

The Engineering Blueprint of Atlas Copco GX 7 and GX 11 Rotary Screw Compressors: A Technical Deep Dive

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In the high-stakes environment of industrial manufacturing, the reliability of compressed air systems is not merely a convenience—it is a critical utility. Among the most respected names in this domain is Atlas Copco, particularly their GX series, including the GX 7 and GX 11 oil-injected rotary screw compressors. These machines are engineered to bridge the gap between smaller piston compressors and large-scale industrial units, offering continuous duty, high efficiency, and low noise levels. This comprehensive technical guide analyzes the mechanical architecture, operational logic, and maintenance protocols of the Atlas Copco GX range, providing engineers and facility managers with the insights needed to optimize their compressed air infrastructure.

1. The Fundamentals of Oil-Injected Rotary Screw Technology

The core of the Atlas Copco GX 7 and GX 11 lies in the **rotary screw element**. Unlike reciprocating compressors that use pistons to displace air in pulses, the rotary screw employs two intermeshing helical rotors—the male and the female—to compress air continuously. As the rotors turn, the space between them decreases, effectively reducing the volume of the trapped air and increasing its pressure.

1.1 The Role of Lubrication and Sealing

In an **oil-injected** system, lubricating oil is injected into the compression chamber for three primary reasons:

- **Sealing:** The oil fills the microscopic gaps between the rotors, preventing air from leaking back to the intake (internal leakage), which significantly improves volumetric efficiency.
- **Cooling:** Compression generates heat (heat of compression). The oil absorbs this thermal energy and carries it away to be cooled by the oil cooler (radiator), ensuring the machine operates within safe thermal limits.
- **Lubrication:** It prevents metal-to-metal contact between the rotors and lubricates the high-speed bearings.

1.2 Thermodynamic Efficiency

The GX series is designed to approach **polytropic compression**, though in reality, it falls between adiabatic and isothermal processes. By injecting oil to absorb heat, the GX series keeps the temperature rise much lower than that of a "dry" compressor. This reduction in discharge temperature means less energy is required to reach the target pressure, adhering to the principle where work (W) is a function of the temperature delta: $W = m * Cp * (T2 - T1)$. Reducing $T2$ via oil cooling lowers the overall power consumption.

2. Technical Specifications and Performance Analysis

Understanding the distinction between the GX 7 and GX 11 is vital for proper sizing and application. The following table provides a comparative analysis of the technical parameters typically found in the Atlas Copco GX instruction books.

Feature/Parameter	GX 7 (Standard)	GX 11 (Standard)	Unit of Measure
Nominal Power	7.5	11.0	kW
Maximum Pressure	10.0 / 145	10.0 / 145	bar / psi
FAD (Free Air Delivery)	~11.5 - 13.5	~16.0 - 18.5	l/s
Noise Level	66 - 69	68 - 71	dB(A)
Weight (Tank Mounted)	265	280	kg
Oil Capacity	3.2	3.2	Liters

2.1 Free Air Delivery (FAD) Considerations

It is important to note that **Free Air Delivery (FAD)** is the actual volume of air compressed and delivered at the outlet, measured at ambient conditions. Designers must account for altitude and ambient temperature, as the air density changes ($\rho = P / RT$), which can impact the actual mass flow rate of the GX 11 in thinner or hotter air environments.

3. Operational Logic: The Electropneumatic (EP) Control System

The **GX 7 EP** (Electropneumatic) model utilizes a sophisticated load/no-load control mechanism. This system is designed to minimize energy waste during periods of fluctuating air demand. When the pressure reaches the upper set point (unloading pressure), the inlet valve closes, and the compressor runs in "unloaded" mode. During this phase, the internal pressure is vented, and the motor continues to run but consumes significantly less power.

3.1 Load/No-Load Workflow

1. Start-up: The motor starts (often via a Star-Delta starter to reduce inrush current). The inlet valve is closed to reduce the starting torque.
2. Loading: Once the motor reaches full speed, the solenoid valve activates, opening the inlet valve and allowing air to be compressed.
3. Unloading: Upon reaching the maximum pressure setting, the pressure switch signals the solenoid valve to close the intake. The machine enters a "run-on" timer phase to prevent frequent motor starts, which can cause thermal damage.
4. Shutdown: If no air is demanded during the run-on period, the motor stops, entering standby mode.

3.2 Specific Energy Consumption (SEC)

The efficiency of the GX series can be measured by its **Specific Energy Consumption (SEC)**, calculated as the power consumed (kW) divided by the flow rate (m³/min). A well-maintained GX 7 should maintain a consistent SEC. If the SEC rises, it typically indicates a clogged air filter or a failing oil separator, forcing the motor to work harder against increased internal resistance.

4. Installation and Electrical Safety Protocols

As emphasized in the **Atlas Copco Instruction Books**, safety is the paramount concern during installation. Screw compressors contain high-voltage electrical circuits and high-pressure components that can be lethal if mishandled.

4.1 Electrical Requirements

Before any work is performed on the electrical circuit, the power supply **must be disconnected**. For the GX 7 and GX 11, the following electrical considerations are mandatory:

- Cable Sizing: Must comply with local regulations and the specific motor amperage (FLA) listed on the data plate.
- Phase Rotation: Unlike piston compressors, rotary screw compressors cannot run in reverse. Even a few seconds of reverse rotation can destroy the screw element due to lack of lubrication and mechanical interference. A phase sequence indicator must be used during commissioning.
- Grounding: Proper earthing is required to prevent electrostatic buildup and to protect the control electronics.

4.2 Ambient Environment and Ventilation

The GX series is air-cooled. Therefore, the compressor room must have adequate ventilation. If the ambient temperature exceeds 40°C (104°F), the oil's ability to cool the compression process is compromised, leading to "High Discharge Temperature" shutdowns. The formula for required ventilation airflow is: $Q_v = 1.05 * N / 9EB$ where N is the motor power in kW and 9EB — 2 F†R ÆÆðwed temperature rise in the room.

5. Maintenance and Service Intervals

To maintain the industry-leading longevity of Atlas Copco equipment, adherence to the service schedule is non-negotiable. The GX series typically follows a 4,000-hour or annual service interval.

5.1 Preventive Maintenance Checklist

Component	Frequency	Action Required
Air Filter	Every 2,000 hrs	Inspect/Clean. Replace if pressure drop is high.
Oil Filter	Every 4,000 hrs	Replace to ensure clean lubricant flow.
Oil Separator	Every 4,000 hrs	Replace to prevent oil carryover into the air lines.
Compressor Oil	Every 4,000 hrs	Drain and refill with Atlas Copco Roto-Inject ND fluid.
Drive Belts	Every 500 hrs	Check tension and alignment. Replace if frayed.

5.2 The Crucial Role of the Oil Separator

The oil separator is the most critical consumable in the GX 7. It is a multi-layered coalescing filter that separates the oil mist from the compressed air. If this component fails or becomes saturated, oil will enter the plant air system, potentially ruining downstream pneumatic tools or products. A differential pressure gauge (if equipped) or a sudden drop in oil level is an indicator of separator failure.

6. Troubleshooting Common Operational Issues

Even with high-quality engineering, mechanical systems can experience faults. Technical personnel should be trained to diagnose symptoms systematically.

6.1 High Discharge Temperature (HDT)

The most common fault in oil-injected compressors. Causes include:

- Low Oil Level: Insufficient thermal mass to absorb heat.
- Dirty Oil Cooler: Dust and debris blocking the fins of the radiator.
- Thermostatic Valve Failure: The valve remains closed, preventing oil from circulating through the cooler.
- Incorrect Oil Type: Using oil with the wrong viscosity or thermal stability.

6.2 Compressor Fails to Load

If the motor is running but the machine is not producing air, the issue usually lies within the **loading solenoid** or the **unloader valve**. Check the electrical signal to the solenoid; if voltage is present but the valve does not actuate, the solenoid coil is likely burnt out. If the solenoid works, the internal piston of the unloader valve may be stuck due to varnish buildup from old oil.

6.3 Excessive Noise or Vibration

While the GX series is known for being quiet, sudden increases in noise levels can indicate bearing wear in either the motor or the screw element. Use a vibration pen to check for abnormal frequencies. Additionally, check the **belt tension**; loose belts can cause a high-pitched squealing during the loading phase.

7. Advanced Optimization: Integration and Air Quality

A GX 11 compressor is only one part of a compressed air system. For maximum efficiency, downstream

components must be integrated correctly.

7.1 Integrated Dryers and Filters

Many GX models are available with integrated refrigerant dryers. These dryers lower the pressure dew point (PDP) of the air, ensuring that water vapor does not condense in the pipes. In a workshop environment, dry air is essential to prevent corrosion and tool failure. The dryer uses a separate refrigerant circuit (usually R134a) to chill the air, causing moisture to drop out in a moisture separator.

7.2 Piping and Storage

The **Air Receiver Tank** (often 200L to 500L for the GX range) acts as a buffer. A larger tank reduces the number of load/unload cycles, which saves energy and extends the life of the motor starter. Piping should be sized to keep the air velocity below 6 m/s to minimize pressure drops. For a GX 11, a 1-inch or 1.5-inch main header is usually recommended.

8. Theoretical Foundations: The Screw Profile Evolution

Atlas Copco's market leadership is largely due to its proprietary rotor profiles. The evolution from the original symmetric profiles to the current **asymmetric profiles** has significantly reduced internal blow-hole losses. The geometry of the GX 7 rotors is designed to optimize the "sealing line," the boundary where the two rotors meet. By minimizing the length of this line and the size of the "blow-hole" (the small triangular gap at the end of the rotors), Atlas Copco has achieved a higher volumetric efficiency compared to generic alternatives.

8.1 Mathematical Model of Compression Ratio

The pressure ratio ($P_{\text{discharge}} / P_{\text{suction}}$) is a key parameter. For a GX series operating at 10 bar, the ratio is approximately 11 (considering atmospheric pressure). The internal volume ratio (V_i) of the screw element must be matched closely to this pressure ratio to avoid "under-compression" or "over-compression" losses, which manifest as noise and wasted energy at the discharge port.

The Atlas Copco GX 7 and GX 11 represent a pinnacle of small industrial compressor engineering. By combining the continuous-duty capabilities of the rotary screw with an intelligent electropneumatic control system and a robust safety-first design, these machines provide a reliable foundation for any compressed air dependent operation. However, the longevity and efficiency of these units are inextricably linked to the quality of their installation and the rigor of their maintenance. Facility managers must prioritize the use of genuine Atlas Copco parts and adhere strictly to the guidelines provided in the instruction books to ensure that their investment continues to deliver high-quality, oil-separated compressed air for years to come. Understanding the thermal, mechanical, and electrical principles outlined in this guide allows for a more proactive approach to utility management, transforming a simple piece of machinery into a optimized asset for industrial productivity.

Baca Juga (Artikel Terkait)

- [Comprehensive Technical Guide to AIRMAN PDS Series Portable Diesel Air Compressors: Operation, Maintenance, and Engineering Specifications](#)

URL: <http://alghafgolden.com/airman-pds-series-compressor-technical-guide.pdf>

- [The Ultimate Technical Guide to Airman PDS 185 Series: Engineering, Operation, and Maintenance](#)

URL: <http://alghafgolden.com/airman-pds185-technical-guide-operation-maintenance.pdf>

- [Comprehensive Engineering Guide to Atlas Copco GA Series: Rotary Screw Compressor Technology and Operational Excellence](#)

URL: <http://alghafgolden.com/atlas-copco-ga-series-rotary-screw-compressor-guide.pdf>

- [Comprehensive Technical Guide to Atlas Copco GA 11-26 Rotary Screw Compressors: Maintenance, Parts, and Engineering Excellence](#)

URL: <http://alghafgolden.com/atlas-copco-ga-11-26-compressor-technical-guide.pdf>

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