How does a pilot-operated 3-way solenoid valve work ?

A pilot-operated 3-way solenoid valve is an electromechanical valve used to control the direction of fluid or compressed air flow in industrial systems.
Unlike direct-acting valves where the solenoid plunger physically opens and closes the main orifice, a pilot-operated valve uses system pressure ("the pilot") to do the heavy lifting, allowing a small electrical coil to control high-pressure or high-flow lines.

How it works?

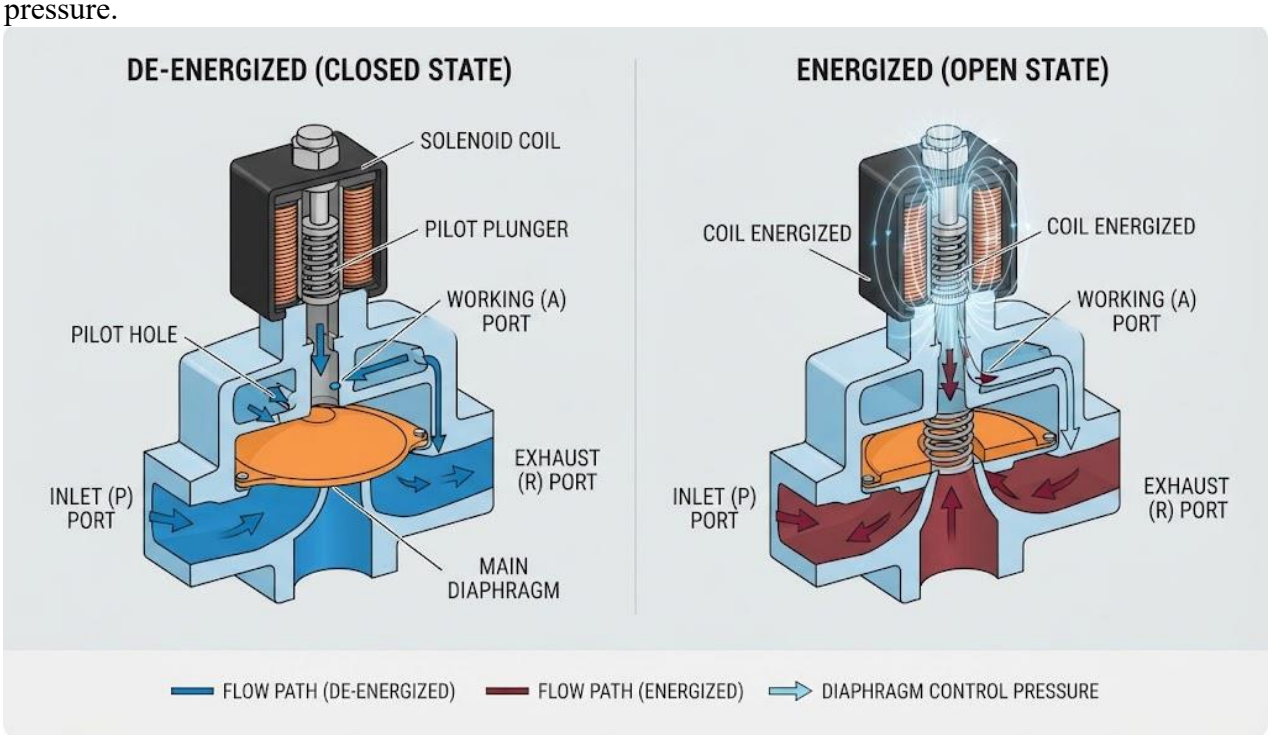
A 3-way valve features three ports (typically designated as Inlet/Pressure, Cylinder/Working, and Exhaust) and operates across two main states:

- **Closed State: (De-Energized coil)**

The solenoid coil is off, and spring pushes the pilot plunger down to seal a small pilot bleed orifice

Fluid pressure equalizes across both sides of the main diaphragm or piston, keeping it closed against the main inlet seat

In this position, the working port (cylinder) is typically connected to the exhaust port to release pressure.



- **Open State: (Energized coil)**

When power is applied, the solenoid coil generates a magnetic field that pulls the plunger up, opening the pilot orifice.

This allows fluid above the main diaphragm to vent out faster than it can enter through the bleed hole.

The resulting pressure drop causes the main valve to lift, opening the flow path from the inlet port to the working port while closing the exhaust.

When it is used?

Pilot-operated 3-way valves are ideal for applications requiring high flow rates or higher pressures where a direct-acting valve would require an excessively large, power-hungry coil.
Common applications include:

- **Actuator Control:**

Operating single-acting pneumatic or hydraulic cylinders, where air/fluid needs to be supplied to extend the cylinder and then exhausted to let it retract.

- **Industrial Automation:**

Directing pilot signals to larger pneumatic process valves or directional control banks.

- **Fluid and Gas Circuits:**

Controlling directional paths in automated manufacturing equipment, commercial irrigation systems, and HVAC machinery.