

Comprehensive Engineering Guide to BITZER Refrigeration Lubricants: Technical Dynamics of BSE 32, BSE 170, and B320SH Systems

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In the high-precision world of industrial and commercial refrigeration, the lubricant is often described as the 'blood' of the system. However, for **BITZER** compressors—globally recognized for their engineering excellence—the role of refrigeration oil extends far beyond simple friction reduction. It serves as a coolant, a sealant, and a hydraulic medium for capacity control mechanisms. As the industry has transitioned away from ozone-depleting substances toward chlorine-free HFCs, HFOs, and natural refrigerants like CO₂ (R744), the chemistry of lubricants has undergone a fundamental evolution.

The Critical Role of Lubrication in Modern Compression Cycles

Lubrication in a refrigeration compressor is a complex discipline of tribology. Unlike standard automotive lubrication, refrigeration oils must coexist with a refrigerant in a closed loop, undergoing extreme temperature fluctuations from the cold suction gas to the high-heat discharge environment. The primary objectives of **BITZER refrigeration oils** such as the BSE and B320SH series include:

- **Hydrodynamic Lubrication:** Maintaining a thin film between moving parts (e.g., pistons, crankpins, and bearings) to prevent metal-to-metal contact.
- **Sealing:** In screw compressors (like the BITZER CSH series), the oil provides a critical seal between the rotors and the housing, which is essential for achieving high volumetric efficiency.
- **Heat Dissipation:** Transporting heat away from friction points and the motor windings in semi-hermetic designs.
- **Hydraulic Function:** Serving as the fluid to actuate sliders for step-less capacity control.

Chemical Fundamentals: POE vs. Mineral Oils

Historically, mineral oils (MO) and alkylbenzenes (AB) were the standards for CFC and HCFC refrigerants like R12 and R22. These oils were naturally miscible with chlorine-containing refrigerants. However, with the introduction of HFCs (R134a, R404A, R507), these traditional oils failed to mix. This lack of miscibility led to oil trapping in the evaporator, causing reduced heat transfer and eventual compressor seizure due to oil starvation.

The **BITZER BSE series** utilizes **Polyol Ester (POE)** chemistry. POE oils are synthetic lubricants specifically engineered to be miscible with chlorine-free HFCs. They are polar molecules, which gives them high affinity for metal surfaces but also makes them highly **hygroscopic** (capable of absorbing moisture from the atmosphere). This chemical characteristic dictates stringent handling and maintenance protocols.

Technical Analysis of BITZER BSE 32 and BSE 55

The **BITZER BSE 32** is the standard lubricant for the majority of BITZER ECOLINE reciprocating compressors when used with HFC refrigerants. Its viscosity is optimized for low and medium evaporation temperatures.

Physical Properties and Viscosity Indices

Viscosity is a measure of a fluid's resistance to flow. For refrigeration, we focus on **Kinematic Viscosity** measured in centistokes (cSt). The BSE 32 is formulated to maintain a stable viscosity index (VI), ensuring that the oil does

not become too thin at high discharge temperatures or too thick at low suction temperatures.

Metric	BITZER BSE 32	BITZER BSE 55
Viscosity @ 40°C	32.5 mm ² /s	55.0 mm ² /s
Viscosity @ 100°C	6.2 mm ² /s	10.1 mm ² /s
Flash Point	250°C	270°C
Density @ 15°C	1.003 g/cm ³	1.007 g/cm ³
Pour Point	-54°C	-51°C

The **BSE 55** is typically utilized in applications with higher pressure differentials or higher thermal loads, providing a thicker lubrication film to protect internal components under stress.

Advanced Lubrication: BITZER BSE 170 and B320SH

As we scale from reciprocating compressors to large-scale screw compressors, the lubrication requirements change dramatically. Screw compressors require higher viscosity oils to handle the high-speed rotation of the rotors and the sealing of the compression chambers.

BITZER BSE 170: The Heavyweight POE

BSE 170 is a high-viscosity POE oil designed for BITZER screw compressors (CS. and HS. series) operating with HFC and HFO/HFC blends. At a viscosity of 170 cSt at 40°C, it provides the necessary robust film strength to withstand the shearing forces found in screw rotors. This oil is critical for maintaining the **Oil Circulation Ratio (OCR)** required to cool the discharge gas before it exits the compressor.

BITZER B320SH: The HCFC Specialist

Unlike the BSE series, the **BITZER B320SH** is a synthetic lubricant specifically formulated for use with **R22** (and other HCFCs) in screw compressors with high discharge temperatures. While R22 is being phased out globally, many legacy systems in industrial plants still rely on the B320SH for its unique solubility characteristics with R22 at high pressures. It prevents the dilution of the oil at the bearing points, ensuring mechanical longevity.

Refrigerant-Oil Miscibility Dynamics

Miscibility is the ability of the refrigerant and oil to mix into a single homogenous phase. This is essential for **Oil Return**. In the evaporator, the temperature drops, and if the oil and refrigerant separate, the oil will coat the internal tubes of the heat exchanger, acting as an insulator and significantly dropping the COP (Coefficient of Performance) of the system.

The Critical Solution Temperature (CST)

The solubility of BITZER BSE 170 or BSE 32 in refrigerants like R404A is temperature-dependent. Engineers must consider the **Lower Critical Solution Temperature**. If the temperature in the evaporator falls below this point, the oil will 'fall out' of the refrigerant. BITZER POE oils are designed with ultra-low pour points and optimized solubility curves to prevent this phenomenon even in low-temperature blast freezers.

Selection Matrix for BITZER Lubricants

Selecting the wrong oil can lead to catastrophic failure. Use the following matrix as a technical reference for standard BITZER configurations:

Compressor Type	Refrigerant Type	Recommended BITZER Oil
Reciprocating (ECOLINE)	R134a, R404A, R507A, R407C	BSE 32
Reciprocating (Subcritical CO2)	R744 (CO2)	BSE 60K / BSE 85K
Compact Screw (CSH / CSW)	R134a, R407C, R404A	BSE 170
Semi-Hermetic Screw (HS series)	R22	B320SH
Open Drive Screw (OS series)	NH3 (Ammonia)	BCT 5 / Reniso KM 32

Handling Protocols and Maintenance Best Practices

Due to the **hygroscopic nature** of POE oils like BSE 32 and BSE 170, technical staff must adhere to strict handling procedures to prevent moisture contamination.

1. Moisture Control and Acidification

POE oils react with moisture in a process called **hydrolysis**. The reaction produces organic acids and alcohols. The equation can be simplified as: **Ester + Water $\rightarrow$ Acid + Alcohol**. These acids are highly corrosive to the motor windings in semi-hermetic compressors and can lead to 'motor burnout.' Always use a vacuum pump to reach a deep vacuum (below 500 microns) to boil off any moisture before charging the oil.

2. Oil Analysis and Replacement Intervals

A professional maintenance regime should include annual oil analysis. Key indicators to monitor include:

- Total Acid Number (TAN): Should typically be $\leq$ 0.1 mgKOH/g. High TAN indicates hydrolysis or oxidation.
- Viscosity Variance: A change of more than 10% indicates dilution or contamination.
- Moisture Content: Should be kept below 50 ppm (parts per million).
- Metal Content: High levels of Iron (Fe) or Copper (Cu) suggest bearing or bushing wear.

3. The Oil Charging Process

1. Ensure the compressor is isolated and the pressure is neutralized.
2. Use a dedicated oil pump to transfer oil directly from the original BITZER container into the crankcase.
3. Never leave the oil container open to the atmosphere for more than 10-15 minutes.
4. Replace the filter-drier whenever the oil is changed to ensure any residual moisture or acid is captured.

Troubleshooting Common Lubrication Failures

Technical field issues often manifest as oil-related failures. Understanding the root cause is essential for effective repair.

Oil Foaming at Start-up

When a compressor is off, refrigerant can migrate to the crankcase and dissolve into the oil. Upon start-up, the sudden drop in pressure causes the refrigerant to flash into gas, creating foam. This foam is a poor lubricant and can cause instant bearing damage. **Solution:** Always ensure the crankcase heater is energized at least 24 hours before starting a BITZER compressor.

Copper Plating

Small amounts of moisture and acid can dissolve copper from the system piping and deposit it on hot surfaces like discharge valves and bearings. This 'copper plating' reduces clearances and leads to mechanical seizure. **Solution:** Strict moisture control and the use of high-quality POE oils like BSE 170.

Oil Discoloration (Varnish/Sludge)

If the discharge temperature exceeds the thermal stability limit of the oil (typically above 120°C for sustained periods), the oil begins to thermally decompose, forming carbon sludge and varnish. **Solution:** Monitor discharge temperatures and ensure proper cooling of the compressor heads (e.g., using Varistep or external fans).

The Future of BITZER Lubrication: CO2 and Low-GWP Refrigerants

As the industry moves toward **R744 (CO2)** and **HFOs (like R1234ze)**, lubrication chemistry is shifting again. CO2 is a highly solvent refrigerant that can significantly thin out oil. BITZER has responded by developing the **BSE 60K** and **BSE 85K** series, which feature specialized additives to maintain lubricity in high-pressure transcritical CO2 environments.

Furthermore, the compatibility of lubricants with the new generation of A2L (mildly flammable) refrigerants requires oils that provide high chemical stability and a high flash point to ensure safety and system reliability. The research and development behind BITZER oils ensure that as refrigerants evolve, the mechanical integrity of the compressor remains uncompromised.

Conclusion: Optimizing System Longevity

The selection and management of BITZER refrigeration oils are not mere administrative tasks but critical engineering decisions. Whether utilizing the standard **BSE 32** for a supermarket rack or the heavy-duty **B320SH** for an industrial screw chiller, understanding the chemical and physical properties of these lubricants is paramount. By adhering to strict moisture control, performing regular oil analysis, and matching the lubricant precisely to the refrigerant and compressor type, operators can ensure their BITZER systems deliver decades of efficient, reliable cooling. In the complex intersection of chemistry and mechanical engineering, high-quality lubrication remains the ultimate safeguard against system failure.

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