

# Reduce Leakage with Expertly Engineered, Precision Crafted Brush Seals

## AUTHORS

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Introduced by the aerospace industry in the 1980s as a means to reduce air pollution and increase efficiencies in jet engines, brush seals have found broad application in land-based turbomachinery to reduce leakage between stationary and rotating parts.

A brush seal is a compliant contacting seal with the innate ability to follow shaft movement while maintaining low wear and leakage characteristics. A brush seal generally consists of three components: a front plate, a back plate and a bristle pack. The seal's densely packed bristles bend with rotor contact (within an elastic limit) instead of wearing away like rigid seals (e.g., labyrinth seals). When rotor contact is removed, the brush seal's inner diameter returns to its original state, while a rigid seal experiences a permanent change in form. Brush seals can be used alone or inserted into existing labyrinth seals to further reduce leakage in a sealing system.

Not every application is a good candidate for a brush seal, however. Typically, brush seals should be considered when at least one of two conditions is present: first, when a large temperature difference exists between standstill (room temperature) and operating condition, as in a gas or steam turbine; second, when conventional rigid seals cannot be tight enough due to potential rub from large rotor excursions or high vibrations when passing critical speeds. In either condition, whether by equipment design or the result of wear, leakage can be quite large and mitigated with brush seals.



*A brush seal generally consists of three components: a front plate, a back plate and a bristle pack, which bends with rotor contact to maintain low leakage.*

The worn state clearances of a seal system must be examined, especially if brush seals are being evaluated as an upgrade. The worn state yields the highest leakage and is the point the brush seal should be compared against to measure its benefit. In some cases, the worn state will occur immediately upon the machine's first start-up. As the rotor passes through the critical speeds, the rotor may rub against the sealing surfaces, thereby opening clearances right away and causing higher leakage rates. In the right application, a brush seal can reduce leakage by up to 80% when compared to a labyrinth seal.

Engineering a brush seal solution is a balancing act between a number of variables and requires a thorough understanding of the equipment and the sealing challenge. Heat generation, wire size, backplate clearances, pressure balancing and hysteresis must all be assessed to ensure the solution will perform properly in its application and not cause new issues, particularly rotor thermal instability. Precision machining of the seal's assembly and exacting tolerances of +/- 0.001" on the brush bore are also required for optimal performance.

A complete rotor train model can provide the most accurate leakage modelling for engineers to identify the best combination of bearing and seal technologies for optimized rotordynamic performance. Such evaluation can be particularly valuable to equipment operators and service technicians seeking to increase reliability and improve operational efficiencies.

*For further information about the application of brush seals, please visit [www.waukeshabearings.com](http://www.waukeshabearings.com) or, for aftermarket retrofits, [www.bearingsplus.com](http://www.bearingsplus.com).*

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