

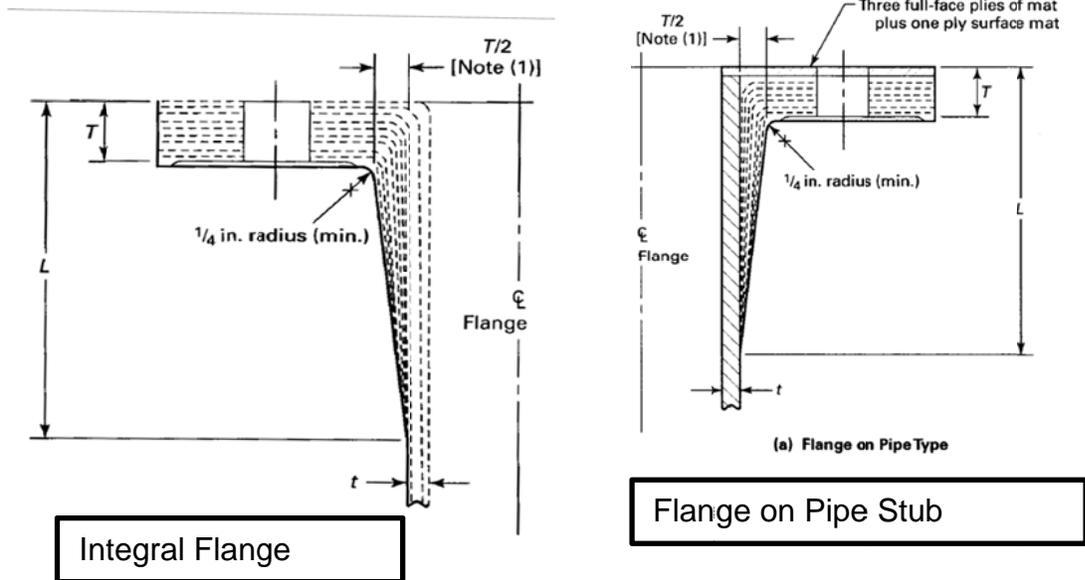


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February 21, 2018

## Sealing FRP Flanges

The most common FRP flange is the flat faced flange, made by a single integral lay up on a flange mold or, in some cases a flange lay up on a stub of pipe.

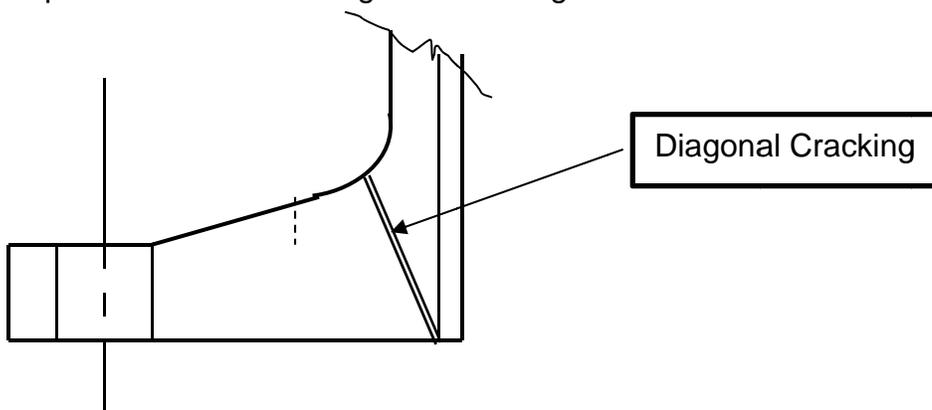


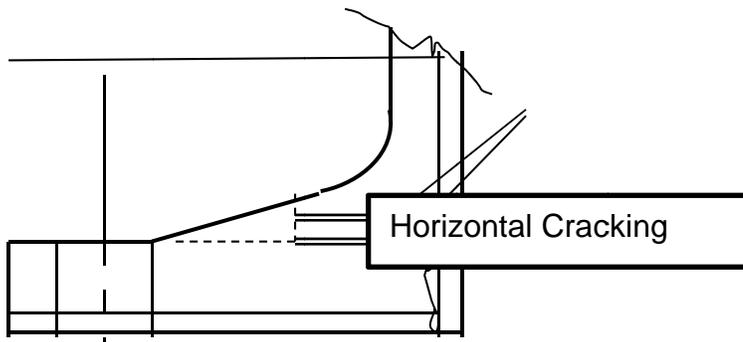
The recommend gasket for these flanges is a full-face elastomeric gasket with a durometer or 50-70 Shore A hardness value.

To seal this gasket the flanges must be torqued to specific values in order to compress the gasket into surface irregularities such as waviness or flange imperfections. After the sealing torque has been reached the gasket begins to creep or relax and the bolt torque drops and thus requires re-torquing. This is a normal process and may be repeated several times before sealing torque stabilizes.

This type of gasket is the most successful but many flat-face flanges will begin to leak at pressures approaching 400 psi under ideal conditions but may leak at much lower pressures when subjected to bending. Bending of the pipe at turns and long support spacing decreases bolt loading and reduces gasket compression allowing leakage or gasket extrusion.

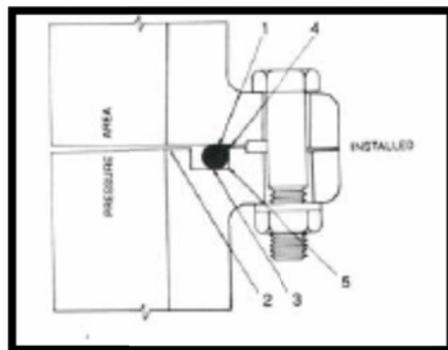
A frequent problem with FRP flanges is cracking in the neck area of the flange.





As the bolts are tightened the gasket is compressed more in the immediate bolt area and is less compressed in the area toward the pipe centerline and the flange is subjected to bending that may induce cracking in and around the hub. Leakage into the cracked area exacerbates the cracking and may result in a complete flange failure.

Alternate flange designs using concentric rings embossed in the flange faces have shown to aid sealing of soft gaskets. Some specifications require hard gaskets for high pressure systems but are difficult to seal. O-Ring seals have proven to provide excellent sealing but require a close tolerance groove that is machined in one flange face. The machining of the groove is expensive and adds a stress concentration at a critical point on the flange. If the groove is machined the groove loses the surface protection of the corrosion barrier.



In the past several years Britt has developed and tested a seal design that uses the O-ring but eliminates the requirement for the O-ring groove. A simple flat plate is used to back the O-ring and when the flange is assembled and bolts are tightened the O-ring is lightly compressed to seal the flange. A thin metal inner ring is placed inside the O-ring to insure the O-ring is not pulled into the pipe under transient vacuum conditions. Britt has applied for a patent for this O-Ring seal that is expected to issue this year.

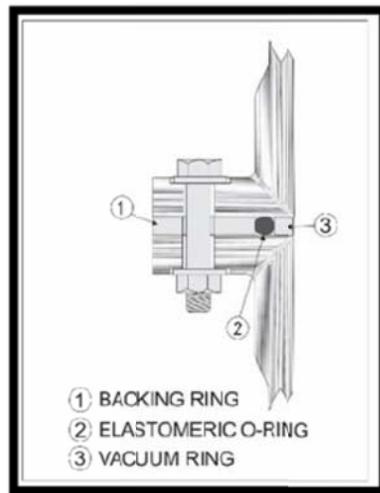
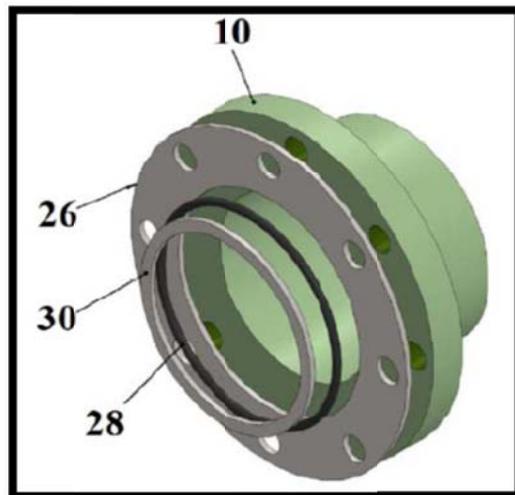


Fig.1 Bak-O-Ring\* Seal

\*Pat Pend.



10 – FRP Flange  
26- Backing Ring  
28- O-Ring  
30- Vacuum ring

A flat metal or hard plastic backing ring is placed between the flanges and is used to back the O-Ring. A flat, thin inner ring is placed inside the O-Ring to prevent the O-Ring from being drawn into the pipe under vacuum conditions. Hydro testing of this seal provides zero leakage up to the full burst pressure of the pipe or flange. The backing ring eliminates the high bending moment in the flange neck and allows the bolts to be torqued to full bolt values without any need for retorquing. An additional advantage is the ability of this arrangement to reduce the effect of flange stress due to piping loads. The bolts transmit the bending without bending the flanges.

### Corrosion Control

The O-Ring can be made from elastomeric materials that are designed to resist the corrosive effects of almost all chemical fluids. The Britt design places the O-Ring near the flange inside diameter thereby protecting the backing ring and the flange faces from contacting the fluid. Standard flat gaskets provide initial protection but as the gaskets begin to relax under load the corrosive effect of the fluid seeps across the face of the flange. The O-Ring stops the fluid at the inner diameter and protects the flange face and backing ring.

### Rating of the O-Ring

The Britt O-ring seal has been tested under ASTM D 1599 burst test conditions and provided a leak free system up to the burst pressure of 2,200 psi. At 2,200 psi the joint connecting the flange and pipe failed but the flanges never leaked. The FRP piping

system was rated at 1,500 psi and the flange at 1,200 psi (80%). This seal rating exceeds the maximum pipe rating. Standard flat gaskets cannot reach 1,200 psi without leakage or gasket extrusion and requires re-torquing to achieve sealing pressure.

### **Cost**

The initial cost of the O-Ring seal depends on the material used in the O-Ring. The most widely used material is EPDM. Flange gaskets cost is also dependent on material selection but for comparison the O-Ring and gasket material will be EPDM. Regardless of pipe size the Britt O-ring seal will have an initial cost of approximately 3 times the cost of a 1/8" thick EPDM full face gasket.

The total installed cost should be the case for selecting any seal and here is where the Britt seal offers a huge difference in cost. The differences are:

- Installation costs are reduced because re-torquing is never required.
- Full face gaskets must be re-torqued 24 hours after installation and may need additional re-torquing to achieve required torque for seal load.
- O-Ring components can be reused in cases where the flanges have to be opened. In most cases the O-Ring is reusable.
- Full face gaskets are not reusable and must be replaced each time the flange is opened.
- Flange face corrosion is eliminated with the O-Ring seal.
- Flat face gaskets do not protect the flange face.

### **Summary Comments and Conclusions**

FRP flanges have been difficult to seal and continue to be problematic because they are flexible and prone to bend when using both ring and full face gaskets. Soft gaskets (Shore A 70) have performed much better than hard gaskets but soft gaskets tend to promote flange cracks. FRP piping systems are pressure rated at 150 psi (1,500 psi ultimate) but are difficult to seal unless the flanges are re tightened several times following installation. Even then the flanges sometimes leak when subjected to piping loads.

Pipe fitters are accustomed to installing steel piping systems and may use the same gasket materials for FRP. Sealing will require much higher bolt torques and as a result flange cracking usually develops after the system is in service.

The O-Ring seal has always performed well in most piping systems but the O-ring groove is not widely accepted and has not proven successful in FRP flanges. The O-Ring seal when combined with the patented backing ring and vacuum ring is the first successful seal ever proposed for FRP flanges. Long term it should prove to be the first zero leakage seal ever proposed. Initial cost is a deterrent but the success should be the long term performance and value of the total installed cost.

For more information contact Britt Engineering Associates, Inc., ([www.beacomp.com](http://www.beacomp.com))



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## Technical News

January 26, 2018

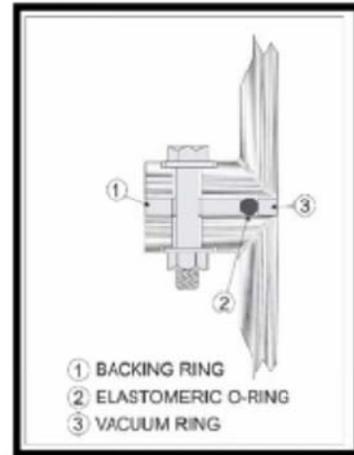
### Subject: New Application of O-Ring Seal for FRP Flanges Pat. Pend

BEA has developed a new seal design for FRP flanges using the ultra-reliable O-Ring without the standard machined O-Ring groove. After more than three years of testing, patent applications have been filed on the design known as **BAK O-Ring** TM Pat. Pend

The seal has proven to be **leak free throughout the pressure rating of the pipe**. This seal design incorporates a solid backing plate **that allows the bolts to be initially torqued to the maximum allowable bolt torque without cracking or damaging the flanges**. Since there is no gasket creep the bolts never require re-torquing.

**The high bolt torque also reduces the effect of flange bending that might be imposed by piping system loads**. The bolts transmit the bending through the bolts without bending the flanges and thereby reduce the stress that would be applied to the flange.

The last piping system test on a 6" diameter 150 psi rated piping system was tested to a pressure that caused the pipe to fail but no leakage was detected throughout the test. **The pipe failed at the pipe to flange joint at a pressure of 2200 psi**.



This seal design has been used in hydrostatic tests for the past three years, and each test has been conducted without leakage or flange cracking.

O-Ring materials will vary according to needs of the fluids in the system. **Since this design eliminates the machined groove, the corrosion barrier is not lost.**

The cost of the **BAK O-Ring** will depend on the O-Ring material, but the total installed cost will be much lower than the full face gasket. **The BAK O-Ring may be reinstalled many times without replacing the O-ring** – gaskets cannot be reused.

Special materials are available

- Neoprene
- EPDM
- Nitrile/Buna N
- Viton
- Red Rubber
- Silicone



Fig. 1 Test Spool Assembly

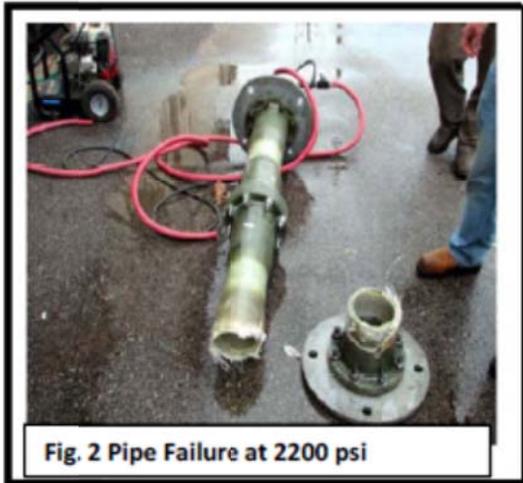


Fig. 2 Pipe Failure at 2200 psi

O-Ring Material

Manufacturers of O-Rings have developed a wide range of compounds that can provide excellent corrosion resistance for most process chemicals and maintain mechanical properties to affect sealing over the range of temperatures of process piping systems. Bak-O-Ring seal <sup>Pat. Pend</sup> can be used in any of the applications where these materials might be selected. The selection of the O-Ring material is left to the design engineer who elects to use the Bak-O-Ring for sealing process flanges.

Availability

Limited quantities for sizes 2" through 24" are now available. Sizes up to 42" are available by special order. Delivery depends on the O-Ring material selected.

