MECHANICAL ENGINEERING SEALING TECHNOLOGY

Technical Engineering Guide to SKF A25-F Wiper Seals: Design, Material Science, and Industrial Application

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In the complex ecosystem of hydraulic and pneumatic systems, the longevity of internal components is often dictated by the efficacy of the outermost seal: the **wiper seal** (also known as a scraper). The **SKF A25-F** represents a pinnacle of machined sealing technology, designed specifically to operate in demanding environments where contamination exclusion and low friction are paramount. This article provides an exhaustive technical analysis of the A25-F profile, its material compositions, manufacturing nuances via the SKF Economos process, and its critical role in maintaining system integrity.

The Critical Role of Wiper Seals in Fluid Power Systems

Contamination is the primary cause of premature failure in hydraulic cylinders. Fine particles, moisture, and abrasive debris from the external environment can adhere to the reciprocating piston rod. If these contaminants pass the rod seal, they enter the hydraulic fluid, leading to abrasive wear on valves, pumps, and the cylinder bore itself. The **A25-F wiper seal** serves as the first line of defense, physically scraping the rod surface during the retraction stroke to ensure no foreign matter enters the system.

Unlike standard lip seals, the A25-F is engineered with a specific geometry and material pairing—typically **SKF Ecoflon** and an **NBR energizer**—to provide a high degree of scraping efficiency while minimizing the stick-slip effect often associated with high-friction elastomeric materials.

Technical Profile: Anatomy of the A25-F Design

The A25-F is a single-acting hydraulic wiper seal. Its architecture is distinct from basic snap-in wipers. It consists of a PTFE-based scraping element (the primary lip) and an elastic energizer (an O-ring or rectangular ring) that provides the necessary radial load to keep the lip in constant contact with the rod.

Geometric Breakdown

- Wiper Lip: The contact point is designed with a sharp edge to maximize the displacement of dried mud, ice, or dust.
- The Energizer: Usually made of NBR70 (Nitrile Butadiene Rubber), the energizer ensures that even under conditions of rod eccentricity or side-loading, the PTFE lip maintains its sealing force.
- Housing Fit: The A25-F is designed for installation in axially open grooves, which is a common requirement for machined seals of this size and material composition.

Standard Dimensions and Ordering Codes

As indicated in technical datasheets, the A25-F follows a specific dimensioning nomenclature (d x D x L). For example, a common specification is **70 x 78.8 x 6 mm**, where:

- d: Shaft (Rod) Diameter (e.g., 70 mm)
- D: Housing Bore Diameter (e.g., 78.8 mm)
- L: Groove Width (e.g., 6 mm)

For larger industrial applications, the profile can be scaled significantly, such as the **200 x 208.8 x 6 mm** variant,

demonstrating the versatility of the machined manufacturing process over traditional injection molding.

Material Science: Ecoflon 3 and NBR Energizers

The performance of the A25-F is heavily dependent on the **SKF Ecoflon 3**material. Ecoflon 3 is a PTFE (Polytetrafluoroethylene) compound, often filled with additives like carbon or bronze to improve wear resistance and thermal conductivity.

Properties of SKF Ecoflon 3

Property	Value / Description
Friction Coefficient	Extremely Low (0.05 - 0.1)
Temperature Range	-200°C to +200°C (Material limited by energizer)
Chemical Resistance	Excellent across most hydraulic fluids
Wear Resistance	High due to specialized fillers

While the PTFE lip handles the friction and chemical exposure, the **NBR70 energizer**provides the "memory" or elasticity that PTFE lacks. NBR70 offers excellent oil resistance and maintains its sealing force within a temperature range of -30°C to +100°C, which typically defines the operating envelope of the entire A25-F assembly in standard applications.

The SKF Economos Machining Advantage

One of the most significant aspects of the A25-F is that it belongs to the **SKF Machined Seals** category. Traditionally, seals are produced via injection molding, which requires expensive tooling and is only cost-effective for high volumes. The A25-F is manufactured using the **SKF SEAL JET** system.

Benefits of Machined Production

1. Customization: Virtually any dimension can be produced without tool charges. If a cylinder rod has been re-chromed to a non-standard diameter (e.g., 70.5 mm), a custom A25-F can be machined to fit perfectly.
2. Rapid Prototyping: Seals can be produced and shipped within 24 hours, minimizing downtime in critical industrial failures.
3. Material Quality: Machined seals are cut from semi-finished billets that have been compression-molded or extruded under highly controlled conditions, often resulting in superior material density compared to injection-molded parts.

Comparative Analysis: A25-F vs. A26-F and A27-F

The SKF catalog includes several variations of the "F" series wiper seals. Understanding the differences is vital for correct engineering specification.

Profile	Design Characteristics	Primary Application
A25-F	Standard PTFE wiper with energizer	General hydraulics, low friction requirements.
A26-F	Heavier scraping lip / Modified geometry	Heavy-duty applications with high particulate count.
A27-F	Integrated pressure relief features	Systems where pressure trapping between seals is a risk.

The **A26-F**, mentioned in the data as a related product, often shares the same material base (Ecoflon) but may feature a different housing fit or a more aggressive lip geometry for extreme environments like mining or cement production.

Operational Limits and Technical Constraints

To ensure the A25-F performs as intended, engineers must adhere to specific operational limits. A critical factor mentioned in technical documentation is the **Surface Speed Limit**.

Surface Speed and Lubrication

The A25-F is capable of handling surface speeds up to **4 m/s**, but there is a major caveat: *these values are only valid in the presence of a lubrication film.*

If the rod is completely dry, the friction between the PTFE lip and the metal rod can lead to localized heating. While PTFE is heat-resistant, the NBR energizer may undergo thermal degradation, losing its elasticity and resulting in a "dead" seal that no longer exerts pressure on the rod. Therefore, in high-speed applications, a microscopic film of oil must be maintained on the rod surface.

Surface Roughness (Tribology)

The finish of the reciprocating rod is equally important. For an Ecoflon-based seal like the A25-F, the following surface finish parameters are recommended:

- Ra (Arithmetical mean deviation): 0.05 to 0.3 µm
- Rz (Mean peak-to-valley height): 0.25 to 2.5 µm
- Rmax (Maximum peak-to-valley height): ≤ 6.3 µm

A surface that is too smooth will not hold a lubrication film, while a surface that is too rough will quickly abrade the PTFE lip.

Practical Implementation and Installation Guide

Proper installation of the A25-F is critical to prevent damage to the delicate PTFE lip. Unlike polyurethane seals, PTFE is less forgiving of being stretched or twisted during assembly.

Step-by-Step Installation Procedure

1. Groove Inspection: Ensure the housing groove is free of burrs, metal shavings, or old seal residue. The A25-F typically installs into an axially open groove or a split housing.
2. Cleaning: Clean the rod and the housing with a compatible solvent.
3. Lubrication: Apply a light coat of the system's hydraulic fluid to the seal and the rod.

4. Orientation: Ensure the scraping lip faces the external environment (outward from the cylinder).
5. Energizer Seating: Place the NBR O-ring into the groove first (if not pre-assembled), ensuring it is not twisted.
6. Lip Insertion: Carefully slide the PTFE element over the rod. If installing over threads or sharp shoulders, use an installation sleeve (bullet) to protect the lip.

Case Study: A25-F in High-Velocity Industrial Pressing

Consider a hydraulic press in an automotive stamping plant. The environment is filled with fine metallic dust and oil mist. The original polyurethane (PU) wipers were failing due to high heat generated by the 2 m/s cycle speed and the abrasive nature of the dust, which was embedding into the PU and scoring the rods.

The Solution: The engineering team switched to the **A25-F with Ecoflon 3**. The low-friction PTFE material reduced the heat generation, while the hardness of the carbon-filled Ecoflon prevented debris from embedding into the seal lip. The result was a 300% increase in the mean time between failures (MTBF) and a significant reduction in rod scoring costs.

Troubleshooting Common Failure Modes

Despite its robust design, the A25-F can fail if misapplied or improperly maintained. Below are common failure modes and their technical solutions.

1. Excessive Leakage (Bypassing)

If fluid is leaking past the wiper, it usually indicates that the **rod seal** (located further inside the cylinder) has already failed. However, if the wiper is not clearing the rod properly, it can "pump" fluid out. **Solution:**Check the NBR energizer for compression set. If the O-ring has flattened, the lip is no longer making contact.

2. Lip Chipping or Tearing

This is often caused by mechanical interference or ice buildup. **Solution:** In sub-zero environments, ensure the material selected is **G-Ecopur**or a specialized low-temperature PTFE compound that can handle the impact of ice scraping.

3. Premature Wear

If the PTFE lip wears down to the energizer quickly, the surface finish of the rod is likely too abrasive. **Solution:**Re-polish the rod to within the Ra 0.05 - 0.3 µm range and check for chemical compatibility between the fluid and the Ecoflon fillers.

The Future of Machined Sealing: Beyond A25-F

As industrial demands evolve, the A25-F profile continues to be a foundation for even more advanced iterations. The integration of **X-Ecopur** (a high-performance polyurethane) into similar geometries offers a bridge between the elasticity of rubber and the wear resistance of PTFE. Furthermore, the ability to produce these seals in **H-Ecopur** (hydrolysis-resistant) allows the A25-F logic to be applied to water-hydraulics and food-grade applications.

The A25-F remains a testament to the power of precision engineering and material science. By combining the friction-reducing properties of PTFE with the reliable energization of NBR, and leveraging the flexibility of the SKF Economos machining process, manufacturers can protect their hydraulic investments from the ever-present threat of contamination. Whether in a 70mm mobile crane cylinder or a 200mm industrial press, the A25-F provides the consistent, high-performance scraping action required for modern high-cycle machinery.

Ultimately, selecting the A25-F is an investment in system reliability. Understanding the technical nuances—from surface speed limits to the necessity of a lubrication film—empowers maintenance professionals and design engineers to maximize the efficiency and lifespan of their fluid power systems.

Tags: #SKF A25 F #Wiper Seals #Hydraulic Seals #Ecoflon 3 #Machined Seals #NBR70