you, getting necessary resources or support from colleagues, enriching your job to include more challenging or meaningful tasks, or making changes to your physical workspace to make it more comfortable and reduce strain.

- **Get some support.**

Accepting help from trusted friends and family members can improve your ability to manage stress. Your employer may also have stress management resources available through an employee assistance program (EAP), including online information, available counseling and referral to mental health professionals, if needed. If you continue to feel overwhelmed by work stress, you may want to talk to a psychologist, who can help you better manage stress and change unhealthy behavior.

References:

American Psychological Association

BUILDING A BETTER TOMMORROW

It is becoming less practical for many companies to maintain in-house engineering staff. That is where we come in – whenever you need us, either for one-time projects, or for recurring engineering services. We understand the codes and standards, and can offer a range of services related to pressure vessels, tanks and heat exchangers.

Training & Development
Engineering and Design Services

CoDesign Engineering

Pressure Vessels ● Heat Exchangers ● Tanks ● Piping

Petroleum ● Petrochemical ● Chemical ●Power ● Fertilizer