LEAKAGE AND METHODS TO DETECT

By Larry Pyle, *LFP Technologies*

Flat gaskets are the "bread and butter" of the gasket industry. What I want to elaborate on with this article are the modes of leakage and the various testing methods which have been used to quantify and qualify leakage. Gaskets allow for "less-than-perfect" mating surfaces of the adjoining flanges where they can fill in the irregularities and create a seal.

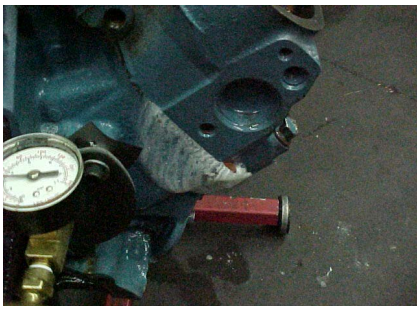
Preventing liquid or gas leaks is one of the most important and most difficult jobs facing a gasket application. It is important because the contained fluids are often important from an economic standpoint. Many of these fluids are dangerous and toxic. A leak is always a nuisance; it can be an expense, and it can even lead to fires, explosions, or other disasters. This danger is clearly evident in industrial applications such as chemical refineries where, in the case of fire, a leaking gasket can add fuel to the fire. Gaskets can also function as seals for enclosures to prevent dirt and water intrusion.

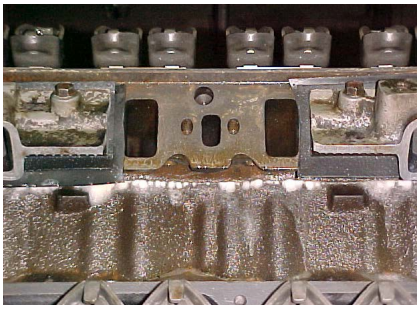
A gasketed joint leaks when the material being contained escapes through the pores or gaps in the gasket, or escapes around the gasket. These will be referred to as INTERSTITIAL and SURFACE leaks respectively.

INTERSTITIAL LEAKAGE:
At the molecular level, it would mean that the size of the liquid or gas being sealed can infiltrate through the spaces between the molecular matrix of the containing material (gasket). Thinking of the classic example of mixing water with alcohol where 1 cup of water added to 1 cup of alcohol does not equal 2 cups of liquid. The molecular size of the water is smaller than that of the alcohol and can infiltrate the matrix formed by the alcohol molecules. Another example of a structure similar in nature is concrete where crushed stone and sand are used. The smaller grains of sand occupy the spaces between the voids between the larger stones.

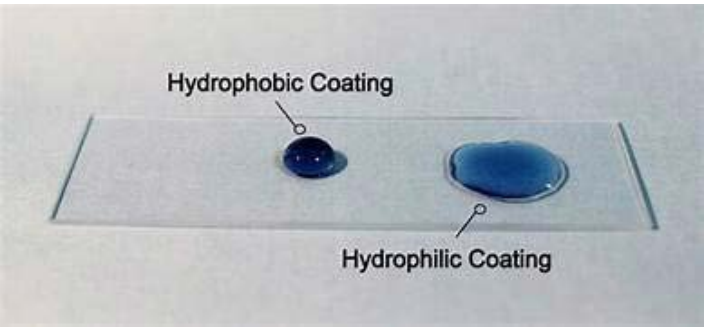
This principle is widely used in molecular filters which can be used to filter one liquid from another.

Sheet gasket materials are made up of various fibers for strength, smaller fillers to fill in the gaps, and binders which hold the matrix together and can be formed and manufactured into sheets of material. Because of the restraints inherent in the method of manufacture and the need for the material to have compressibility, they contain voids. These voids can provide paths for leakage. Pictures below illustrate a case of interstitial leakage. They are of an assembled engine head and block internally pressurized and sprayed with a soap solution. This type of leakage is identified by the "shaving soap" foam. Surface leakage would be more localized with larger bubbles.





- The lower the density, the larger the pathways, the greater the leakage.
- Compressing the gaskets reduces the size of the voids thus reducing the amount of leakage.
- Adding enhancements such as screen printing or grommets can shield the gasket material from the contained gas or fluid and increase the density of the gasket in critical areas.
- Soaking a gasket in a liquid can reduce the amount of liquid that escapes through the maze of pathways. This was a common practice in the refrigeration industry to reduce leaks in their closed systems. Refrigerant lubricating oil or mineral oil being the liquid of choice.

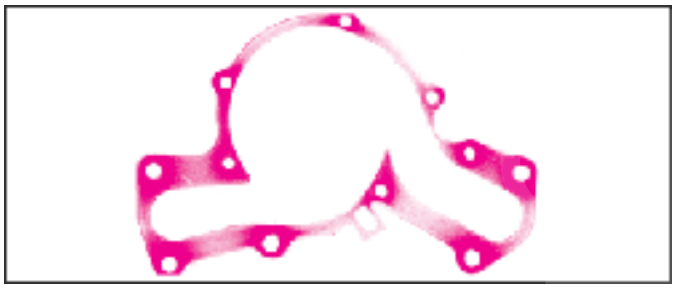


- Saturating gasket sheets with hydrophobic compounds are effective when the contained fluid is water based and relatively low pressure.
- Replacing the grade of gasket material with one with improved sealing properties.

SURFACE LEAKAGE:
Eliminating leaks around the gasket or across the gasket surface is a more difficult job. It's not just a question of eliminating major openings or gaps between gasket and flange surface. That is relatively easy to do. Instead, enough contact pressure called gasket compressive stress must be maintained. The selection of the gasket material must be selected based on other variables of the gasketed joint:

- Available champ loads
- Structure and rigidity of the mating flanges
- Surface finishes
- Bolt spacings
- Surface waviness
- Internal/external pressures
- Temperature environment and cycle

Shown below using Fuji Prescale pressure sensitive film are some of these parameters at work. The lighter areas between bolt holes are areas of least amount of gasket loading and the areas most prone to leak over the surfaces. These are also areas which the gasket material is least compressed and more prone to exhibit interstitial leakage.



LEAK DETECTION METHODS:
Leak detection can take different forms:

- **Standardized** tests are used to differentiate the properties of gasket materials for side by side comparisons. The standard for the gasket industry is ASTM F37, "Test Method for Sealability of Gasket Materials". The testing is done at room temperature. Method A is restricted to liquid measurements and method B may be used for both gas and liquid leakage measurements. These methods are suitable for evaluating the seal characteristics of a gasket material under differing compressive flange load (within the limits of the fixture). When desired, the method may be used as an acceptance test when the following test conditions are agreed upon between a supplier and purchaser: fluid, internal pressure on fluid, and flange load on gasket specimen.

- **Assembly** tests can take many forms but are generally used as a final check after assembly.
  - Air check at the end of the production assembly line to ensure that all seals are intact, and fasteners torqued. These are not precise checks but do catch major faults.
  - Blacklight inspections can be used to detect fluid leakage where the fluid contains any kind of fluorescence as contained in lubricating oils and coolants. Engine manufacturers will use this test after their "green" run of each engine.
  - Pressure leak down checks are sometimes performed after total assembly in order to establish that it conforms to a standard. The assembly is closed up and pressurized at a prescribed pressure with the pressure supply valve closed. Over a specified time interval, the pressure cannot drop below an established amount. Air is usually the pressurizing fluid although Nitrogen or gas over liquid is sometimes used.
  - In the case of contained hydrocarbons or refrigerants, electronic leak detectors can detect leaks external to the assembly.
  - Other non-standard leakage tests may be designed for gasket development work with specific parameters which may include different fluids, configurations, pressures. Besides air or Nitrogen gases, Helium is often used as a pressurizing gas because of its' small molecular size.

NEW GFA MEMBERS

REGULAR MEMBERS

Impresos RTM S.A. de C.V.
Tamaulipas, Mexico
www.gruportm.com.mx

Premier International
Wixom, MI
www.premierdiecut.com

ASSOCIATE MEMBERS

Toray Plastics (America) Inc.
Front Royal, VA
www.toraytpa.com