How to prevent downtime due to leakage

The effects and risks of using non-Alfa Laval gaskets **Case story**

Leakage due to the use of non-original nitrile rubber (NBR) and ethylene propylene rubber (EPDM) gaskets.
Is this the best way to protect your investment?

To achieve the best sealing performance, gasket design and material properties must match the intended application.

Although a gasket may look like the original, it may not perform like an Alfa Laval gasket. The manufacturing process – as well as the composition of the gasket's rubber components – are different.

Two investigations of nitrile rubber (NBR) and ethylene propylene rubber (EPDM) gaskets compare the performance of non-original and original gaskets used on plates designed for an Alfa Laval plate heat exchanger (PHE).

Both the non-original and original Alfa Laval gaskets were put through the same tough conditions typical for gaskets in real-life applications. Normally testing goes on for at least 12 months; however, this period of time was not required since results were derived at three months for the NBR gaskets and at six months for the EPDM gaskets.

Background

What happens if you replace Alfa Laval gaskets on an Alfa Laval plate heat exchanger with similar gaskets from another parts supplier?

Designing a gasket for a particular heat exchanger type requires detailed analysis of both the plate and the gasket. Alfa Laval and selected expert suppliers developed new or improved rubber compounds for Alfa Laval plate heat exchangers by determining the exact proportions of the different ingredients in the rubber formulation.

To discover whether gaskets from different parts suppliers stand up to the task, Alfa Laval conducted thorough investigations to evaluate the quality of non-original gaskets intended as replacement parts for Alfa Laval plate heat exchangers.

The surface of a gasket can be analyzed by sight, but it is impossible to judge the material properties without testing.

Results of functional tests on NBR gaskets*

Supplier	Material properties	Sealing	Partition	Compression set	Hardness change	Air ageing
Alfa Laval	Approved	Approved	Approved	Approved	Approved	Approved
Parts supplier 1	Not approved	Approved	Not approved	Not approved	Not approved	Approved
Parts supplier 2	Not approved	Not approved	Not approved	Not approved	Not approved	Approved
Parts supplier 3	Not approved	Not approved	Not approved	Not approved	Not approved	Approved

* Gaskets tested at 140°C for 84 days with aqueous fluids.

Results of functional tests on EPDM gaskets*

Supplier	Material properties	Sealing	Partition	Compression set	Hardness change	Air ageing
Alfa Laval	Approved	Approved	Approved	Approved	Approved	Approved
Parts supplier 1	Not approved	Not approved	Not approved	Not approved	Not approved	Approved
Parts supplier 2	Not approved	Not approved	Not approved	Not approved	Approved	Not approved
Parts supplier 3	Not approved	Not approved	Approved	Not approved	Approved	Not approved
Parts supplier 4	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved

*Gaskets tested at 165°C for 180 days.

Alfa Laval has performed this testing for our customers to avoid onsite testing and process interruption.

Examination

The investigation of the gaskets consisted of:

- Visual examination with photographic documentation;
- Laboratory testing of material properties on the virgin gaskets;
- Test on the PHE where the following is evaluated:
  - Ability to seal over the time
  - Gasket deformation or Compression Set (C.S.)
  - Analysis of air ageing and hardness change
  - Evaluation of how easy the plates are separated after service.

The general impression is that the gaskets from other parts suppliers are manufactured with less precision and lower quality than Alfa Laval gaskets. The gaskets generally fail standard Alfa Laval requirements in several areas

Discrepancies were identified in these major areas:

- Sealing and compression set
- Air ageing
- Hardness
- Partition of plates
- Markings

Sealing tests

Alfa Laval designs its gaskets to provide the exact sealing force required to ensure proper sealing function and to optimize plate heat exchanger performance. If the local sealing force is too low, both the performance and service life of the plate heat exchanger is reduced. If it is too high, the risk of mechanical damage increases and the gasket may fail due to stress and elevated temperatures.

The sealing tests were carried out under hot conditions at 100°C and cold conditions at 20°C with a maximum pressure of 20 bar. The cold sealing test is a lot harder for the gasket and corresponds to a PHE that is shut down but still pressurized as they are in many cases.

Sealing tests on the NBR gaskets were conducted after 33 and 84 days service at 140°C. After 33 days, leakage occurred on the PHE using NBR gaskets from both Parts suppliers 2 and 3.

Sealing tests on the EPDM gaskets were carried out every month during the test period of 180 days at 165°C.

The PHE with gaskets from Parts supplier 1 had a leakage pressure of only 4 bars after 148 days of service. A decline in sealing performance of gaskets from Parts supplier 2 was detected after 52 days in service. On the unit with gaskets from Parts supplier 3, it was impossible to fill up the PHE with water after 180 days due to leakage. After 118 days, leakage occurred on the PHE using gaskets from Parts supplier 4. The genuine EPDM gaskets from Alfa Laval were tightened to 20 bar.

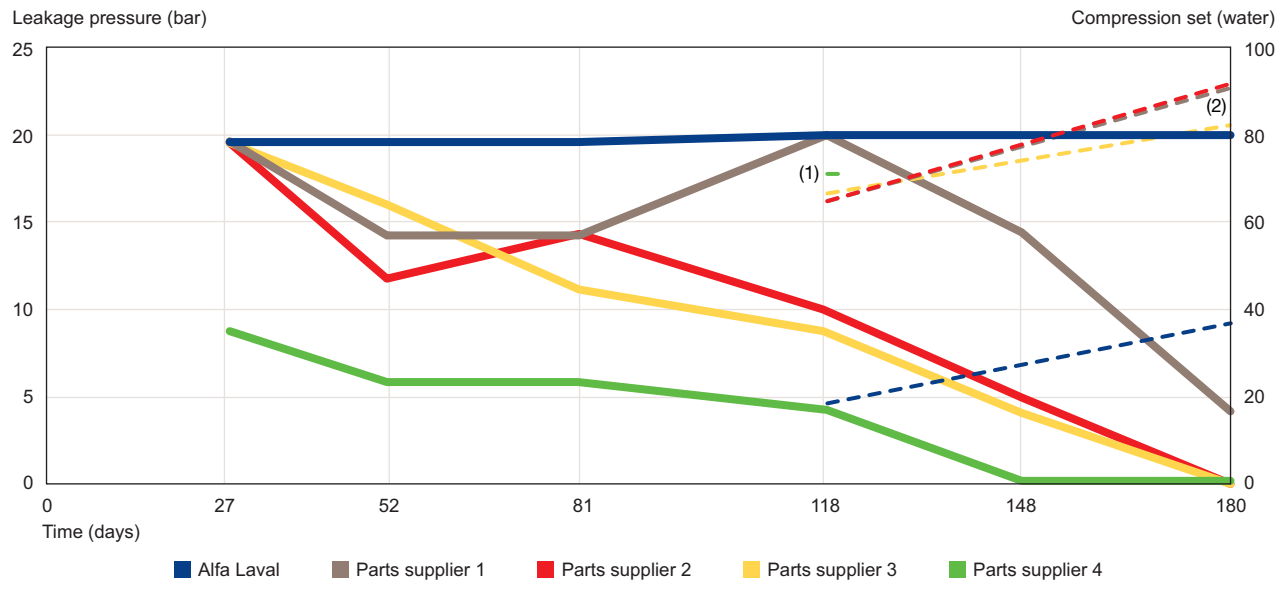
Faults: Bad sealing force.

Risks: Leakage in the heat exchanger on both hot and cold sides. The bad sealing performance shortens the lifetime of the gaskets.

Sealing tests on NBR gaskets at 140°C

Supplier	Time (days)	Leakage pressure (bar)	Compression set (%)	Judgment
Alfa Laval	33	tight		
	84	20	38	Approved
Parts supplier 1	33	20		
	84	0	100	Not approved
Parts supplier 2	33	10		
	84	0	96	Not approved
Parts supplier 3	33	8		
	84	0	100	Not approved

Sealing tests on EPDM gaskets at 165°C



(1) Compression set testing for PHE from Parts supplier 4 could not be completed due to leakage.
(2) The compression set values for Parts suppliers 1 and 2 were almost identical.

Compression set testing
During research and development, Alfa Laval gaskets are not only subject to compression set testing but to crushing tests and functional tests for a 12-month period. This helps determine the quality of rubber compounds, their applicability to certain types of usage and the service life of the gasket.

Compression set is the permanent set of the gasket after having been exposed to elevated temperatures. It is linked to the elasticity and sealing ability of the gasket.

Compression set was measured on the NBR gaskets after service in a PHE for 84 days at 140 °C. All parts suppliers had compression set values close or equal to 100% for both the water and steam sides.

Tests on the EPDM gaskets were conducted for 180 days at 165°C. After 180 days service, the units using gaskets from Parts suppliers 1 and 2 had compression set values above 90% on the water side, which indicates that the units are at significant risk for cold leakage. For the steam side, the values were 79% and 82%, respectively. Compression set values for Parts suppliers 3 and 4 on the water side were 82% and 75%, respectively, and 67% and 88% on the steam side. Alfa Laval's compression set values were 37% water side and 32% steam side.

The risk for cold leakage is very high for a compression set above 80%.

Faults: Gasket deformity and incorrect sealing force.

Risks: Inability to restore elasticity and sealing function after applied compression. Leakage.

Air ageing
Normal exposure to the air changes the material properties of rubber. Only the outer edges of Alfa Laval gaskets are subject to minor oxidation, leaving the compressibility and sealing capabilities of Alfa Laval gaskets largely intact.

For the NBR gaskets, it is impossible to evaluate if air ageing has occurred due to hydrolysis hardening of the Parts suppliers' gaskets.

For the EPDM gaskets, Parts suppliers 1 and 2 have high air ageing rates. Gaskets from the Parts 3 supplier age at approximately the same rate as an Alfa Laval gasket. After 118 days, gaskets from the Parts supplier 4 have an oxidation frontier that has advanced 2 to 3 mm on the upper side of the gasket and close to the gasket groove on the lower side.

Faults: Gaskets get hard due to oxidation from outside or hydrolysis hardening in contact with steam. Several non-Alfa Laval gaskets show the advance of the oxidation frontier by 2 to 5 millimetres on the upper side of the gasket and close to the gasket groove.

Risks: Brittleness that can cause leakage and reduced sealing capability, leakage, loss of product and equipment failure.

Hardness
This material property is vital to the compressibility and sealing function of a gasket. Alfa Laval designs its gaskets for minimal variances in hardness to provide the correct sealing forces of the gasket for a given application. This ensures that the gaskets deliver optimal performance over time.

For NBR gaskets, gaskets from all three parts suppliers had hardness values close or equal to 100 IRHD and variances ranging from +17 to +26 after service of 78 days at 140°C in steam/water media.

For EPDM gaskets, Parts suppliers 1 and 4 did not meet the standards for hardness after 180 days of service at 165°C. Parts suppliers 2 and 3 had acceptable hardness values.

Fault: Increased gasket hardness.

Risks: Faster wear, cracking and embrittlement of the gasket. Total loss of elasticity. Leakage, loss of product, heavy wear on the plates, equipment failure.

Partition of plates

Alfa Laval PHEs are designed to open quickly and easily for routine cleaning and maintenance. Being able to separate, or partition, the plates is vital to maintaining Alfa Laval PHEs in top operating condition. The plates using NBR gaskets from the Parts supplier 3 were impossible to separate.

Fault: Gaskets that adhere to the adjacent plates, making it difficult or even impossible to separate, or partition, the plates. This can result from improper operating conditions, the use of inappropriate cleaning agents, improper properties of the rubber compound, or other unauthorized service actiivities.

Risks: Use of tools to partition the plates can cause gasket destruction, plate damage and deformation. Costly gasket and/or plate replacement. Equipment failure, loss of product, unplanned stoppages

Partition of plates with NBR gaskets

	Partition (Cold)	Judgment
Alfa Laval	By hand	Approved
Parts supplier 1	Difficult with tool	Not approved
Parts supplier 2	Difficult with tool	Not approved
Parts supplier 3	Cannot be separated	Not approved

Partition of plates with EPDM gaskets

	Partition (Cold)	Judgment
Alfa Laval	Easy by hand	Approved
Parts supplier 1	Difficult with tool	Not approved
Parts supplier 2	Difficult with tool	Not approved
Parts supplier 3	Difficult by hand, easy with tool	Not approved
Parts supplier 4	With tool	Not approved

Markings

Each Alfa Laval gasket is colour-coded to identify gasket material and stamped with the year and quarter in which it was manufactured since rubber ages whether the gasket is in use or stored. Proper markings are vital to ensure that the right gaskets with the right material properties and media resistance are used for a given duty.

Faults: Lack of, or incorrect, colour-coding or date of manufacture.

Risks: Use of wrong materials for a given duty. Gasket failure. Leakage of the unit.

Economic effects

Using non-Alfa Laval gaskets undoubtedly has economic effects on the operation of the Alfa Laval plate heat exchanger as well as the entire plant. The use of non-Alfa Laval spare parts can affect the profitability of operations in the following ways:

- More frequent parts replacement. Due to the increased wear and fouling caused by inferior quality spare parts, plates and gaskets may require more frequent, and therefore more costly, replacement.

- Equipment failure. Using non-Alfa Laval gaskets negates the initial investment in your Alfa Laval PHE. Equipment failure is costly. For instance, replacing a marine oil cooler with titanium plates, which is vital when using seawater as the cooling medium, can cost upwards of 150,000 euro depending on the size of the unit.

- Lost production time. Productivity losses are probably the most expensive consequence of using non-Alfa Laval gaskets. Downtime can vary from a few hours to several weeks. An hour of lost production time on an offshore oil production platform, for example, can cost hundreds of thousands of euros, while downtime at a nuclear energy plant can cost 1 million euros per week.

Conclusions

Manufactured to precisely the correct tolerances and material specifications, Alfa Laval gaskets are subject to stringent quality control procedures. It has been proven that it pays to invest in Alfa Laval gaskets.

Using non-Alfa Laval spare parts that do not match the original specifications can contribute to less reliable PHE performance and put worker safety as well as the safety of your plant and the environment at risk.

In addition, the cost of using non-Alfa Laval spare parts can have a significant – and unexpected – impact on your operating and maintenance budget.

How to contact Alfa Laval
Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com