



TECHNICAL GUIDE

Air Dryer: Faults, Replacement & Maintenance Guide

Heavy commercial vehicle Air Dryer: fault symptoms, step-by-step replacement and maintenance. VADEN ORIGINAL technical guide.

What Is an Air Dryer? Its Function and Operating Principle

The air dryer is a critical safety component in the pneumatic brake system of heavy commercial vehicles (trucks, tractors, buses) that removes moisture and oil from the hot, moist, oil-vapour-laden compressed air coming from the compressor before it enters the air reservoirs (tanks). As the compressor compresses the air, it inevitably carries ambient moisture and some engine oil into the system. This moisture condenses in the tanks and causes corrosion, freezes valves and lines in winter, while the oil degrades valve diaphragms and seal surfaces. The air dryer stops these two enemies at the system's inlet.

At its heart is a **desiccant (moisture-absorbing) cartridge**. The cartridge is filled with hygroscopic desiccant beads (usually molecular-sieve / silica based) with a very large surface area. In modern "oil coalescing" (oil-separating) cartridges there is also a coalescing (oil-trapping) layer ahead of the desiccant bed.

On heavy commercial vehicles the most common dryer types are the Bendix **AD-9 / AD-IP / AD-HFi**, the Wabco (ZF) **single-cartridge dryer and EAC/LA series**, the Knorr-Bremse **LA-series air dryers**, and **Haldex** dryers. On most of these brands the desiccant cartridge is supplied separately as a spin-on consumable part and can be replaced as an OE equivalent.

Charge Cycle

When the compressor produces pressure (governor in the "cut-in" position), moist air enters the dryer. First, larger water and oil droplets are captured in the oil-separator / coalescing section; then, as the air passes through the desiccant column, moisture adheres to the desiccant surface (adsorption). The dry air leaving the column pushes open the outlet check valve and fills the wet tank (the first reservoir).

Purge (Discharge/Regeneration) Cycle

When system pressure reaches the governor "cut-out" value (typically around 8.6 bar / 125 psi; set within a 7.2–9.7 bar / 105–140 psi range depending on the vehicle and governor type), the compressor is unloaded. At this moment the **purge valve** at the base of the dryer opens to atmosphere. As the pressurised air inside the dryer is expelled with a sudden "pfff", part of the small volume of dry air at the top of the cartridge flows back through the desiccant bed in the reverse direction. This dry reverse-flow strips the moisture the desiccant has just captured and sweeps it out through the valve to atmosphere — that is, it "reactivates" the desiccant. It normally takes **15–30 seconds** for the entire purge volume to pass through the desiccant bed. Thanks to this self-regeneration, the cartridge can work for thousands of cycles.

There are three lines connected to the dryer, and recognising them is important in diagnosis: (1) the main supply line coming from the compressor, (2) the dry outlet line going to the wet tank, (3) the thin control/signal line going to the governor — this line carries the "open/close" signal to the purge valve as pressure.

💡 **TIP —** A schematic showing the three lines and the charge/purge direction speeds up diagnosis. *[Image placeholder: "Air dryer connection diagram – compressor supply line → coalescing/desiccant column → outlet check valve → wet tank; below, the purge valve and governor control line; flow upward in the charge cycle, reverse (downward/atmosphere) in the purge cycle"]*. This diagram is also a reference for verifying, before installation, which port goes to which line.

💡 **TIP —** To keep the purge valve and discharge port from freezing in winter, the dryer body has a built-in **electric heater + thermostat** (12 V or 24 V). The thermostat engages only in the cold. Some winter complaints of constant purging/freezing are caused by a faulty heater.

Fault Symptoms and Diagnosis

Air dryer faults are usually noticed as "water is coming into the tanks" or "it keeps leaking air". The table below speeds up field diagnosis; afterwards we address each main symptom separately.

Symptom	Possible Cause	Check / Verification
Continuous air leak from the purge valve (the hissing does not stop even though the compressor has filled)	Purge valve diaphragm torn/stuck open, dirty seat surface; valve frozen due to heater failure	Listen to the valve after cut-out; if it does not stop, confirm the leak with soapy water
Water / water+oil mixture coming from the tanks	Desiccant cartridge saturated or coated with oil; cartridge replacement interval exceeded	Open the wet-tank drain valve and inspect the liquid coming out
Tanks drain when the engine stops (does not hold pressure)	Outlet check valve leaking	Fill to cut-out, stop the engine, measure the rate of pressure drop
No purge at all, compressor never unloads	Governor fault or blocked control line; purge valve stuck	Check the governor control-line pressure and the valve movement
Oil being expelled from the purge	Compressor passing excessive oil; cartridge clogged with oil	Inspect the base of the cartridge and the discharge port; assess compressor oil passing
Freezing in the lines / brake sticking in winter	Heater/thermostat fault, saturated cartridge passing moisture	Measure the heater resistance/supply (reference values below); assess the cartridge condition

Is there continuous purging/air leakage?

A short purge burst after the compressor reaches "cut-out" and unloads is **NORMAL**. If this burst does not end and turns into continuous hissing, the purge valve is not closing. The most common causes are a torn diaphragm, dirt/debris caught on the seat surface, or a valve frozen in winter. On some integrated purge types, the valve can stick open after purging.

Is water getting into the tank?

If noticeable water comes from the manual drain of the wet tank, the desiccant can no longer hold moisture. If the liquid is clear water it is classic cartridge saturation; if it is dark, an emulsion (oil+water), the compressor's oil passing has finished off the cartridge early, and replacing the cartridge alone may not be enough.

Is it not holding pressure?

Tanks draining rapidly when the engine stops most often points to the dryer's outlet check valve; this valve should prevent tank air from leaking back through the dryer. To tell whether the leak is in the dryer or in the brake valves, a pressure-drop test is carried out (see "Technical Values" below).

Replacement / Installation Steps

The steps below are for spin-on desiccant cartridge replacement and/or complete dryer installation on heavy diesel vehicles. Make the vehicle safe before starting.

- 1** Stop the engine, chock the vehicle and apply the parking (hand) brake. During cartridge replacement, watch out for the parking-brake spring releasing; if necessary, mechanically lock the park chambers with caging bolts.
- 2** **Exhaust all the air in the system.** Bring the pressure of every tank (wet tank, primary, secondary, park) to zero from its drain valve. Do not disconnect any connection until you see 0 bar on the gauge.
- 3** Disconnect the heater/thermostat electrical connector (on complete dryer replacement). Label the connecting lines (supply, outlet, governor control).
- 4** **Spin-on cartridge:** Undo the cartridge anticlockwise with a suitable strap/chain wrench. Pressurised air may remain inside the cartridge; loosen it in a controlled way.
- 5** Clean the gasket seating surface and the o-ring groove on the dryer body. Fully remove old o-ring/gasket residue; the surface must be free of scratches and rust.
- 6** Apply a thin film of clean system oil or the manufacturer's recommended grease to the top gasket of the new cartridge (do not fit it dry).
- 7** **Turning the cartridge by hand,** fit it until the gasket CONTACTS the body; then tighten it a further **one full turn (360°)** clockwise by hand. Do not over-tighten with a strap wrench — the gasket will be crushed and leak.
- 8** On types held by a central shoulder bolt, tighten this bolt to the manufacturer's torque, typically **~7–9 Nm (60–80 in-lb)**.
- 9** On complete dryer installation, connect the supply, outlet and governor control lines to the correct ports; plug in the heater connector.

- 10 Charge the system: start the engine and build pressure up to the governor cut-out value. A clear purge burst should be heard at cut-out.
- 11 Leak-check all connections and the cartridge gasket with soapy water. Then perform the pressure-drop test.
- 12 Open the wet-tank drain and verify that the air coming out is dry.

Points to Watch (Common Mistakes)

⚠ CAUTION — Do not disconnect any connection, cartridge or purge valve without FULLY exhausting the system. On heavy diesel vehicles, the high-pressure air stored in the tanks can cause serious injury. Seeing 0 bar on the gauge is mandatory.

⚠ CAUTION — Do not underestimate the energy of the parking-brake spring (spring brake). When system pressure drops, the parking brake engages; having the vehicle chocked during cartridge replacement is vital.

- **Replacing only the cartridge and ignoring the purge valve:** A significant share of continuous-purge/moisture complaints lie in the purge valve. Renewing the purge valve kit (diaphragm + seat) together with the cartridge during service prevents repeat faults.
- **Over-tightening the cartridge with a strap wrench:** The correct method is "gasket contact + one full turn by hand". Over-tightening crushes the gasket, makes removal impossible, and causes leaks.
- **Fitting the gasket dry:** An unlubricated gasket twists during installation and leaks. A thin film of lubrication is essential.
- **Ignoring a compressor that passes oil:** Oil coats the desiccant and finishes off even a new cartridge quickly. If an emulsion (oil+water) is seen, the root cause is the compressor/excess oil; replacing only the cartridge is a temporary fix.
- **Connecting the wrong line:** Connecting the governor control (thin) line to the outlet port will not operate the purge. Label before disassembly.
- **Forgetting to connect the heater supply:** This leads to winter freezing and recurring purge faults.
- **Blowing compressed air toward the eyes / opening a port under pressure:** Wear safety glasses.

Technical Values and Check Points

The values below are general-safe references for heavy diesel air brake systems. **The exact value is always per the vehicle/dryer manufacturer's service card;** the governor setting, heater resistance and torque values vary by model.

- **Governor cut-in / cut-out:** Common combinations are 7.2/8.6 bar (105/125 psi), 7.2/9.0 bar (105/130 psi) and 8.3/9.7 bar (120/140 psi). The purge is triggered at cut-out.

- **Purge duration:** A purge flow of ~15–30 s after cut-out is normal for desiccant regeneration.
- **Pressure-drop test:** Fill to cut-out, stop the engine; with the service brakes released, the acceptable drop is ~1 psi/min (≈ 0.07 bar/min) for a single vehicle and ~3 psi/min (≈ 0.2 bar/min) for a tractor-trailer combination. A faster drop points to a check-valve/system leak.
- **Cartridge installation torque:** By hand, "gasket contact + 1 full turn". On the central shoulder-bolt type, ~7–9 Nm (60–80 in-lb).
- **Heater voltage and resistance:** 12 V or 24 V depending on the vehicle system; thermostat controlled. When measuring the heater element, the typical cold resistance is around **1.5–3 Ω** on 12 V units (about 4–8 A draw) and around **6–12 Ω** on 24 V units (about 2–4 A draw). On an ohmmeter, **infinite resistance (open circuit)** = a broken/faulty element, while a very low (short-circuit) value indicates a winding fault. Rely on the service card for exact values.
- **Oil-passing reference:** Even a healthy compressor can pass up to a litre of oil per year; that is why an oil-coalescing cartridge and regular replacement matter.

OE Type / Cross-Reference (Dryer and Cartridge)

The dryer families commonly encountered in the field and the equivalent desiccant-cartridge logic are below. VADEN offers OE-equivalent cartridges and purge valve kits for these families; for the correct equivalent according to your vehicle chassis/OE number, rely on the application list on our product page.

OE manufacturer / type family	Common use	Service part
Bendix AD-9 / AD-IP / AD-HFi	North American and export-type tractors/trucks	Spin-on desiccant cartridge + purge valve kit
Wabco (ZF) single-cartridge dryer / EAC-LA	European-built trucks and buses (common)	Spin-on desiccant cartridge; integrated valve block on some types
Knorr-Bremse LA series	European-built heavy commercial vehicles	Spin-on desiccant cartridge
Haldex air dryer	Trailer/tractor applications	Desiccant cartridge

Note: The OE number and equivalent match vary by vehicle model; always carry out a vehicle/chassis-based application check before installation.

TIP — The nature of the liquid coming from the wet-tank drain is the most practical diagnostic indicator: a clear drop = normal condensation; continuous water = cartridge saturation; dark emulsion = oil passing + cartridge finished.

Maintenance and Service Life

The desiccant cartridge is a consumable part and requires regular replacement. Its life depends on the age and oil passing of the compressor, the vehicle's air consumption (number of axles, vocation), the operating environment and the moisture level.

- **Standard line-haul (≤ 5 axles):** Typically ~24 months or ~320,000 km (200,000 miles) with oil-coalescing cartridges.

- **Medium-heavy use (double trailers, light off-road, ≤8 axles):** ~18 months or ~240,000 km (150,000 miles).
- **Heavy/vocational use or a compressor that passes oil:** More frequent replacement is required; monitor the wet-tank water regularly.
- The complete dryer body (types similar to the Bendix AD-9) typically has a 3–5 year service interval in line-haul; however, the cartridge is renewed more frequently than this.

These month/km values are general-safe industry references, and **the exact interval should always be determined according to the vehicle or dryer manufacturer's service bulletin/maintenance schedule** (e.g. Bendix, Wabco/ZF and Knorr-Bremse service documents tie cartridge life to the usage profile). For vehicles that pass oil or operate in a very humid climate, manufacturers recommend a shortened interval.

Should the wet tank be drained manually or automatically?

Even though the air dryer holds most of the moisture, some condensation can build up over time in the wet tank; that is why there is a drain point under the wet tank. There are two methods:

- **Manual drain valve:** The driver/technician drains the tank by pulling the ring.
Recommendation: drain the wet tank **every day (end of shift)** in winter and humid conditions, and at least **once a week** in mild conditions. The amount and colour of the liquid coming out is also an indicator of cartridge health.
- **Automatic drain valve:** A valve that is triggered by pressure changes and expels accumulated liquid on its own. It makes the manual-drain discipline easier; however, it too can clog/freeze, so it should be checked periodically to see whether it is working. If noticeable water begins to appear, the priority is again the condition of the desiccant cartridge.

A good maintenance routine is: renew the purge valve kit together with the cartridge at every service (cartridge replacement), drain the wet tank at the above frequency and observe the liquid quality, test the heater/thermostat before winter, and monitor whether the compressor is passing excessive oil. If the cartridge replacement interval is unknown, it is time to replace when the water coming from the wet tank starts to increase.

For related maintenance topics, you can review our content on [air compressor faults and maintenance](#), [pressure regulator \(governor\) adjustment](#) and [brake valves technical guide](#); the air dryer works as a system together with these components.

Frequently Asked Questions

How often should the air dryer purge — is constant hissing normal?

The dryer performs a short 15–30 second purge once, each time the compressor reaches cut-out. If air keeps leaking from the purge valve even though the compressor is full, this is NOT NORMAL; usually the purge valve diaphragm or seat surface is faulty, or in winter a frozen valve may be involved.

Water is coming into my tanks — will replacing the cartridge fix it?

If clear water is coming out, the desiccant cartridge is usually saturated and replacement fixes it. But if the liquid is an oil+water emulsion, the real cause is the compressor passing excessive oil; in that case replacing only the cartridge will be short-lived, and the compressor/oil source must also be addressed.

How tight should I make the cartridge — is a torque wrench essential?

A torque wrench is not needed for spin-on cartridges: lubricate the gasket with a clean film of oil, turn it by hand, and after the gasket contacts the body, tighten it a further one full turn by hand. On types held by a central bolt, tighten the bolt to the manufacturer's torque (~7–9 Nm). Over-tightening with a strap wrench crushes the gasket and causes leaks.

Pressure drops rapidly when I stop the engine — is the dryer to blame?

It could be. If the dryer's outlet check valve leaks, tank air escapes back through the dryer. Perform a pressure-drop test: the acceptable drop is ~1 psi/min for a single vehicle and ~3 psi/min for a combination. Above this, there is a check valve or system leak.

My dryer freezes in winter — what should I do?

Check the built-in heater and thermostat; verify that it operates at the correct voltage (12 V/24 V) and that its connector is plugged in. Measure the heater element with an ohmmeter: an open circuit (infinite resistance) indicates the element is broken; the typical value is ~1.5–3 Ω at 12 V and ~6–12 Ω at 24 V. If the heater is sound, also assess the cartridge condition, since a saturated cartridge can pass moisture into the tanks and cause freezing in the lines.

What is the difference between an oil-coalescing cartridge and a standard cartridge?

An oil-coalescing cartridge has an oil-trapping (coalescing) layer ahead of the desiccant bed; by capturing the oil aerosol coming from the compressor it protects the desiccant, so it both delivers cleaner air and extends cartridge life. It is preferred on vehicles that pass oil or are in heavy use.

To guarantee the brake air quality of your heavy diesel vehicle, renewing your desiccant cartridge on time and correctly is the cheapest insurance. The VADEN Air Dryer product family is developed to make this maintenance routine easier, with OE-equivalent cartridge and purge valve solutions suited to Bendix AD-9, Wabco/ZF, Knorr-Bremse LA and Haldex type dryers; for the product and technical values suited to your vehicle model, you can review our product pages.