

The Topog-E Gasket Company

Technical Specification and Usage Guide

GASKETS

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The requirements of a superior boiler gasket

THE STEAM BOILER ENVIRONMENT MAKES EXTREME DEMANDS ON GASKETS; A TOPOG-E® RUBBER GASKET IS SPECIFICALLY FORMULATED TO MEET THEM AND DELIVER INDUSTRY STANDARD PERFORMANCE.

Topog-E® rubber gaskets have been refined through a series of over 600 research formulation tests, to ensure that they are able to meet the exacting performance standards of steam boilers. A superior boiler gasket must:

- Conform to the topography of the mating surfaces
- Withstand the boiler's full, continuous, and sometimes fluctuating operating pressure.
- Withstand continuous exposure to appropriate boiler treatment chemicals.
- Withstand continuous exposure to ion and oxygen attack in the hot air outside the boiler shell.
- Stop all leakage.
- Replace easily without any chiselling or buffing.

A properly installed Topog-E® gasket meets, and exceeds, all these requirements. The Topog-E Gasket Company continues to research all the factors that affect gaskets – including cure characteristics, tensile and tear strength, accelerated ageing, modulus, compression set and stress relaxation – to ensure that we continue to remain at the forefront of technological advances.

Expected service life in steam boiler application

When used on steam pressure vessels, Topog-E® gaskets are typically used at operating pressures of up to 180 PSI (12 bar) and 380° F (193° C) for an average service life of twelve months. This level does not represent an absolute upper service limit for Topog-E® gaskets; rather it represents the approximate highest and continuous pressure level at which one can expect to obtain an average service life of twelve months from properly installed Topog-E® gaskets.

Because there are many factors – some of which are application specific- that can affect the service life of a Topog-E® gasket, it is impossible to develop a precise, accurate table of expected service life versus operating pressure / temperature. However, it is important to remember that the action which causes Topog-E® gaskets to degrade over time is primarily a chemical reaction with the oxygen in the atmosphere. Increasing the temperature accelerates this reaction, and thus the higher the operating temperature of the boiler, the shorter the service life obtained.

The following table was prepared, based on actual customer use and extensive testing, to be used as a general guide for estimating approximate service life for properly installed Topog-E® gaskets in steam pressure vessels:

<i>Continuous Operating Steam Pressure in PSI (bar)</i>	<i>Approximate Maximum Service Life in Months⁽¹⁾</i>
Below 25 (2)	18-24
25-100 (2-7)	12-18
100-180 (7-12)	12-15
180-200 (12-14)	10-12
200-225 (14-16)	8-10
225-250 (16-17)	6-8

The Topog-E Gasket Company invests heavily in research and development efforts to insure that Topog-E® gaskets live up to their worldwide reputation for quality, durability, and ease of use. Topog-E® gaskets are tested in-house at steam pressures and temperatures far exceeding the 180 PSI (12 bar) and 380° F (193° C) levels below which most Topog-E® gaskets are used in steam applications. Carefully installed and monitored Topog-E® gaskets are routinely subjected for extended periods of time to steam pressures and temperatures of up to 360 PSI (25 bar) and 438° F (226° C). However, we do not actively recommend service in boilers at these elevated levels because we have no control over how our gaskets are installed and because there are always unique application specific factors that can affect both the installation and service life obtained with Topog-E® gaskets.

Remember that the best way to maximize the service life of a Topog-E® gasket is to follow closely the installation instructions provided with the gaskets.

Finally, regardless of operating pressure, we recommend that Topog-E® gaskets be changed out at least every twelve months, in conjunction with a regularly scheduled equipment shutdown and inspection.

(1) These figures are based on general customer experience, and do not represent any guarantee of service life for Topog-E® gaskets. Actual service life obtained may vary.

Maximizing service life of Topog-E® gaskets in steam boilers

WHEN INSTALLING

The Topog-E® gasket is designed to offer specific and aggressive resistance to the hostile atmosphere of live steam and to demonstrate minimum deflection under load. We recommend a limit of 180 PSI steam (12 bar) and 380° F. (193° C.) in steam boiler applications. This is not stated as a maximum upper limit, but since we have no control over the mounting of the gaskets in the field, it is a statement of reasonable expectation of service capability. The following precautions, if observed, can help maximize the service life of Topog-E® gaskets.

- The curvature of the cover plate should match the curvature of the boiler shell.
- Observe good housekeeping; let clean metal surfaces bear on the gasket at all times. Be sure that no encrusted matter or residual pieces of another gasket material are on the boiler shell or plate.
- We do not recommend the use of sealants, adhesives, or anti-seize compounds with Topog-E® gaskets. Our own tests and field experience suggest that these materials, especially when used in large amounts can lead to premature failure of the gasket for at least three reasons:
 - Uncured portions of this material can act as a lubricant rather than an adhesive (esp. RTV silicone), thereby making it more difficult to get the gasket properly aligned and seated. It

HELPFUL HINT

It is essential to always replace with a fresh gasket if a seal is ever broken. Remember, the cost of an unplanned boiler shutdown is far greater than the cost to install a fresh set of Topog-E® gaskets!

also increases the chance that the gasket may slide or extrude out after installation due to a lack of friction.

– Cured portions, if spread on too thickly and/or unevenly, can make it more difficult for the gasket and internal pressure to effect a proper seal in the normal manner.

– Adding another material with a different chemical compatibility profile than the gasket can lead to problems depending on the exposure media.

- Machine the crabs to a true 90° from the vertical axis so that an absolutely balanced stress acts on the gasket.
- Press the gasket into firm contact with the cover plate, and the bolt gasket, if used, into firm contact with the bolt head.
- Center the gasketed cover plate exactly on the opening, then apply the crab. Tighten only enough to hold the assembly in place.
- Start making steam. As the gasket heats, stress relaxation occurs and leakage will occur. At this stage tighten only sufficiently to stop serious leakage and ignore hissing. Follow this procedure in gentle stages until the internal pressure itself causes the seal.
- Keep the crab snug. In the event of shutdown, inverse pressure will displace a loose cover plate, violating the seal. Once an escape path has been established for the steam or water, it can be difficult to reestablish a seal with complete integrity. This can also have the effect of exposing larger localized areas of the gasket to the atmosphere (in similar fashion as would reinstalling a used gasket).

HELPFUL HINT

Misaligned plates often occur in bottom inspection openings where it is hard to see if they are aligned. Using an inspection mirror helps determine proper alignment, and ensures equal pressure distribution over the gasket.

- Minimize as much as possible the amount of outside air that reaches the annulus of rubber that is exposed and subject to oxidation. Properly centering the cover plate will help significantly in protecting this vulnerable area of the gasket. Sometimes the design and age of the plate and opening can have an effect on this level of exposure. Badly worn or pitted areas on the shell or plate can allow increased exposure of the gasket to the atmosphere.
- Never overtighten!! A properly mounted gasket is held in place by internal pressure, and is secured from shifting by the crab. In this manner, the rubber never witnesses greater pressure than steam pressure, and thus its elastic memory will not be exceeded.

OTHER FACTORS

- **ALWAYS FOLLOW THE ADVICE OF A QUALIFIED WATER TREATMENT SPECIALIST.** The proper use of boiler water and steam line treatment formulations is essential for efficient boiler operation. Over many years we have analyzed the chemicals that are used on a regular basis in treatment formulations. Data compiled from solubility parameters, chemical resistance data, suppliers' guidelines, customer feedback, and input from treatment specialists, suggest that there should not be a noticeable effect on the service life of a properly installed Topog-E® gasket from the normal use of these water and steam line treatments when used in accordance with treatment specialists' guidelines. Boiler operators should always seek and follow the recommendations of a reputable water treatment specialist, as doing so increases system efficiency, prolongs the life of expensive equipment, and minimizes the potential for

chemical compatibility problems with various system components (e.g. gaskets).

- **NEVER RE-USE A GASKET!!** Some Topog-E® gaskets are removed at the end of a year's service looking as if they are capable of completing another year's work. We do not recommend re-use under ANY circumstances, as it can result in expensive boiler failure and shut-down during the subsequent year. There is some evidence that suggests that if an inspection plate is opened – or in some way the seal is broken – after several months of service, and then reinstalled and tightened with the same gasket, it is possible that a proper seal is never recaptured because of the permanent “set” or impressions made in the gasket after several months' service. This could lead to an increased rate of degradation at specific points, resulting in an abbreviated service life.
- **HOT SPOTS:** Some gaskets are located close to hot flue gases containing the products of combustion from the boiler. The higher temperature makes oxygen more active, and the products of combustion contain more ozone. These “hot spots” can cause these gaskets to age quicker and typically look worse than their companion gaskets upon removal.

HELPFUL HINT

A sheet-metal baffle plate can sometimes reduce the heat and flow of gases to the area around the gasket.

Stress relaxation & manual over-tightening during installation

STRESS RELAXATION IS A VISCO-ELASTIC RESPONSE OF AN ELASTOMER WHEN COMPRESSED WHILE IN SERVICE. THIS RELAXATION IS PROMOTED BY SUCH STRESSES AS HEAT, COMPRESSION, ELONGATION, AND SHEAR.

If this relaxation proceeds at a measured pace, very little impairment is caused to the physical properties profile of the gasket. When a combination of stresses, one of which is heat, is visited on rubber, relaxation is specific with this heat. The compressive stress must be coordinated with heat relaxation, but if applied at a rapid rate and maintained (i.e. by prematurely over-tightening), irreversible damage is caused to the gasket, and a shortened service life can be expected. Remember, manual over-tightening (especially when applied all at once in the cold state) can sometimes subject the Topog-E® gasket to a shearing force which can slice through the gasket and substantially weaken it, thereby impairing its inherent resistance to the force of internal pressure. In addition, the rate at which rubber is attacked by the hot, dry, oxygen-laden air from outside the boiler increases as the amount of stress (compression) increases. Consequently, even though over-tightening doesn't always cause a gasket to fail due to shearing force, it can cause the gasket to age quicker so that it appears in a much worse state upon removal (e.g. more brittle, cracks, etc.). Topog-E® gaskets can normally take a good deal of abuse and still perform satisfactorily. However, when over-tightening is combined with, or is a result of, misalignment of gasket and/or plate, the chance of premature failure can sometimes increase dramatically. This situation – where tightening is applied unevenly – can often create abnormally high

and severely concentrated pressure points that can, in combination with moderate over-tightening and internal pressure, lead to a gasket's rupture. In fact, when a gasket is not properly seated or the plate is not properly aligned, it is possible that the position of the gasket actually makes additional tightening necessary in order to stop the seepage caused by the inability of internal pressure to make a seal in the usual manner.

The environment of steam pressure vessels

EVEN UNDER IDEAL CONDITIONS, TOPOG-E® GASKETS WILL DETERIORATE OVER TIME.

The three principal factors that cause this natural degradation in elastomeric material, oxygen, stress, and heat, are interdependent and synergistic (i.e. working in concert these factors create a more hostile environment than they do when acting independently of each other).

1. Atmospheric oxygen is the cardinal agent of harm to the rubber gasket in service, and its effect increases significantly in the presence of the other two elements.
2. Stress is the compressive effect - the reduction in thickness brought about by the steam pressure of the boiler.
3. Heat and steam pressure are gradients of each other in an exponential relationship. As a generalization, it may be stated that the speed of a reaction doubles for each 18°F. (10° C) rise in temperature. Refer to the Topog-E® Steam Temperature Calculator to calculate specific temperatures and pressures (we will be happy to send you one upon request).

Topog-E® proprietary gasket material has specific and aggressive resistance to the hostile environment of live steam. If very low oxygen content is present in the steam, trouble rarely arises inside the boiler with a properly mounted Topog-E® gasket. The real test is outside the boiler where a thin periphery of the gasket is exposed to the atmosphere that contains 21% oxygen. This component is highly corrosive to rubber, an effect which increases with heat, pressure, and the amount of gasket surface area directly exposed to the outside atmosphere.

The situation is further complicated by the fact that rubber under stress degrades more rapidly than rubber that is not. Unperturbed, survival of a rubber component is measured in years, while under stress, it is most often measured in terms of months. This is why it is important to follow the installation instructions and the precautions listed in the section: Maximizing Service Life in order to insure that the optimal service life of Topog-E® gaskets is achieved.

A system like the one used in Topog-E® gaskets can seal effectively for periods averaging one year in a steam pressure vessel, even though the outer surface of the gasket will gradually crack and degrade under the unremitting and combined attack of oxygen, stress, and heat. The 180 P.S.I. (12 bar) level does not represent an absolute upper service limit for Topog-E® gaskets; rather it represents the approximate highest and continuous pressure level at which one can expect to obtain an average service life of twelve months from properly installed Topog-E® gaskets. Customers have reported using Topog-E® gaskets successfully in steam pressure vessels operating at pressures moderately higher than 180 P.S.I. (e.g. 200-250 P.S.I. / 14-17 bar), and it is important to note that doing so is not imprudent or inherently unsafe, especially if the Topog-E® gaskets are carefully

installed. However, it must be remembered that the higher the steam pressure and corresponding temperature, the shorter the expected service life of the gasket becomes.

The Topog-E Gasket Company invests heavily in research and development efforts to insure that Topog-E® gaskets live up to their worldwide reputation for quality, durability, and ease of use. Topog-E® gaskets are tested in-house at steam pressures and temperatures far exceeding the 180 PSI (12 bar) and 380° F (193° C), levels below which most Topog-E® gaskets are used in steam applications.

Material Specification Sheet – Molded Gaskets and Sheet Material (Standard Material)

MATERIAL DESCRIPTION: SPECIAL, PROPRIETARY RUBBER COMPOSITION, BLACK, 80-85 DUROMETER.

When used on steam pressure vessels, Topog-E® gaskets are typically used at operating pressures of up to 180 PSI (12 bar) and saturated steam temperatures up to 380° F. (193° C.) for an average service life of one year. When used in other applications (e.g. condensate, water, and air vessels), Topog-E® gaskets are sometimes used at pressures above 200 PSI (14 bar) where temperatures are typically more moderate (e.g. below 250° F./121° C.). When operating under less severe conditions (e.g. water applications at ambient temperatures) Topog-E® gaskets can provide very long service lives.

Topog-E® gaskets have been used successfully around the world for over forty years. In general, any type of industrial pressure vessel or tank that has inspection openings is a potential application where Topog-E® gaskets can be used as a cost effective sealing device. In addition to using them in steam pressure vessels, customers also use Topog-E® molded gaskets and sheet material with great success in many other applications, including: water softeners, hot water heaters, steam humidifiers and cookers, water purifiers and demineralizers, refrigeration units, liquid treatment vessels, carbon absorption and filtering vessels, dryer cans in paper mills, water hydrants, various types of mixing tanks, compressed air tanks, various types of dryers, air starters and receivers, hatch covers on railroad tank cars and river barges, water towers and columns, PVC reactor vessels, and in applications where excellent low-temperature sealing properties are required.

Topog-E® gaskets are specifically formulated to have excellent resistance to steam and hot and cold water. They also have good resistance to alcohols, ketones, phosphate esters, silicone oils and greases, dilute acids, bases, salts, glycols, ammonia, selected refrigerants, and animal and vegetable fats. Water treatment chemicals, when used in accordance with supplier's guidelines, should not have a significant effect on the service life of properly installed Topog-E® gaskets. In general, Topog-E® gaskets are not recommended for use in applications where they see direct exposure to high concentrations of aromatic hydrocarbons, chlorinated solvents, or petroleum based oils, fuels, and lubricants.

Topog-E Gasket Company, which formulates and mixes its own rubber, invests heavily in research and development efforts to insure that Topog-E® gaskets live up to their worldwide reputation for quality, durability, and ease of use. Topog-E® gaskets are tested in-house at steam pressures and temperatures far exceeding the 180 psi and 380° F, levels below which most Topog-E® gaskets are used in steam applications. Carefully installed and monitored Topog-E® gaskets are routinely subjected for extended periods of time to steam pressures and temperatures of up to 360 PSI (26 bar) and 438°F (226° C).

Because there are many application specific factors that can affect service life, it is always advisable to first test Topog-E® gaskets in a particular application to determine their ultimate suitability. Please contact your distributor or Topog-E® Gasket Company if you have questions regarding a specific application. If you have never used Topog-E® gaskets, we would be happy to provide you with the name of a Topog-E® gasket distributor in your area and a sample gasket for your evaluation.

Material specification sheet – Special Food Grade (SFG)

MATERIAL DESCRIPTION: SPECIAL PROPRIETARY RUBBER
COMPOSITION, BLACK, 70-75 DUROMETER

Topog-E® SFG gaskets are typically used in low pressure food processing applications such as steam cookers, sterilizers, carbon absorption vessels, and various food and beverage mixing vessels and processing columns that have inspection openings which must be sealed using a food grade gasketing material certified to US FDA regulations. Topog-E® SFG gaskets are made from a compound that complies with the FDA Code of Federal Regulations for rubber and rubber-like materials under Title 21, Paragraph 177.2600.

Most SFG gaskets are used in applications with operating pressures below 100 PSI (7 bar) and temperatures below 300°F (149° C).

Topog-E® SFG gaskets have excellent resistance to steam and hot and cold water. They also have good compatibility with a range of food and beverage substances, including animal and vegetable fats, whisky, alcohols, and corn syrup. Because there are many application specific factors that can affect service life, it is always advisable to first test Topog-E® SFG gaskets in a particular application to determine their ultimate suitability. Please contact your distributor or Topog-E® gasket Company if you have questions regarding the chemical compatibility of Topog-E® SFG gaskets with a particular food or beverage substance.

Material specification for alternative elastomeric materials

Here are some other elastomeric materials that Topog-E Gaskets can be made from:

Topog-E® Special Oil-Resistant Material (SOR):	75-80 durometer, black. Good solvent, oil, and hydraulic fluid resistance. Temp. to 250°F. (121°C.)
Topog-E® Fluoroelastomer Material (FKM):	70-80 durometer, black (e.g. Viton®). Heat resistance to over 400°F (204°C.), good resistance to wide range of oils and solvents, esp. aliphatic, aromatic, and halogenated hydrocarbons and acids.
Topog-E® Special Food Grade Material (SFG):	70-75 durometer, black. Special material that complies with applicable FDA regulations for selected food applications.
Topog-E® ANSI Flange Material (ANSI):	87-88 durometer, black. Modified Topog-E® Standard Material for use in selected standard flange gaskets or higher pressure applications (e.g. piping, air tanks, refrigeration vessels).
Topog-E® 70 Duro Material (70D):	70-75 durometer, black. Modified Topog-E® Material for use in selected applications that require a softer gasket material (e.g. those with very low operating pressure).

Viton® is a registered trademark of DuPont Dow Elastomers.

Refrigerant Compatibility Recommendations

Topog-E® gaskets (Standard Material) should provide “good to excellent” service when used in service with the following refrigerants, which should have little or no effect:

Ammonia (R-717), R-22, R-407C, R-410A, R-13, R-13B1, R-14, R-31, R-32, R-114, R-115, R-142b, R-152a, R-218, R-C316, R-C318, R-502, TA, T-P35

Topog-E® gaskets (Standard Material) should provide “fair to good service” when used in selected applications with the following refrigerants, which may have a minor to moderate effect:

R-12, R-134a, TC, TMC, T-WD602

Topog-E® gaskets (Standard Material) are not recommended for use with the following refrigerants:

Propane (R-290), Propylene (R-1270), R-11, R-21, R-112, R-113, R-114B2, BF, MF, TF, PCA

Topog-E® gaskets (Standard Material) have been used with good success for over fifteen years in refrigerant applications, especially in those where resistance to ammonia and R-22 is important. These applications generally also contain process oils in various concentrations that typically do not have a significant effect on the service life of Topog-E® gaskets. Topog-E® ANSI gaskets, a more reinforced version of our Topog-E® Standard Material gaskets, are sometimes used in applications with higher

operating pressures (e.g. over 200 PSI [14 bar]). Both of these gasket materials are especially well suited to the typical operating temperatures of these applications – which are usually less than 250° F [121° C].

For Propane (R-290), R-11, and R-12 service, we recommend Topog-E® Special Oil Resistant (SOR) gaskets. For Propylene (R-1270) service, we recommend Topog-E® Fluoroelastomer (FKM) gaskets.

Because there are many application-specific factors (e.g. temperature and pressure) that can affect service life, it is always advisable to first test Topog-E® gaskets in a particular application to determine their ultimate suitability.

Topog-E Gasket Company has not tested the compatibility of its gaskets with every refrigerant listed. These are recommendations only, and are based on published chemical resistance data, 15+ years of actual customer experience, and literature provided by material manufacturers and suppliers. We are unable to guarantee the accuracy of this information and assume no liability for the use thereof.

Applications and Product Range

APPLICATIONS

- Steam pressure vessels
- Hot water heaters and demineralizers
- Steam humidifiers and cookers
- Water purifiers
- Refrigeration units
- Carbon absorption and filtering vessels
- Liquid treatment vessels
- Compressed air tanks
- Dryer cans in paper mills
- Water towers and columns
- Water softners
- Deaerators
- Make-up tanks

Because there are many application specific factors that can affect service life, it is always advisable to first test Topog-E® gaskets in a particular application to determine their ultimate suitability. Please contact your distributor or Topog-E Gasket Company if you have questions regarding a specific application.

PRODUCT RANGE

- **Thickness:** All molded gaskets are a nominal 1/4 in [6mm] thick. Molded sheets are available in 1/8 in [3mm], 3/16 in [5mm], and 1/4 in [6mm] thicknesses. Typical tolerances: gaskets +/- 1/32 in [0.8mm]; sheets +/- 1/16 in [1.6mm]. The tolerances will have no noticeable effect on gasket performance.
- **Elliptical gaskets – inch sizes:** Over 100 sizes of imperial standard measure manhole and handhole gaskets are currently available – the vast majority of these will be supplied from stock.
- **Elliptical gaskets – metric sizes:** Gaskets are available from stock for boilers built to metric sizes.
- **Obround, round, and special shaped gaskets:** These are available from stock to fit virtually all types of boilers and other pressurized vessels and tanks.
- **Sheet material and custom gaskets:** These are supplied to order. Any size or shape of custom-designed gasket will be cut or molded on request – set-up charges may apply.

General Boiler Care

BOILER CARE FACTS AND TIPS

- If the cover plate is too small for the opening in the boiler, it is easy to place the cover plate off-center. An off-center inspection plate can concentrate forces on the gasket and cut it in two. The plate may also drag on the shell and fail to seal as the pressure rises.
- After start-up, crabs should be re-tightened as pressure increases and the gasket seats. A loose crab on the bottom, or below the water line, can cause a boiler to drain or shutdown as the steam pressure lowers to zero.
- A coating of scale is a coating of insulation. It will lower the efficiency of a boiler and cause it to use more fuel. It will cause fire surface temperatures to rise beyond their designated scope, and will insulate fusible plugs, altering their melting temperatures.
- A fusible plug changes its melting point with time and temperature and should be replaced annually for that reason.
- Low water level is one of the most dangerous of boiler conditions, and therefore, gauge glasses should be kept clear and operational at all times. Try cocks should be kept only as a means of checking gauge glass readings and as a temporary measure when repairing gauge glasses.

- A 'slow' pressure gauge indicates that its anti-syphon nipple is filled with scale and rust, and its readings are inaccurate. Brass pigtail nipples are generally more trouble-free.
- Grease or oil in a boiler is not good. It usually causes priming or foaming, and can be seen on top of the water in the gauge glass. To remedy, skim the water in the boiler before draining, and when refilling, add a small amount of soda ash to cut the grease.
- Regular blow down of a boiler removes sludge collected in the bottom of a boiler, but is no substitute for proper water treatment which stops the formulation of sludge and scale. Boiler repair and water treatment agencies in your area will be able to advise what your water may require.
- Fuel efficiency changes gradually. A regularly scheduled maintenance program is more economical.
- A gasket that leaks is eroding the boiler it is supposed to help. A properly installed Topog-E® gasket will not leak.

Cleaning a boiler's gauge glass

Follow these simple steps precisely to clean a boiler's gauge glass while steam pressure is on boiler and without disassembly.

- Fill a cup with household ammonia
- Close top and bottom gauge valves. Open drain valve beneath column.
- Open the top gauge valve a fraction, so steam pressure blows all the water out of the drain line and so that the glass contains only steam.
- With a very gentle flow of steam out of the drain line, hold the cup of ammonia to the end of the drain line so that the steam bubbles up through the ammonia.
- Close the top gauge valve. The steam will quickly condense in the gauge glass causing a vacuum. The resulting contraction will suck ammonia up into the gauge glass.

Repeat until the glass is completely clean.

WARNING: DO NOT USE THIS PROCEDURE IF EITHER THE TOP OR BOTTOM GAUGE VALVE WILL NOT SEAL-OFF COMPLETELY! APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (MASKS, GLOVES, EYE PROTECTION) SHOULD ALWAYS BE WORN WHEN PERFORMING THIS OR ANY OTHER WORK ON OR AROUND STEAM BOILERS.

How to determine if a sight glass is full or empty.

When no water level shows on a sight glass, you can quickly tell whether it is completely full or completely empty. Hold a pencil, or equivalent, against the far side of the sight glass tube at an angle of approximately 45°. If the image of the pencil viewed through the glass appears to run across the glass and changes no matter what the angle of the pencil, the glass is full.

If the image viewed through the glass runs up and down the glass at a sharper angle than the actual angle of the pencil, the tube is empty.

Practice this procedure with the normal water level by viewing through the sight glass above and below the water line. Thick wall tubing gives a less pronounced difference, but the difference is still obvious.

Caring For an Out of Service Boiler.

There are two primary ways to care for an out of service boiler. These are usually chosen on the basis of whether freezing temperatures will exist while the boiler is stored, and whether the boiler may be needed for service on short notice. The boiler can be stored dry or wet. In either case, it should be cleaned before service.

DRY STORAGE

The cleaned boiler should be thoroughly dried. Any moisture will cause corrosion over time. All lines to the boiler that could carry moisture back to it must be blocked off. (Remember, even air can carry moisture).

Moisture absorbing material may be placed on trays inside the shell at the rate of 2lbs/1kg of quick lime, or 10lbs/5kg of silica gel for each 1000gal. of capacity. Periodic inspections of the effectiveness of these materials are recommended during extended storage.

WET STORAGE

The cleaned boiler should be closed and filled to overflowing using chemically conditioned water (condensate is purer than feedwater for this purpose). Caustic soda can be used for this treatment at a concentration of 450ppm with an oxygen scavenger such as sodium sulfite at 200ppm. Water pressure greater than atmospheric should be maintained during storage.

Understanding steam

A VERY BASIC, BUT SERIOUS LOOK AT STEAM

Boilers make steam by boiling water. That is about the most over simplified statement we can make. However, some interesting things happen when water is boiled. At atmospheric pressure water expands 1,600 times its original volume when it turns to steam. This explains why a tea kettle can fill your kitchen full of steam.

Water at atmospheric pressure boils at 212° F (100° C). The boiling water in an open vessel measures 212° F, the steam coming off the surface also measures 212° F. Once boiling all the time that heat is applied to the vessel, nothing increases in temperature. The applied energy is changing the water into steam. The steam will give-up energy before turning back into liquid. This energy is called *Latent Heat* and for most purposes is considered the useable energy of steam.

Below the boiling point the heat applied to the vessel goes into the water and raises the temperature. We are able to measure this temperature change with a thermometer and we call this heat *Sensible Heat*.

Steam is so familiar to all of us that we easily forget what a marvelous thing it is. Steam will carry 20 times the BTU's per pound that Freon 12 will, nearly 15 times the BTUs of F22 and twice that of ammonia. Even when we use nuclear energy for power, it is only to heat the water to make steam. For all this we tend to take steam for granted without much thought to how it really is produced or how it works best for us.

For most purposes for which steam is used it is the Latent Heat of the steam that we utilize, for after the Latent Heat is given up, the steam condenses back into a liquid. Whenever possible we return this condensed steam (condensate) to the boiler for reuse. This conserves a large portion of the Sensible Heat we had to apply in the first place to produce the steam. Even if the condensate has become contaminated by materials that make its return to the boiler unsuitable, we can still use it to heat the incoming water through a heat exchanger and thus reduce fuel requirements.

So far we have only considered an open vessel for boiling water. If we seal the vessel from the atmosphere and continue to apply heat the expanding steam causes the pressure inside the vessel to increase. This increase in pressure causes the temperature at which the water will boil to increase. This requires further Sensible Heat to get the water to its newer, higher, boiling point. At the same time the Latent Heat required to reduce the water into steam is reduced. The net result is that only a slight increase in Total Heat is required for each pound of steam. But since that same pound (by weight) of steam will occupy 26.8 cubic feet of space at atmospheric pressure and only 2.14 feet at 200lbs per sq inch pressure it is more handily packaged at higher pressure. While occupying only 1/8th the volume, 200 P.S.I. steam has only required 4% more heat per pound. Smaller piping will serve the same system and will reduce piping heat loss as well.

Steam can be in one of three conditions Wet, Dry or Superheated.

WET STEAM contains small water droplets entrained with it. These droplets contain no Latent Heat and therefore have nothing to contribute to the process before being returned to condensate. Just 6% of water particles at 200 P.S.I. reduces the Total Heat in a pound of steam to less than the Total Heat in a pound of steam at atmospheric pressure.

DRY STEAM requires the elimination of water particles from the steam line. This can be achieved mechanically with baffles in the steam flow designed so that the water particles are deposited and left behind, or by removing the wet steam from the water surface and applying additional heat to drive all of the water particles into steam. Flue gas heat is often used for this purpose.

SUPERHEATED STEAM occurs when sufficient additional heat is applied to raise the steam temperature to any level above that of saturated dry steam. Some Superheat is sometimes required to ensure that dry steam is achieved at the end of long pipe runs. It would seem that Superheat would be the course to take in all cases as a means to transfer more heat. In reality the amount of additional heat transferred is not great. One pound of steam at 200 P.S.I. superheated by 100° F has gone from 1200 BTUs total heat to 1260 BTUs total heat (an increase of 4.8%). While that small change was

For steam engines or turbines, it is often part of the power unit's design to use superheated steam. This is a specialized application of steam utilizing the entropy of steam (which needs to be treated separately). Suffice it to say that after expansion through the engine, the steam has nearly all the heat units that were put into it, and can often be put to additional use in process applications.

taking place the saturated steam started acting like a perfect gas and expanded in volume from the original 2.14 cu feet to 2.45 cu feet a volume change of 14.5%. Therefore the heat content per cubic foot of steam has actually reduced by superheating.

Reflecting then, we get eight times the volume of steam in the same space by raising the pressure from atmospheric to 200 P.S.I. but we lose 14.5% volume efficiency by superheating it by another 100° F. Therefore at the same 200 P.S.I. Superheat is therefore an advantage only when the heat requirement can be met by the small amount of energy in the Superheat and where the higher temperature gradient from the hotter steam is required by the process job.

We have not addressed many of the other areas of steam use; for example steam trapping – which is a very necessary consideration in most steam systems. We have, however, been able to address steam's basic simplicity, its great heat transfer capabilities and the versatility of its application.

When all of these issues are considered together it is obvious that steam will always continue to be a very important tool for industry. It will not become obsolete because nothing comes even close to having these properties.

Steam safety pop valves

The term “pop valve”, often applied to safety valves, is not a bad term in that it accurately reflects the action of the valve. As the pressure of the steam within a boiler approaches the set pressure of the valve, the steam pressure on one side of the actuating disc approaches the pressure of a spring applied to the outer-side of the disc. When equilibrium is passed the disc starts to lift from its seat. The moment this happens steam is released all around the disc. The additional steam creates an artificial shoulder around the circumference of the disc, thus increasing its surface area. This sudden increase in area under pressure makes the pressure much more unbalanced in the direction of the opening which pops the valve to the wide-open position. This pop action prevents wiredraw of the seat due to slow action.

Closure of the valve only occurs when the boiler pressure has dropped several pounds below the set point. To ensure a tight closure after a valve has popped under pressure the boiler maximum operating pressure should be set several pounds below the set pressure of the safety valve. Some manufacturers recommend setting 10% below.

Proper installation of a safety valve is a result of careful adherence to the manufacturer’s instructions.

A safety valve body is a part of the precision of the whole device. If the body becomes distorted the valve’s integrity and calibration will be destroyed. Care MUST be taken to apply wrenches only to the points required for installation.

Boiler safety valves are little understood, often incorrectly installed, and usually neglected. This is a general statement, and as with most general statements must not be taken as universally true. There is, however, sufficient evidence to warrant discussion.

Similarly the discharge side of the valve must not be made to bear the weight of the discharge piping. A short nipple from the valve body should enter the mouth of an independently supported large bell reducer or drip pan elbow leading through piping to a safe discharge area, preferably outdoors.

All piping to or from a safety valve must be at least as large as the safety valve’s connection and the restrictive action of elbows and friction be taken into consideration.

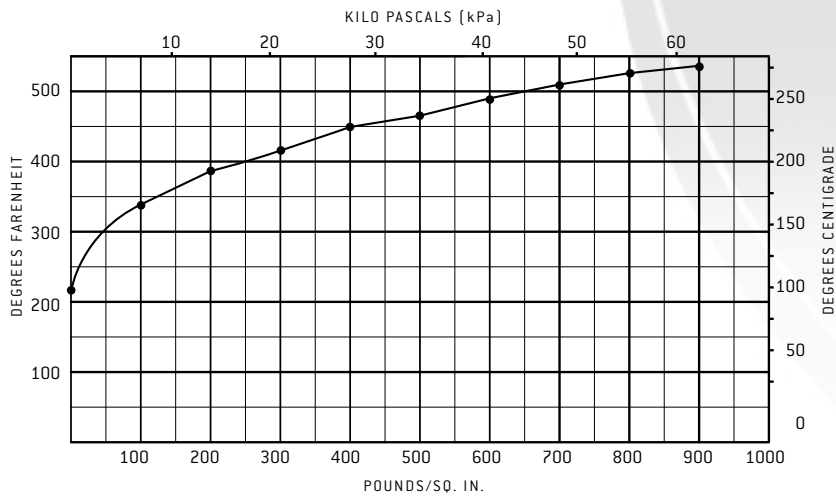
For a safety valve to operate properly it should be capable of being opened to an extent that it releases all of the steam a boiler is able to produce when operating at maximum capacity.

There is some discussion in the field about whether or not it is wise to periodically pop a steam safety valve. Since there is the possibility of the valve becoming incapable of proper operation due to scale coating inactive parts. The Hydronics Institute in their Operations and Maintenance Manual for Steam Boilers recommends an operations check on safety valves at the beginning of the heating season and every six months. Their recommended method is to raise the pressure until the valve pops. Whether by this, or by a hand lever, the pressure should be high enough to blow the seat and other parts clear of any foreign matter.

Metric equivalents: Steam Pressure and Temperature

In 1960, 36 countries participated in a conference to standardize weights and measures. Many have adopted the Systeme International (SI) metric system that resulted from that conference. The USA too is rapidly moving toward the metric system.

Steam Pressure vs. Temperature



Steam Pressure vs. Temperature

kg per sq cm (kPa)	lbs per sq in	Temp deg F	Temp deg C
.0	0	212	100
.140	2	219	103.5
.281	4	224	106.2
.421	6	230	110.0
.562	8	235	112.8
.700	10	240	116.0
1.05	15	250	121.0
1.40	20	259	126.5
1.75	25	267	130.9
2.10	30	274	134.4
2.46	35	281	139.0
2.81	40	287	141.3
3.16	45	292	144.6
3.51	50	298	147.7
3.86	55	303	150.6
4.21	60	307	152.3
4.57	65	312	155.1
4.92	70	316	157.7
5.27	75	320	160.0
5.62	80	324	162.2
5.97	85	328	164.8
6.32	90	331	166.5
6.68	95	335	168.7
7.03	100	338	170.0
7.73	110	344	173.2
8.43	120	350	177.0
8.79	125	353	178.6
9.14	130	356	180.0
9.84	140	361	182.5
10.54	150	366	185.3
11.25	160	371	188.5
11.95	170	375	190.5
12.65	180	380	193.0
13.36	190	384	195.2
14.06	200	388	197.8
15.47	220	395	201.6

Calculating the amount of boiler blowdown required

The blowdown required as a percentage of the steam generated is:

$$\left(\frac{F}{B-F} \right) \times 100\%.$$

Where B = Desired boiler water total dissolved solids (ppm)
 F = Feedwater TDS (ppm)

Savings from reduced blowdown

For each 1% reduction in the blowdown rate the % saving in the cost of fuel consumed in the boiler is:

Boiler pressure bar g	Boiler pressure psig	Percentage fuel savings by 1% reduction in blowdown rate
7	102	0.19%
10	145	0.21%
17	247	0.25%
25	363	0.28%

Example

Original conditions were: average boiler water TDS 2500 ppm and a feedwater of 300 ppm.

$$\text{Blowdown rate} = \left(\frac{300}{2500-300} \right) \times 100\% = 13.6\%$$

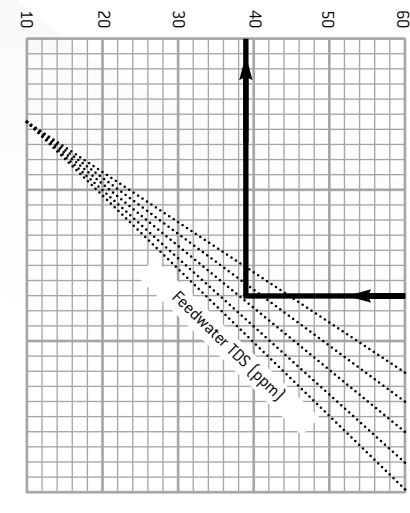
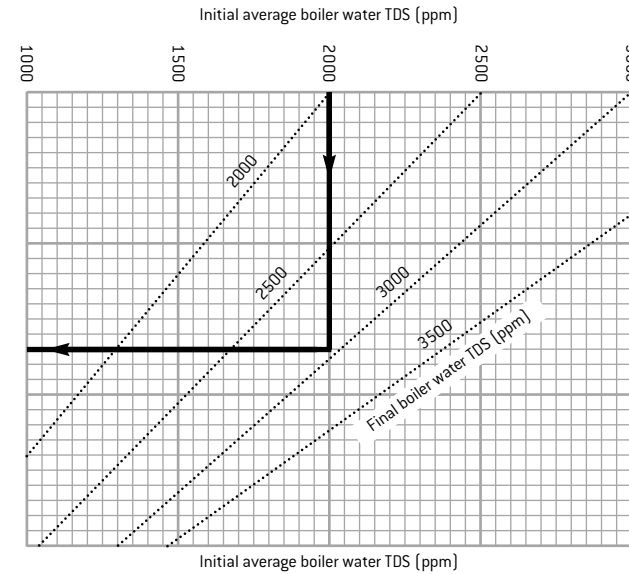
Conditions were improved by installing a TDS control system and increasing the amount of condensate return. Final conditions are: average boiler water TDS 3000 ppm and a feedwater TDS of 200 ppm.

$$\text{Blowdown rate} = \left(\frac{200}{3000-200} \right) \times 100\% = 7.1\%$$

The saving of blowdown is therefore 13.6% - 7.1% = 6.5%

For a boiler pressure of 10 bar g the saving is 6.5 x 0.21% = 1.37% of annual fuel bill.

Savings by better control of boiler water TDS



The graph shows the % saving of blowdown which may be obtained by better control of the boiler water TDS.

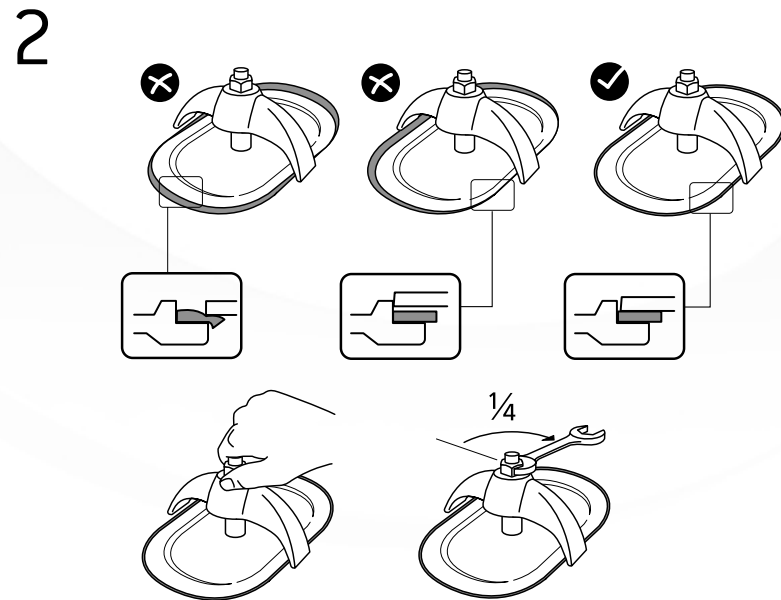
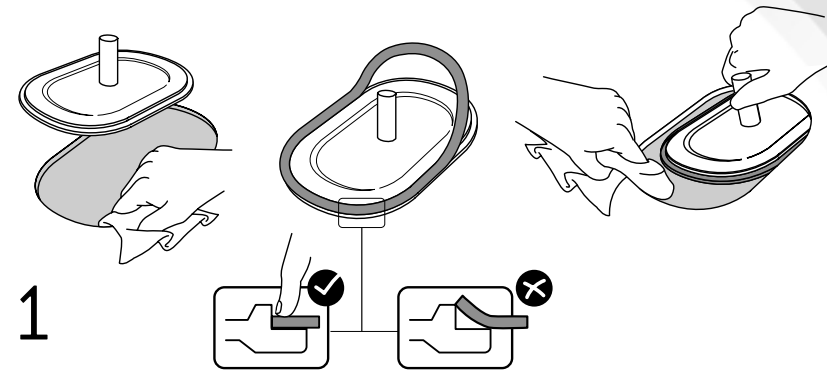
A TDS system will maintain TDS at just below maximum allowable levels unlike manual systems where allowance must be made for a safety factor.

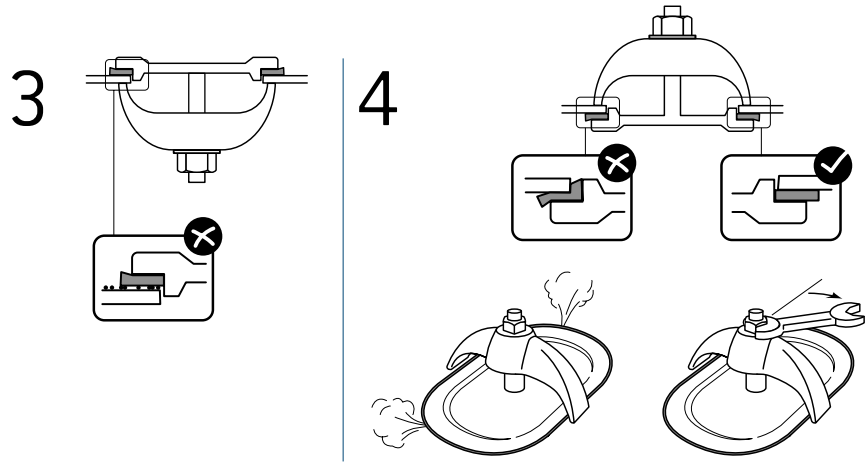
- Initial average boiler water TDS with manual control: 2000 ppm
- Final boiler water TDS with automatic control: 3000 ppm
- Feedwater TDS: 400 ppm
- From the graph the percentage saving of blowdown is 39%
- Up to 80% of the Blowdown Energy may be recovered with a Heat Recovery System

Installation of Topog-E® gaskets in steam boilers

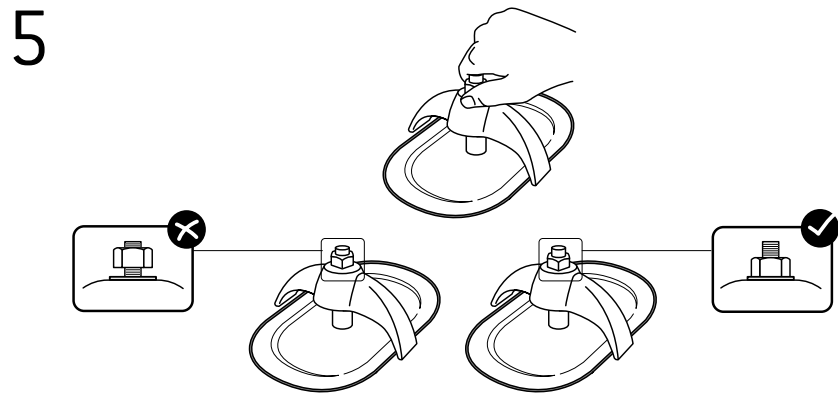
1. Remove old gasket and thoroughly clean the surface on boiler and on cover plate. It may be necessary to buff each surface. Place new Topog-E® gasket on inspection cover plate, and make sure that the gasket is pushed down tight on the plate. Do not use any grease, lubricant or adhesive. When the cover plate is in the boiler and the gasket is in place, make one last cleaning swipe using a rag wrapped around your finger to ensure the mating surface in the boiler is clean.
2. Set crab, then center plate in opening and tighten nut enough to give a snug fit. Make it hand tight then increase pressure on the gasket with a quarter turn of wrench.
3. Gaskets on the bottom of a boiler shell are typically more difficult to install without leaking because small particles tend to become lodged between the mating surfaces after they have been cleaned. This can lead to over-tightening of the gasket to stop leakage. It is recommended to drain the boiler and start over or the gasket's service life may be shortened.
4. Do not over-tighten as it will over-compress the gasket and shorten its service life. If gasket leaks while pressure is being built up, tighten only enough to stop leakage.
5. As pressure builds up to operating level in the boiler, the nut and crab will loosen as it typically takes several days for the gasket to reach its ultimate compression. It is important to keep the nut at least finger tight until it no longer loosens.
6. Never re-use a Topog-E® gasket!
7. Topog-E® bolt gaskets (when required) should be used with Topog-E® handhole gaskets.

Topog-E gaskets are sold for use in steam, water, air, and other selected applications only. Recommendations for their use are based on tests believed to be reliable and on actual customer experience. Since their installation and use are beyond our control we cannot guarantee the results, whether or not such use is in accordance with directions. We disclaim any responsibility.





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Technical specification and usage guide

THE TOPOG-E GASKET COMPANY HAS BEEN MANUFACTURING AND SELLING MOLDED RUBBER GASKETS AROUND THE WORLD FOR OVER FORTY YEARS. WE MAKE GASKETS TO FIT EVERY BOILER IN PRODUCTION TODAY, AND OUR GASKETS ARE RENOWNED FOR THEIR QUALITY, DURABILITY, AND EASY INSTALLATION AND REMOVAL.

The purpose of this booklet is to give appropriate information, technical specifications, and guidance, to ensure that your boiler's needs are correctly and safely addressed.

The first section focuses on the gaskets themselves, and the second section considers issues associated with boiler maintenance.

At the Topog-E Gasket Company, we are proud of our long-standing knowledge of the boiler industry. Our continuing research and development work helps us to remain at the forefront of technical advances.

We trust this guide will be helpful when using Topog-E® gaskets, performing boiler maintenance, and conducting education and training seminars.

If you require any further advice or clarification, please call your local distributor or log on to www.topog-e.com