Pressure Vessel Newsletter

Volume 2015, January Issue

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From The Editor's Desk:

Welcome to 2015. To say that 2014 has been an interesting year is putting it very mildly. The crude oil began its descent in mid-2014 when it went below $100 per barrel and is now down in 40s. The last time crude oil took a similar dive was in mid-2008 and that was the period of meltdown of financial institutions in most of the western world. From everything we know so far, the two events were not related. Let us hope that time too the economy plays out independently of crude oil, notwithstanding some industry segments which will be badly hurt by falling crude.

The falling oil brings cheer to the oil consuming nations like Japan or the USwhile wreaking havoc on oil producing countries like Russia whose economy is facing a potential meltdown and Venezuela which is facing serious unrest. But why are the oil prices falling?

For much of the past decade, oil prices were high – bouncing around $100 per barrel since 2010 – because of soaring oil consumption in countries like China and conflicts in key oil producing nations like Iraq. Oil production couldn't keep up with demand, so prices spiked.But beneath the surface, many of the dynamics were rapidly shifting. High prices spurred companies in the US and Canada to start drilling for new hard-to-extract crude in North Dakota's shale formations and Alberta's oil sands. At the same time, demand for oil in places like Europe, Asia and the US began tapering off, thanks to weakening economies and new efficiency measures. On top of that countries like Iraq began producing more oil. By 2014, world oil supply was on track to rise much higher than actual demand. And in September, prices started falling sharply.

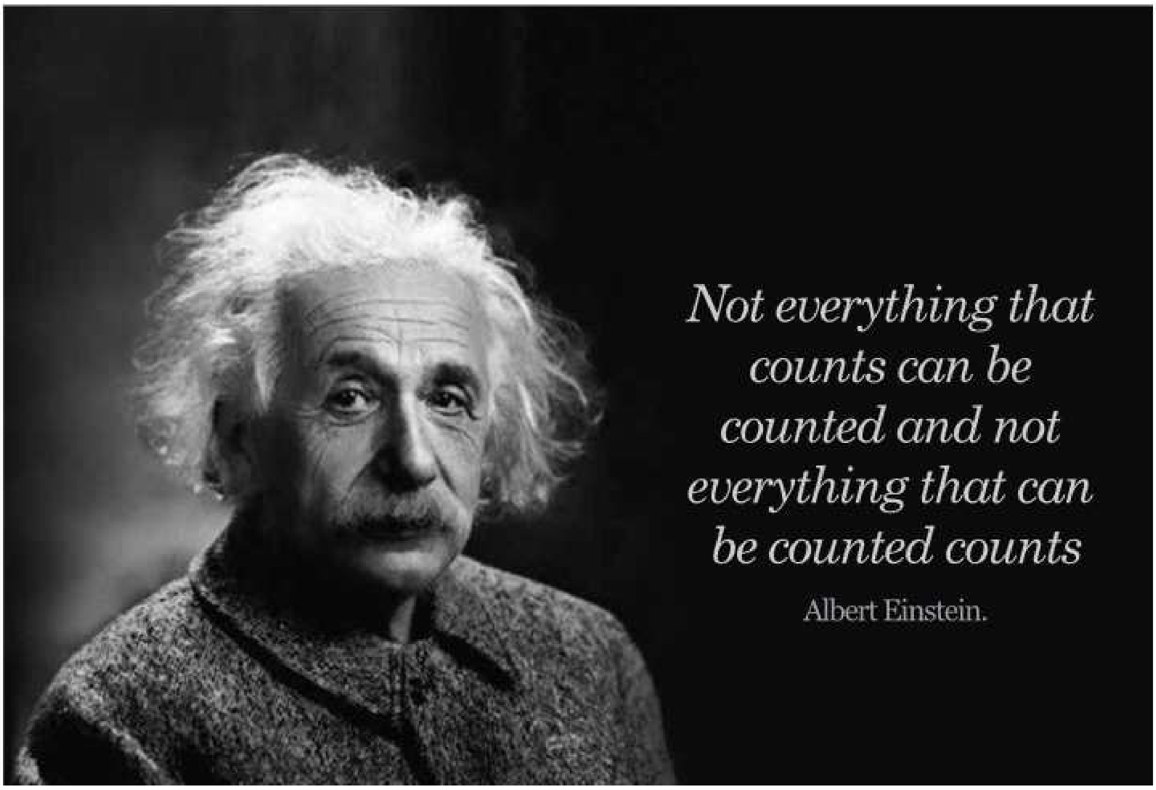
As prices slid, many observers waited to see whether OPEC would cut back on its production. At its big meeting in November, there was a lot of heated debate about how best to respond to the drop in oil prices. Some countries like Venezuela and Iraq wanted the cartel to cut back on production in order to prop up the price. ButSaudi Arabia was opposed to cutting production and didn't want to give up market share. It hoped that lower prices would help rein in US oil boom.

OPEC is now engaged in a "price war" with the US. What that means is that it's relatively cheap to pump oil out of places like Saudi Arabia and Kuwait. But it is more expensive to extract oil from shale formations in places like North Dakota. As the price of oil keeps falling, some US producers may become unprofitable and go out of business. And the price of oil will stabilize. At least that's what the OPEC countries hope.The catch is that no one quite knows how low prices need to go to rein in the US oil boom. Even at current prices, some US drillers may try to cut their costs, grit it out and try to keep drilling. That makes it very hard to predict where the global oil prices will bottom out.

What about the impact on Indian economy? The most visible impact has been about 17% reduction in the petrol and diesel prices at the pump. At the macro level, the benefit reflected by higher excise duties (the government raised excise duties on petroleum products in November) and lower subsidies in the 2016 budget would be about 0.8% of GDP according to some estimates. On the other hand, the dip is also because of global economic slowdown and that will hurt demand for Indian exports. On balance though, benefits of lower oil prices will outweigh the negatives.

[*Based on article by Brad Plumer in Vox on January 6, 2015*]

In this issue…



Math of real world seldom adds up due to intangible variables that cannot be easily captured. For final tally, we know we don't just have to win contracts, we must earn customer confidence too. Our main focus is customer delight achieved due to & through positive interactions, quality alertness, proactive involvement and personalized service for varying situations & requirements.

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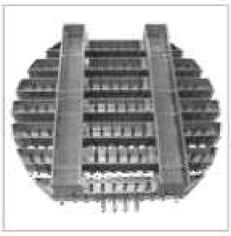
Random Packings



Tower Internals

Fractionation Trays

Structured Packings

Mist Eliminators

WHEN IS FULL RADIOGRAPHY REQUIRED IN ASME SECTION VIII, DIV. 1 PRESSURE VESSELS?

How well do know the requirements for full radiography in ASME VIII-1 pressure vessels? Take the quiz below to find out. The answers are provided at the end of article.

Question 1:

> The nominal thickness at the welded joint is the nominal thickness of the thicker of the two parts joined. True or False?

Question 2:

> A shell is made from stainless steel 410 material and the nominal thickness at the butt welded joint is 0.75”. Does the joint have to be fully radiographed?

Question 3:

> The butt welds in the shell and heads of vessels used to contain lethal substances are required to be fully radiographed. True or False?

Question 4:

> Can the radiography required for the closure seam of a pressure vessel be substituted with an ultrasonic examination?

Question 5:

> The design pressure in the shell of an unfired steam boiler is 25 psi and the nominal thickness at the welded joint is 1”. The shell is made from SA 516-70. Does the joint have to be fully radiographed?

Question 6:

> The longitudinal seam in the shell of a pressure vessel is fully radiographed. The circumferential seams are spot radiographed. Is it permissible to assume efficiency from UW-12(a) for the design of this shell? If yes, then what additional condition needs to be satisfied?

Question 7:

> A 12” diameter nozzle, 0.5” thick, is attached to a shell where full radiography is required. Does the Category A weld in the nozzle have to be fully radiographed?

Question 8:

> The nominal thickness at a butt welded joint in a shell is 1.75”. Does the joint need to be fully radiographed?

Question 9:

> A pressure vessel is built using layered construction satisfying the requirements of Part ULW. The inner shell of the layered shell section is 5/8” thick. Does the Category A joint in the inner shell have to be radiographed before the application of layers?

These requirements are from the Code paragraph UW-11(a).

Lethal Service [UW-11(a)(1)]

All butt welds in the shell and heads of vessels used to contain lethal substances must be fully radiographed.

Shell and Heads [UW-11(a)(2)

All butt welds in the shell and heads of vessels in which the nominal thickness at the welded joint exceeds 1½ in. (38 mm) must be fully radiographed. The nominal thickness at the welded joint under consideration is defined as the nominal thickness of the thinner of the two parts joined.

For some materials, the full radiography for butt welds is a must for lower nominal thicknesses at the welded joint than stated above. These requirements are listed below.

Carbon and Low Alloy Steels (UCS-57)

Table 1: Thickness Above Which Full Radiographic Examination of Butt Welded Joints is Mandatory

P-No. & Group No. Classification Of Material	Nominal Thickness Above Which Butt Welded Joints Shall be Fully Radiographed, in. (mm)
1 Gr. 1, 2, 3	1 ¼ (32)
3 Gr. 1, 2, 3	¾ (19)
4 Gr. 1, 2	5/8 (16)
5A Gr. 1, 2	0 (0)
5B Gr. 1	0 (0)
5C Gr. 1	0 (0)
15E Gr. 1	0 (0)
9A Gr. 1	5/8 (16)
9B Gr. 1	5/8 (16)
10A Gr. 1	¾ (19)
10B Gr. 1	5/8 (16)
10C Gr. 1	5/8 (16)
10D Gr. 1	¾ (19)

Nonferrous Materials (UNF-57)

For vessels constructed of titanium or zirconium and their alloys, all joints of Category A and B must be fully radiographed. For vessels constructed of nickel, cobalt and high nickel alloys, with the exception of UNS Nos. N02200, N02201, N04400, N04401 and N06600, must be examined radiographically for their full length when nominal thickness at the welded joint exceeds 3/8 in. (10 mm).

High Alloy Steel (UHA-33)

Butt-welded joints in vessels constructed of materials conforming to Type 405 welded with straight chromium electrodes, and to Types 410, 429 and 430 welded with any electrode must be fully radiographed in all thicknesses.

Material with Corrosion Resistant Integral Cladding, Weld Metal Overlay Cladding, or with Applied Lining (UCL 35 and 36)

The requirements provided in UCS-57 and UHT-57 (discussed later) must be satisfied. The radiographic examination shall be made after the joint, including the corrosion resistant layer, is complete. However, the radiographic examination may be made on the weld in the base material before the alloy cover weld is deposited, provided the following requirements are met:

1) The corrosion resistant alloy weld deposit is non-air-hardening.
2) The completed alloy weld deposit spot examined by any method that will detect cracks.
3) The thickness of the base material is used in determining the radiography requirement.

The alloy weld joints between the edges of adjacent chromium stainless steel cladding layers or linear sheets must be examined for cracks as follows:

a) Joints welded with straight chromium stainless steel filler metal shall be examined throughout their full length. The examination must be by radiographic methods when the chromium stainless steel welds are in continuous contact with the welds in the base metal. Liner welds that are attached to the base metal, but merely cross the seams in the base metal, may be examined by any method that will disclose surface cracks.
b) Joints welded with austenitic chromium-nickel steel filler metal or non-air-hardening nickel-chromium-iron filler metal shall be given a radiographic spot examination. For lined construction, at least one spot examination shall include a portion of the liner weld that contact weld metal in the base material.

Ferritic Steels with Tensile Properties Enhanced by Heat Treatment (UHT-57)

Radiographic examination for the complete length of weld is required for all welded joints of Type No. 1. The radiographic examination shall be made after any corrosion-resistant alloy cover weld has been deposited.

Nozzle attachment welds shown in Figure 1 (UHT-18.1) and Figure 2 (UHT-18.2) shall be fully radiographed. However, nozzles shown in Figure 2 having an inside diameter less than or equal to 2 in. (50 mm) shall be examined by magnetic particle or liquid penetrant method.

Layered Construction (ULW-51, 52(d), 54)

Category A and B joints in the inner shells of layered shell sections, and in the inner heads of layered heads before application of the layers, must be fully radiographed. However, such joints need not be radiographed in thicknesses over 7/8 in. (22 mm) if the completed joint is radiographed.

Category A joints in layers not welded to the previous surface must be examined before assembly for their full length by radiography.

Categories A, B and D joints attaching a solid section to a layered section of any of the layered thicknesses shall be fully radiographed.

Category A and B joints attaching a layered section to a layered section need not be radiographed after being fully welded when the Category A hemispherical head and Category B welded joints of the inner shell or inner head made after the application of layers have been fully radiographed.

Materials Having Higher Allowable Stresses at Low Temperatures(ULT-57)

All butt welds shall be fully radiographed.

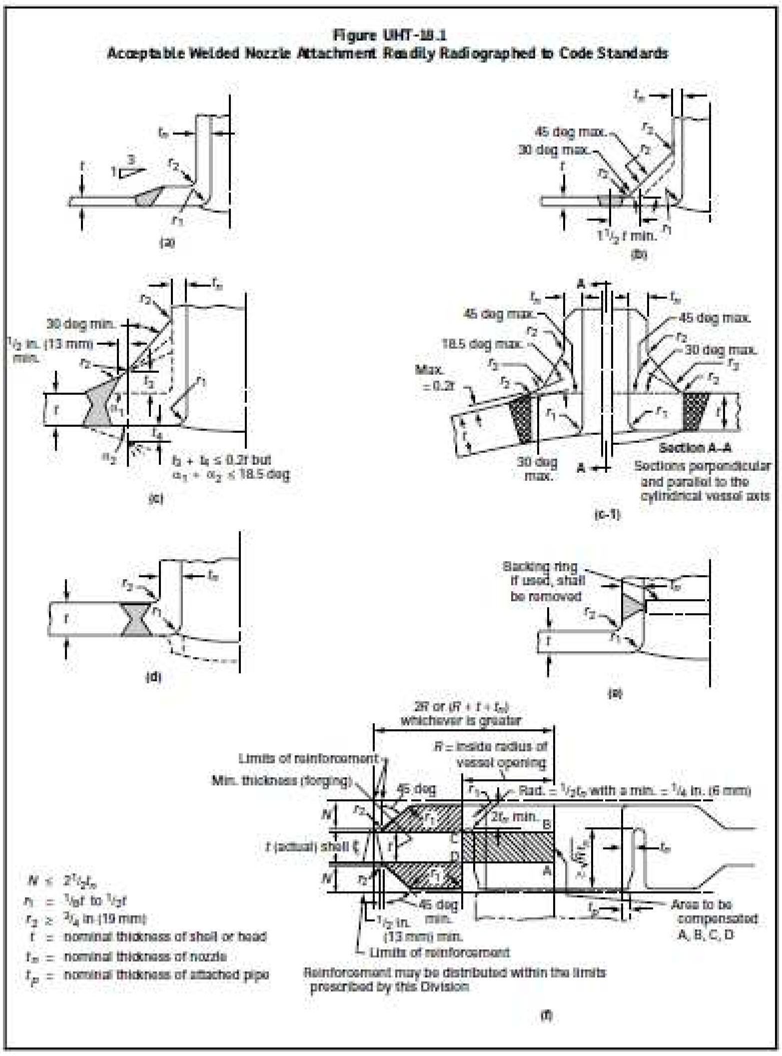


Figure 1: Acceptable Nozzle Attachment Readily Radiographed to Code Standards

Unfired Steam Boilers [UW-11(a)(3)]

When the design pressure in the shell and heads of unfired steam boilers exceed 50 psi (350 kPa) **or** the nominal thickness at the welded joint exceeds thickness for which full radiography is mandatory (as discussed above), all butt welds must be fully radiographed.

Nozzles [UW-11(a)(4)]

All butt welds in nozzles with nominal thickness at the welded joint that exceed thickness for which full radiography is mandatory, **or** are attached to shell or heads where full radiography of butt welds is mandatory, must be fully radiographed. However, except for the materials addressed by UHT-57, Categories B and C butt welds in nozzles that neither exceed NPS 10 (DN 250) nor 1 1/8 in. (29 mm) wall thickness do not require any radiographic examination.

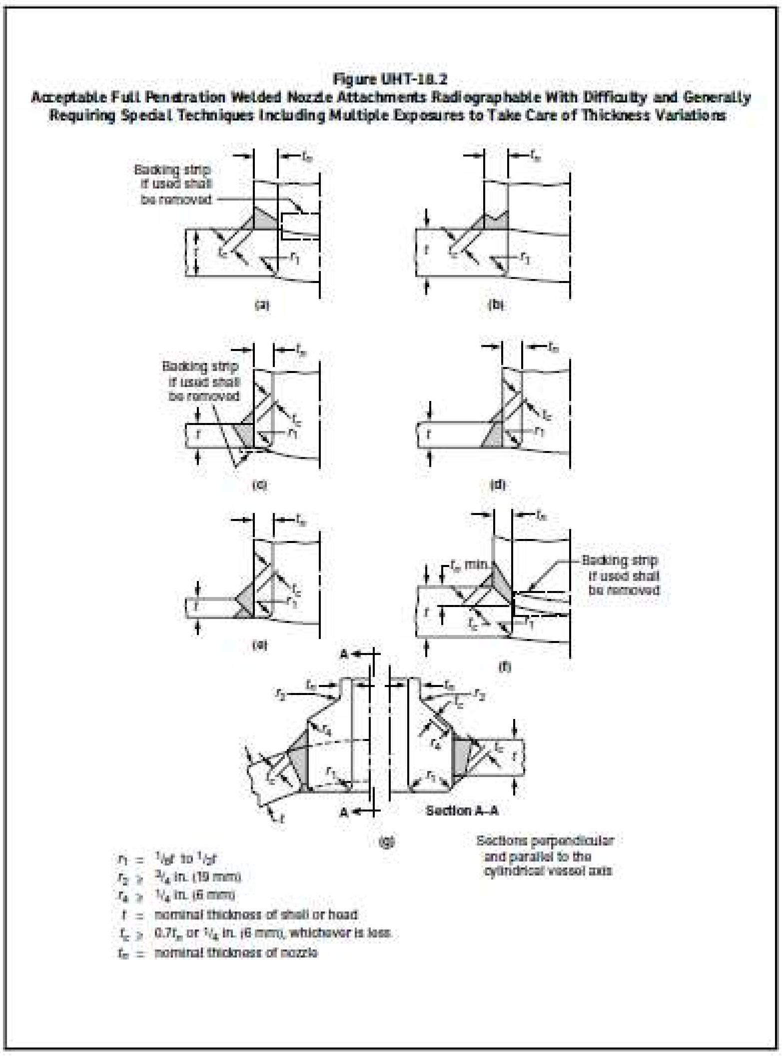


Figure 2: Acceptable Full penetration Welded Nozzles not Easily Radiographable

UW-11(a)(5)

When the design is based on joint efficiency permitted by full radiography in UW-12(a), all A and D butt welds in shell and heads must be fully radiographed. Additionally:

> UW-11(a)(5)(a) – Category A and B welds connecting shell or heads shall be Type No. 1 or 2.
>
> UW-11(a)(5)(b) – Category B or C butt welds (but not including those in nozzles addressed in UW-11(a)(4) above) which intersect the Category A butt welds in the shell or heads, or connect seamless vessel shell or heads, as a minimum, be spot radiographed. These spot radiographs shall not be used to satisfy the spot radiography rules as applied to any other weld increment.

Electrogas and Electroslag Welding [UW-11(a)(6)]

All butt welds joined by electrogas welding with any single pass greater than 1½ in. (38 mm), and all butt welds joined by electroslag welding shall be fully radiographed.

Ultrasonic Examination [UW-11(a)(7)]

UT may be substituted for radiography for the final closure seam of a pressure vessel if the construction of vessel does not permit interpretable radiographs.

Answer Key for the Quiz:

Question 1: False

Question 2: Yes

Question 3: True

Question 4: Yes

Question 5: No

Question 6: Yes. The spot radiographs on the circumferential seams for this weld increment shall not be used to satisfy the spo radiography rules as applied to any other weld increment.

Question 7: Yes

Question 8: Yes

Question 9: Yes

Evaluation Yardstick:

7 to 9 correct answers: Congratulations!! You can give yourself a pat on the back. You know your welding requirements well.

4 to 6 correct answers: You are the familiar with the basic welding requirements of the Code

1 to 3 correct answers: Reading the UW requirements of the Code is highly recommended.

Source: ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1 – 2013 Edition

TRAINING ANNOUNCEMENT

DESIGN & FABRICATION OF PRESSURE VESSELS: ASME SECTION VIII, DIVISION 1

Pressure vessels, along with tanks, are the workhorses for storage and processing applications in the chemical, petroleum, petrochemical, power, pharmaceutical, food and paper industries. ASME BPV, Section VIII, Div. 1 Code is used as a standard for the design and fabrication of pressure vessels by most companies across the world.

Wewould like to announce a one (1) day pressure vessel workshop on **January 31, 2014** at Vadodara. This course provides the information that will help you understand the ASME requirements for the design and fabrication of pressure vessels. The course material follows the contents of 2013 edition of the code, and is replete with worked examples covering important aspects of pressure vessel construction. The course is more than just a glimpse into the Code, it is packed with lots of information that includes several solved examples as well.

The contents of the training course will be as follows:

- Organization of ASME Boiler and Pressure Vessel Code
- Allowable Stresses
- Low Temperature Operation
- Welding Requirements
- Pressure Vessel Design – Shells and Heads
- Openings and Reinforcements
- Pressure Testing
- Markings and Reports
- Introduction to ASME Section VIII, Division 2
- Code Case 2695

The instructor, Ramesh Tiwari, is internationally recognized specialist in the area of pressure vessels, heat exchangers, materials, and codes and standards. He holds Bachelor's and Master's degrees in mechanical engineering from universities in India and United States. He is also a registered Professional Engineer in the State of Maryland in the United States. Mr. Tiwari is a member of ASME Boiler & Pressure Vessel, Section VIII Subgroup on Heat Transfer Equipment, and a member of ASME International Working Group on B31.1 for Power Piping in India. In this capacity, he has made invaluable contribution in resolving technical issues in compliance with the ASME codes for Code users. Mr. Tiwari has over 24 years of design engineering experience on a variety of projects spanning industries such as oil & gas, power, nuclear, chemical, petrochemical, pharmaceutical, food etc. He has provided engineering advice and code interpretations to senior management and guidance to several companies he has worked for in the US, India and Germany. He has initiated and implemented numerous innovative ideas to improve working process and quality, and developed and conducted training programs for peers as well as clients. Mr. Tiwari is an approved pressure vessel instructor at NTPC, a premier thermal power generating company in India and at several other companies, both public and private.

Registration fee for the training course is Rs. 6,500 for professionals and Rs 4,500 for students (inclusive of all applicable taxes). Registration fee includes training, a collection of articles on design and fabrication of pressurevessels, electronic copy of the presentation, certificate from CoDesign Engineering, and beverages and lunch on all days. It excludes travel to and from Vadodara, accommodation, and meals and beverages other than those provided during the course. We invite you to make nominations.

In case of any queries, including the registration process, please email at learning@codesignengg.com, or call at +91 98109 33550.

CREEP IN PRESSURE VESSELS

Many pressure vessels are subjected simultaneously to the action of stress and high temperature. This continual increase in the temperature of operation has placed great practical importance on the strength of material at elevated temperatures, and development of materials to cope with this trend.

In general, the strength properties (yield point and ultimate strength) decrease with high temperature while the ductile properties (elongation and reduction in area) increase. The tensile diagrams for a medium carbon steel vessel for very high temperatures are shown in Figure 1. At these temperatures, the ultimate strength falls rapidly, the yield point becomes less pronounced, and above 1100^{O}F loses its characteristics, and the modulus of elasticity represented by the slope of the straight portion of the curve likewise decreases.

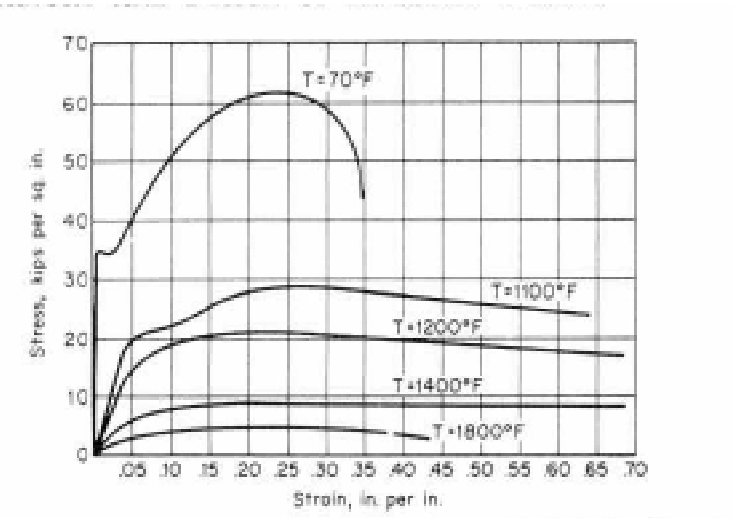


Figure 1: Effect of Temperature on Stress-Strain Relationship of Mild Carbon Steel

Creep may be defined as a time-dependent deformation at elevated temperature and constant stress. It follows, then, that a failure from such a condition is referred to as a creep failure or, occasionally, a stress rupture. The temperature at which creep begins depends on the alloy composition. For the common materials used in superheater and reheater construction of a boiler, Table 1 gives the approximate temperatures for the onset of creep. It should be pointed out that the actual operating stress will, in part, dictate or determine the temperature at which creep begins.

Table 1: Initial Creep Temperatures

Carbon Steel	800^{O}F
Carbon + ½% Molybdenum	850^{O}F
Carbon + 1¼% Chromium + ½% Molybdenum	950^{O}F
Carbon + 2¼% Chromium + 1% Molybdenum	1000^{O}F
Stainless Steel	1050^{O}F

Creep properties are obtained by subjecting tensile specimens to a constant load at a constant temperature and observing the axial strains at selected time intervals. From this data, a series of constant stress creep-strain curves may be plotted as shown in Figure 2.

Creep curves for metals exhibit three characteristic behavior regions. In Figure 3, *OA* is the instantaneous deformation that occurs immediately upon application of the load and may contain both elastic and plastic deformation. The portion *AB* is the primary stage in which the creep is changing at a decreasing rate as a result of strain hardening. The deformation is mainly plastic. The portion *BC* is the secondary steady state stage in which the deformation is plastic. In this stage, the creep rate reaches a minimum and remains constant as the effect of strain hardening is counterbalanced by an annealing influence. Here the creep rate is a function of stress level and temperature. The portion *CD* is the tertiary stage in which the creep continues to increase and is also accompanied by a reduction in cross-sectional area and the onset of necking; thereby resulting in failure.

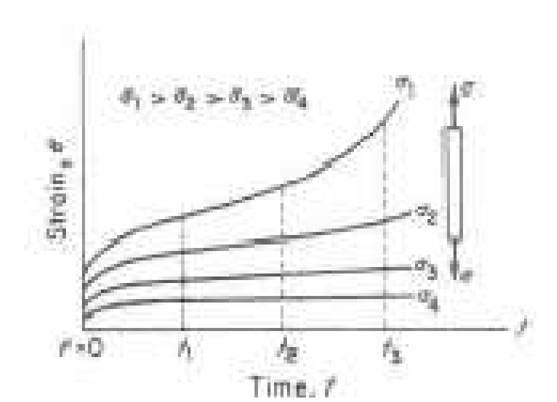


Figure 2: Constant Stress, Creep-Time Curves

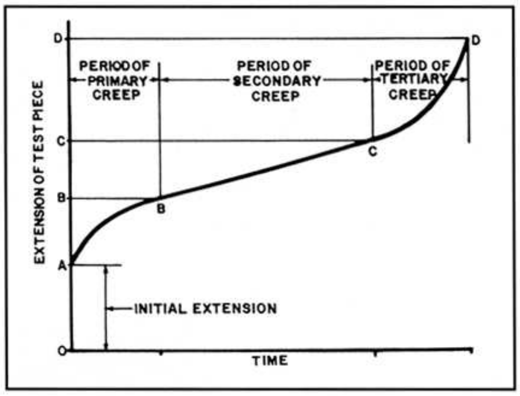


Figure 3: Schematic Creep Curve

How does ASME code account for creep phenomenon?

At temperatures in the range where creep and stress rupture govern the selection of stress, the maximum allowable stress value for all materials is established not to exceed the lowest of the following:

1. 100% of the average stress to produce a creep rate of 0.01%/1000 hr.
2. 100 F_{avg}% of the average stress to cause rupture at the end of 100,000 hr.
3. 80% of the minimum stress to cause rupture at the end of 100,000 hr.

F_{avg} is a multiplier to average stress for rupture in 100,000 hr. For 1500^{O}F and below, $F_{avg} = 0.67$. Above 1500^{O}F, it is determined from the slope of the log time-to-rupture versus log stress plot at 100,000 hr such that $\log F_{avg} = 1/n$, but it may not exceed 0.67. n is a negative number equal to Δ log time-to-rupture divided by Δ log stress at 100,000 hr.

Chromium, molybdenum, and nickel are major alloying elements for high-temperature service metals. In using creep data, the designer must establish the expected service life and corresponding amount of permissible permanent deformation; and accordingly, choose the stress that satisfies these conditions. As an example, the structures that involve closely fitting moving parts, such as turbines, are designed for a low value of permissible creep; whereas vessels, heat exchangers tubes, etc., are designed for a higher creep since small deformations do not influence their operations.

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

ASME Boiler and Pressure Vessel Code, Section II, Part D

NEWS AND EVENTS

Government to Auction 69 Small, Marginal Oil Fields

January 13, 2015 | New Delhi

The government plans to auction 69 small and marginal oil and gas fields to private firms on a new revenue share model. Sixty three of these fields are being surrendered by ONGC, and additional six fields have been surrendered by Oil India. These were found to be uneconomical for large firms with huge overheads to develop or bring to production. Smaller firms with a fraction of operating cost can develop them much at faster and economical rate. Under the revenue sharing model, the bidders will have to upfront state how much oil and gas they will share with the government. The firm offering maximum will win the right to explore and produce from the field.

Jacobs to Upgrade BP's PTA Units in Geel, Belgium

January 7, 2015 |

Jacobs Engineering Group announced today that it received a contract from BP Chembel N.V. for basic and detailed engineering services to upgrade its facilities in Geel, Belgium. Under the terms of the contract, Jacobs is installing new equipment and performing upgrades in the facility’s PTA units. BP’s Geel site is a major producer of purified terephthalic acid and paraxylene, typically used in the manufacture of polyesters. The goal of this project is to optimize operational performance of the BP Geel facilities.

OxyChem and Mexichem Start Construction of Their JV Ethylene Cracker:

December 18, 2014 |

Ingleside Ethylene, LLC, the 50/50 joint venture between Occidental Chemical Corporation (OxyChem) and Mexichem, S.A.B. de C.V., today announced that construction of its ethylene cracker at OxyChem’s Ingleside, Texas, complex is underway and the project remains on schedule to become commercially operational in the first quarter of 2017. Construction of the cracker began in the second quarter of 2014. When completed it will have the capacity to produce 1.2 billion pounds (550,000 cubic meters) of ethylene per year and provide OxyChem with an ongoing source of ethylene for manufacturing vinyl chloride monomer (VCM), which Mexichem will use to produce polyvinyl chloride (PVC resin) and PVC piping systems. The project will create approximately 1,700 jobs at peak construction and generate more than 150 permanent jobs. OxyChem will operate the cracker upon completion.

2015 Pressure Vessels & Piping Conference

July 19-23, 2015 | Boston

The ASME 2015 PVP Conference promises to be the outstanding international technical forum for participants to further their knowledge-base by being exposed to diverse topics, and exchange opinions and ideas both from industry and academia in a variety of topics related to Pressure Vessel and Piping technologies for the Power and Process Industries. PVP is looking forward to fruitful technical exchanges with participants from Europe, Africa, the Middle East, Asia, the Americas, and the Oceania islands.

Deep Offshore Technology International

October 13-15, 2015 | Houston

Deep Offshore Technology (DOT) International has been showcasing pioneering technology that has been shaping the future of the deep and ultra-deepwater industry. DOT showcases the most innovative technologies in the deepwater oil and gas industry, and provides a forum to discuss the specific challenges associated with hostile and ultra deepwater environments.

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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 for pressure vessels, and can offer a range of services related to them.

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