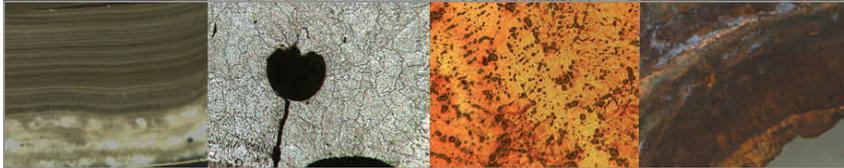


NU S & B L S



New Hampshire
MATERIALS
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O-RING FAILURES

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Welcome to New Hampshire Materials Laboratory

Premature failures of O-rings can cost a customer not only time and money, but can also potentially endanger their personnel. These failures can include many factors, but are usually due to improper design or improper material selection for the application. However, the O-rings appearance can also provide significant insight into the potential causes of the initial failure.

In this month's issue of the Nuts & Bolts, the "O-Ring Failures" provides you with an overview of these failures to help better educate yourself in the identification process for the common O-ring failure modes.

Tim Kenney
Laboratory Director

O-Ring Failures

by Tim Kenney

An O-ring seal consists of the actual O-ring (usually an elastomer) installed in a cavity or gland. Generally, O-rings have a circular cross section; however, lobed variations are available.

The most common O-ring failures are due to mechanical damage. This damage can take place during assembly, usually the result of nicking, cutting or pinching of the O-ring (sharp gland edges increase the likelihood of cutting). Poor gland design can result in excessive squeezing of the O-ring and subsequent extrusion. A few assembly failures are caused by improper size selection, resulting in the over stretching of the O-ring.

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Example of extrusion and wear

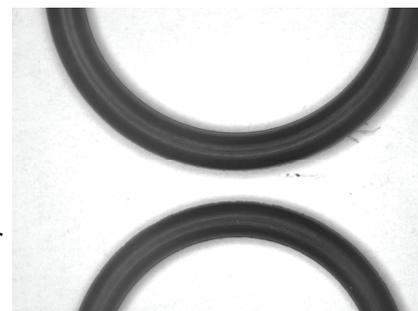
The remaining (mechanical) O-ring failures are usually design related. These failures include wear, extrusion, blow-by due to excessive pressure and explosive decompression. Abrasive wear is usually seen as a flat surface over all of a portion of the O-ring surface. This is the result of a rough finish on the sealing surfaces or abrasive particles in the system fluid. A flat surface on the O-ring may also be due to compression set, usually due to excessive compression caused by poor gland design, but sometimes caused by the selection of an elastomer

with a high compression set value. Excessive compression may result in circumferential cracking on the flattened surface. Explosive decompression is caused by the absorption of gas in a high pressure environment and the subsequent blistering if the pressure is removed rapidly.

Occasionally, O-ring failures are due to manufacturing defects. Usually the manufacturing defect is the result of a too high, or too low, molding temperature or cycle time issues. This can result in incomplete curing and inadequate mechanical properties or flow lines that can develop into cracks in severe service environments.

The most common failures that we see in the laboratory are due to degradation, either by chemical attack or overheating.

Chemical degradation may result in blistering, softening or cracking. The deterioration in mechanical properties by chemical degradation may also not be evident in a visual examination, but only revealed by mechanical testing. While a flat surface on an O-ring may be the result of compression set during assembly, excessive swelling due to chemical exposure is often the reason for a flat surface.



Example of swelling (top) due to chemical attack

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Thermal degradation usually results in radial cracking of the O-ring. Thermally degraded O-rings usually show an increase in hardness and brittleness.

Extrusion results in ragged edges on the low pressure side of the O-ring. This can be caused by excessive pressure or excessive clearances, but we see this phenomenon most commonly associated with a softening or swelling of the elastomer due to exposure to an incompatible chemical. An internet search for "elastomer compatibility" will generate a number of useful guides for compatibility.



Extrusion Example



Example of Cross Section of Extrusion Failure



Example of Gross Extrusion Cross Section