



★ 2026 EDITION ★

HVAC COMPRESSOR HANDBOOK

COMPLETE GUIDE TO HVAC COMPRESSORS, REFRIGERANTS & TROUBLESHOOTING

FROM BASIC CONCEPTS TO ADVANCED COMPRESSOR DIAGNOSTICS



WHAT YOU WILL LEARN

- COMPRESSOR TYPES
- REFRIGERANTS
R22, R410A, R32, R454B
- ELECTRICAL TROUBLESHOOTING
- FAILURE ANALYSIS
- MAINTENANCE TIPS
- INTERVIEW QUESTIONS

SCAN FOR HVAC NOTES & UAE JOB UPDATES

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★ ★ PREPARED BY ★ ★
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PROFESSIONAL HVAC TRAINING SERIES – VOL. 1

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FACEBOOK PAGE

Types of Compressors in HVAC

What is a Compressor?

compressor is the heart of an HVAC and refrigeration system. Its main job is to compress refrigerant gas and circulate it through the system.

In HVAC and refrigeration systems, there are 5 main types of compressors:

- Reciprocating Compressor
- Rotary Compressor
- Scroll Compressor
- Screw Compressor
- Centrifugal Compressor

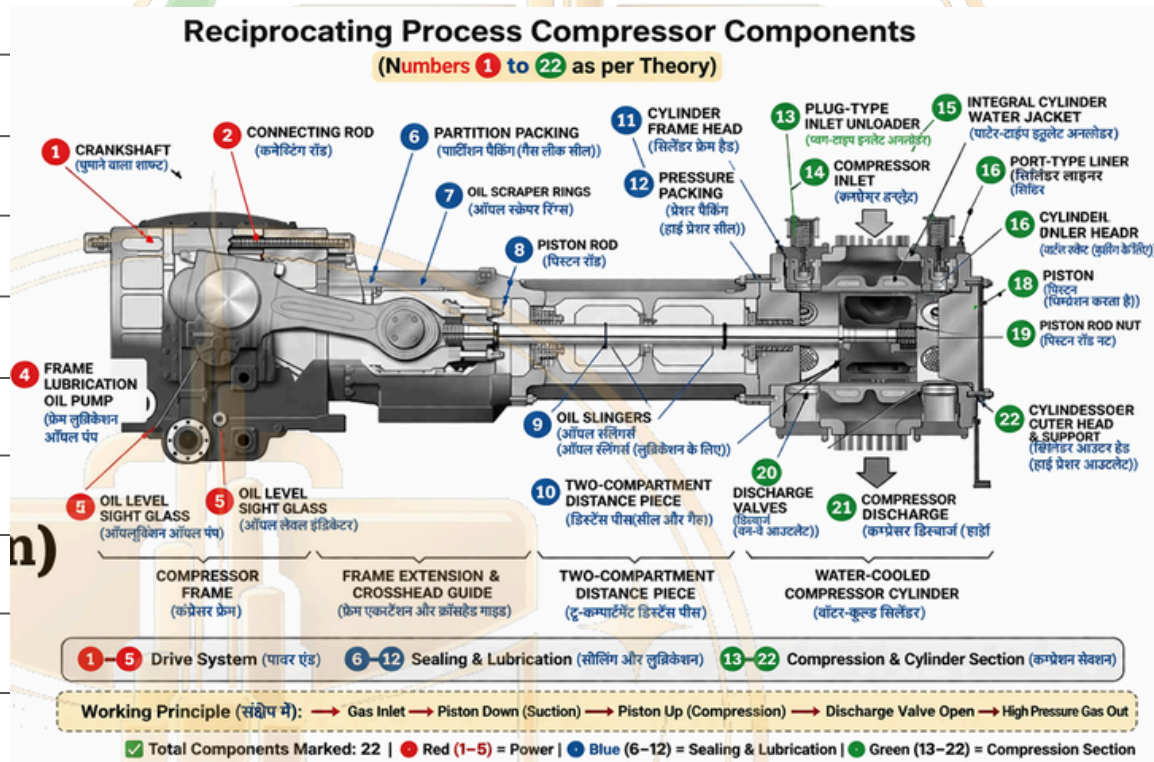
Simple Understanding

Main Type	Simple Meaning
• Reciprocating	Piston type compressor
• Rotary	Small AC compressor
• Scroll	Spiral type compressor
• Screw	Industrial continuous compressor
• Centrifugal	Large high-capacity compressor

1. Reciprocating Compressor

What is a Reciprocating Compressor?

A reciprocating compressor is a piston-type compressor. In this compressor, the piston moves up and down inside a cylinder and compresses the gas. It is used for high-pressure applications.



Where is it used?

- Oil and gas plants
- Chemical industries
- Refineries
- Gas pipeline compression systems

Main Components of a Reciprocating Compressor.

1. Crankshaft

The crankshaft is the rotating shaft that takes power from the motor. It converts rotary motion into reciprocating motion.

2. Connecting Rod

The connecting rod connects the crankshaft and the piston. It transfers motion from round movement to up-and-down movement.

3. Crosshead

The crosshead guides the piston rod.

It absorbs side load and helps prevent damage to the cylinder.

4. Frame Lubrication Oil Pump

This pump supplies lubrication oil to the moving parts of the compressor. It reduces friction and wear.

5. Oil Level Sight Glass

This is used to check the oil level.

It is important for maintenance.

6. Partition Packing

This prevents gas leakage and separates the frame section from the cylinder section.

7. Oil Scraper Rings

These rings remove extra oil from the piston rod. They help control oil entry into the cylinder.

8. Piston Rod

The piston rod connects the piston with the crosshead. It transfers linear motion.

9. Oil Slingers

Oil slingers splash oil and help provide lubrication.

10. Distance Piece (Two-Compartment Type)

This provides space between the frame and cylinder sections. It helps control gas leakage and contamination.

11. Cylinder Frame Head

This supports the cylinder and holds the internal components.

12. Pressure Packing

This prevents high-pressure gas leakage around the piston rod.

13. Inlet Unloader (Plug Type / Port Type)

This is used for compressor capacity control.
It helps increase or decrease the load.

14. Compressor Inlet

This is the point where low-pressure gas enters the compressor.

15. Cylinder Liner

The cylinder liner provides a smooth surface inside the cylinder. It can be replaced if worn out.

16. Water Jacket (Integral Cylinder)

This cools the cylinder and protects it from overheating.

17. Piston

The piston compresses the gas.

Its up-and-down movement increases the pressure.

18. Piston Rod Nut

This nut tightly fixes the piston to the rod.

19. Discharge Valves

These valves allow compressed gas to leave the cylinder. They maintain one-way flow.

20. Compressor Discharge

This is the point where high-pressure gas comes out.

21. Cylinder Outer Head

This is the outer cover of the cylinder.

It holds the valves and gas passages.

22. Cylinder Support

This provides proper alignment and support to the cylinder.

Working Principle of a Reciprocating Compressor.

Step 1: Suction Process

When the compressor starts, the piston moves downward. This creates vacuum or low pressure inside the cylinder. Because of this, the inlet valve opens and gas enters the cylinder.

Simple line: Low-pressure gas fills the cylinder.

Step 2: Filling Complete

When the piston reaches the bottom position, called BDC (Bottom Dead Center), the cylinder becomes fully filled with gas.

At this stage, the inlet valve closes automatically.

Step 3: Compression Process

Now the piston moves upward.

The gas volume decreases and pressure starts increasing. When the pressure becomes higher than the discharge line pressure, the discharge valve opens.

Simple formula: Volume decreases → Pressure increases

Step 4: Discharge Process

The high-pressure gas comes out through the discharge valve and moves into the pipeline or system.

Final output: High-pressure compressed gas is produced.

2. Rotary Compressor

What is a Rotary Compressor?

In a rotary compressor, the rotor rotates and traps the refrigerant gas against a stationary blade.

Then it compresses the gas and discharges it at high pressure.

Working Principle of a Rotary Compressor

1. Suction

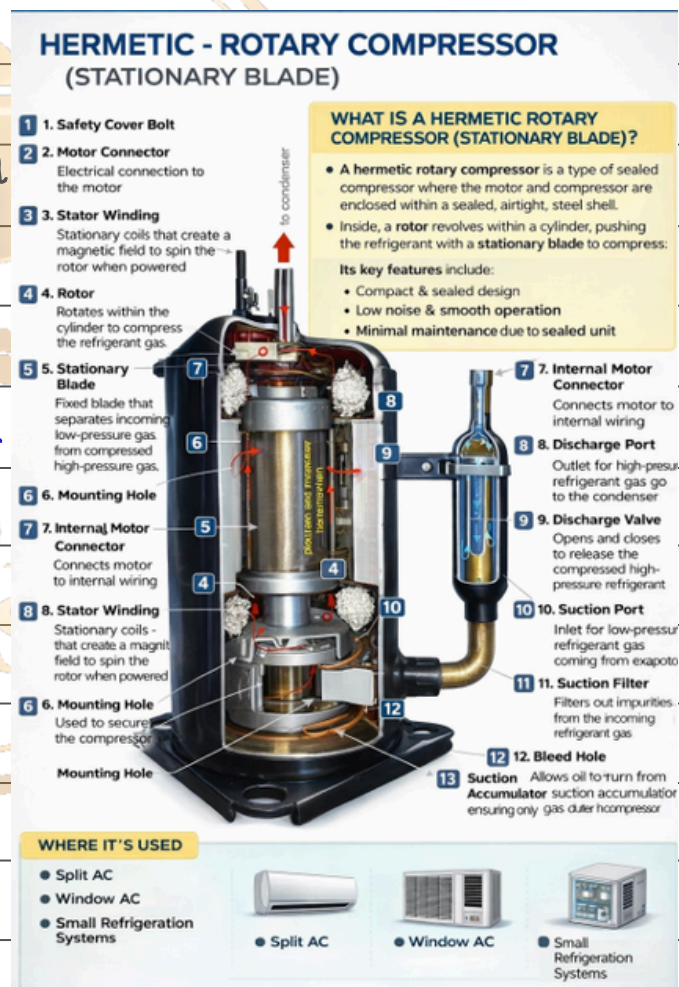
Low-pressure gas comes from the evaporator.

It enters through the suction port and suction filter.

2. Compression Start

The motor turns ON and the rotor starts rotating inside the cylinder.

A stationary blade traps the gas.



3. Gas Compression

As the rotor rotates, the space becomes smaller.

The gas gets compressed, and pressure and temperature increase.

4. Discharge

The high-pressure gas comes out through the discharge port and goes to the condenser.

Main Parts of a Rotary Compressor

1. Safety Cover Bolt

This tightens the outer cover.

It is important for safety and sealing.

2. Motor Connector

This connects the power supply to the motor.

Electrical input enters from here

3. Stator Winding

This is the stationary coil.

It creates a magnetic field that rotates the rotor.

4. Rotor

This is the moving part that rotates.

It compresses the gas.

5. Stationary Blade

This is a fixed blade.

It traps and separates the gas.

It plays a major role in compression.

6. Mounting Hole

This is used to fix the compressor on the base or frame.

7. Internal Motor Connector

This provides the internal electrical connection inside the motor.

8. Discharge Port

This is the outlet where high-pressure gas leaves the compressor. It goes directly to the condenser.

9. Discharge Valve

This is a one-way valve.

It allows only compressed gas to move out and prevents backflow.

10. Suction Port

This is the entry point for low-pressure gas.

11. Suction Filter

This removes dust and impurities.

It protects the compressor from damage.

12. Bleed Hole

This is used for oil return.

It helps maintain oil circulation.

13. Suction Accumulator

This stops liquid refrigerant from entering the compressor. It allows only gas to enter and protects against liquid slugging.

14. Oil Chamber

This stores compressor oil for lubrication and cooling.

15. Blade Spring

This keeps the blade in contact with the rotor.

It helps maintain proper sealing

Why is it called Hermetic?

It is called hermetic because the motor and compressor are sealed inside the same body. It cannot usually be repaired and is replaced as a complete unit.

Where is it used?

- Split AC
- Window AC
- Cassette AC
- Small refrigeration units
- Water coolers

Advantages

- Low noise
- Compact size
- Less maintenance
- Smooth operation
- High efficiency in small systems

Disadvantages

- Repair is not possible
- If overheating happens, the whole unit can fail
- Not suitable for large capacity systems

3. Scroll Compressor

What is a Scroll Compressor?

A scroll compressor has two spiral-shaped scroll plates.

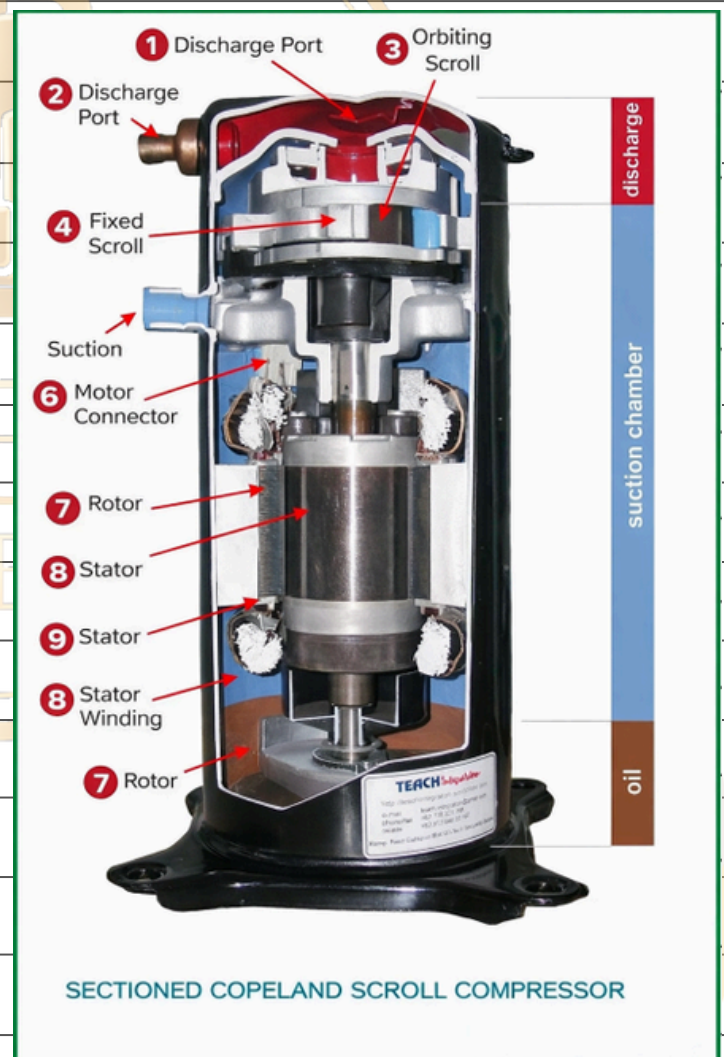
The refrigerant gas is compressed continuously from the outer side toward the center and then discharged at high pressure.

Main Parts of a Scroll Compressor.

1. Discharge Area (Top Chamber)

This is the place where the final compressed gas collects.

Here, the gas is at high pressure and high temperature.



2. Discharge Port

This is the outlet of the compressor.
From here, gas goes to the condenser.

3. Orbiting Scroll.

This is the moving scroll.

It does not rotate like a normal rotor; instead, it moves in an orbiting motion.

It pushes gas from the outer side toward the center.

4. Fixed Scroll

This is the stationary scroll plate.

It creates the compression chambers and works with the orbiting scroll to trap the gas.

5. Suction Line / Suction Area

This is the entry point for low-pressure refrigerant gas. Gas fills the outer side of the scroll.

6. Motor Connector

This supplies electricity to the motor and controls compressor operation.

7. Rotor

This is the rotating part of the motor.

It provides motion to the orbiting scroll.

8. Stator

This creates the magnetic field and helps rotate the rotor.

9. Stator Winding

This is the copper coil.

When current flows through it, it generates a magnetic field.

Oil Section (Bottom Section)

This provides lubrication for the bearings and other moving parts.

Where is it used?

- Split ACs, especially inverter ACs
- VRF / VRV systems
- Chillers
- Central AC plants

Advantages

- Smooth operation
- High efficiency
- Low noise
- Long service life

Disadvantages

- High cost
- Difficult to repair
- Can be damaged by dust and moisture

Working Principle of a Scroll Compressor

Step 1: Suction

Refrigerant gas enters through the suction port.
It fills the outer pockets of the scroll.

Step 2: Trapping

The gas gets trapped between the fixed scroll and the orbiting scroll. Several small pockets are formed.

Step 3: Compression

The orbiting scroll moves in a circular motion.
The gas moves from the outer side toward the center.
The volume decreases and pressure increases.

Step 4: Discharge

When the gas reaches the center, it becomes fully compressed.

It then comes out through the discharge port.

Important Concept

Scroll compressors give continuous compression.

That is why they have:

- Less vibration
- Less noise
- High efficiency

4. Screw Compressor

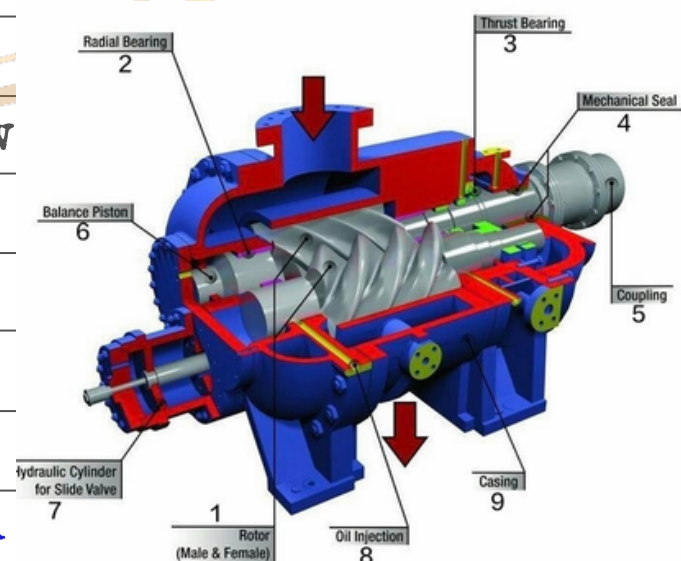
What is a Screw Compressor?

A screw compressor uses male and female rotors. The refrigerant gas gets trapped between them and is compressed as the rotors rotate. The compressed gas is then discharged at high pressure.

Working Principle of a Screw Compressor.

1. Suction

Low-pressure refrigerant enters through the inlet and fills the rotor grooves.



2. Trapping

The gas becomes trapped between the male and female rotors.

3. Compression

As the rotors rotate, the gas moves forward.

The volume decreases and pressure increases.

4. Discharge

The high-pressure gas comes out through the outlet and moves toward the condenser.

Main Parts of a Screw Compressor

1. Rotor (Male and Female)

These are the main compression parts.

They trap and compress the gas.

2. Radial Bearing

This supports the rotor and handles side load.

3. Thrust Bearing

This handles axial load, or forward and backward force.

4. Mechanical Seal

This prevents gas leakage and seals the shaft.

5. Coupling

This connects the motor and the compressor.

6. Balance Piston

This balances pressure and reduces thrust load.

7. Hydraulic Cylinder (Slide Valve)

This is used for capacity control.

It adjusts the load according to requirement, such as 25%, 50%, 75%, or 100%.

8. Oil Injection

Oil is injected for cooling, sealing, and lubrication.

9. Casing

This is the outer body that covers all the parts.

Where is it used?

- Industrial refrigeration
- Chillers
- Cold storage
- Large HVAC systems

Advantages

- Continuous flow, no pulsation
- High capacity
- Reliable
- Long service life

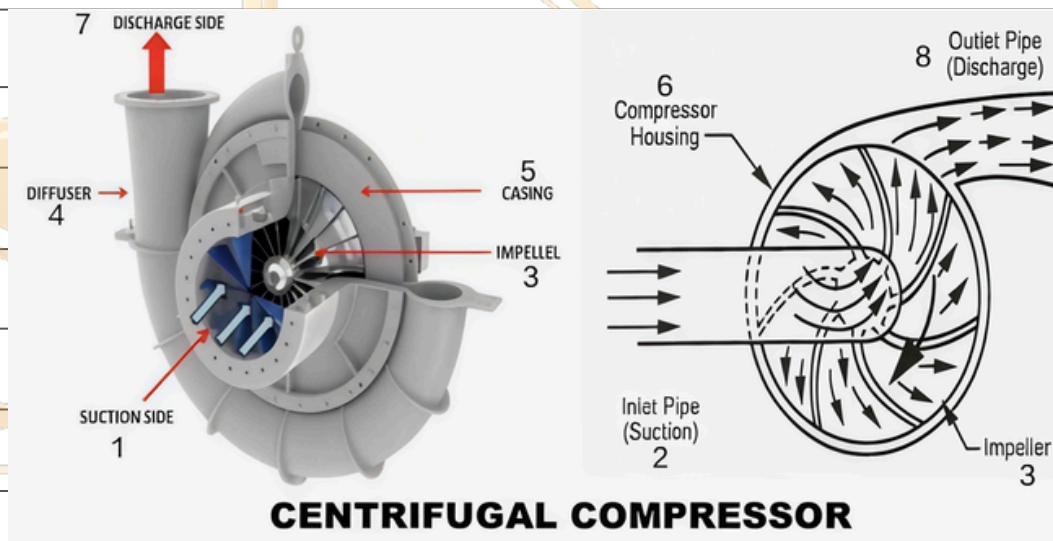
Disadvantages

- High cost
- Maintenance required
- Oil separation system is needed

5. Centrifugal Compressor

What is a Centrifugal Compressor?

A centrifugal compressor uses an impeller to give gas high velocity. Then a diffuser converts this velocity into pressure, and the gas is discharged at high pressure.



Working Principle of a Centrifugal Compressor.

1. Suction

Gas enters through the inlet pipe and reaches the center of the impeller

2. High-Speed Rotation

The impeller rotates very fast and gives the gas high velocity.

3. Centrifugal Action

The gas is thrown toward the outer side by centrifugal force. Its kinetic energy increases.

4. Diffuser Conversion

The diffuser converts velocity into pressure.
The gas gets compressed.

5. Discharge

The high-pressure gas leaves through the outlet pipe.

Main Parts of a Centrifugal Compressor

1. Suction Side

This is the entry zone for low-pressure refrigerant gas.

2. Inlet Pipe

This brings gas from the evaporator to the compressor. The gas enters the center, or eye, of the impeller.

3. Impeller

This is the most important rotating part.

It rotates at high speed and gives the gas velocity.

Centrifugal force pushes the gas outward.

4. Diffuser

This is a fixed passage after the impeller.

It slows the gas down and converts kinetic energy into pressure energy.

5. Casing

This is the outer shell or body.

It guides the gas flow and safely contains the high-pressure gas.

6. Compressor Housing

This is the full structural body of the compressor.

It supports the shaft, bearings, and impeller, and maintains alignment.

7. Discharge Side

This is the high-pressure zone where the gas becomes fully compressed.

8. Outlet Pipe (Discharge)

This is the exit point for the high-pressure gas.

It goes toward the condenser.

Where is it used?

- Large chillers
- Central AC plants
- Power plants
- Oil and gas industries

Advantages

- Very high capacity
- Continuous flow
- Low vibration
- Smooth operation

Disadvantages

- High cost
- Skilled maintenance is needed
- Efficiency is lower at low load

Quick Interview Answer

There are five main types of compressors used in HVAC systems: reciprocating, rotary, scroll, screw, and centrifugal compressors.

Easy memory trick:

- Reciprocating = Piston type
- Rotary = Rotor and blade type
- Scroll = Spiral type
- Screw = Male and female rotors
- Centrifugal = Impeller and diffuser

WHY COMPRESSOR FAIL

1. What is a Compressor?

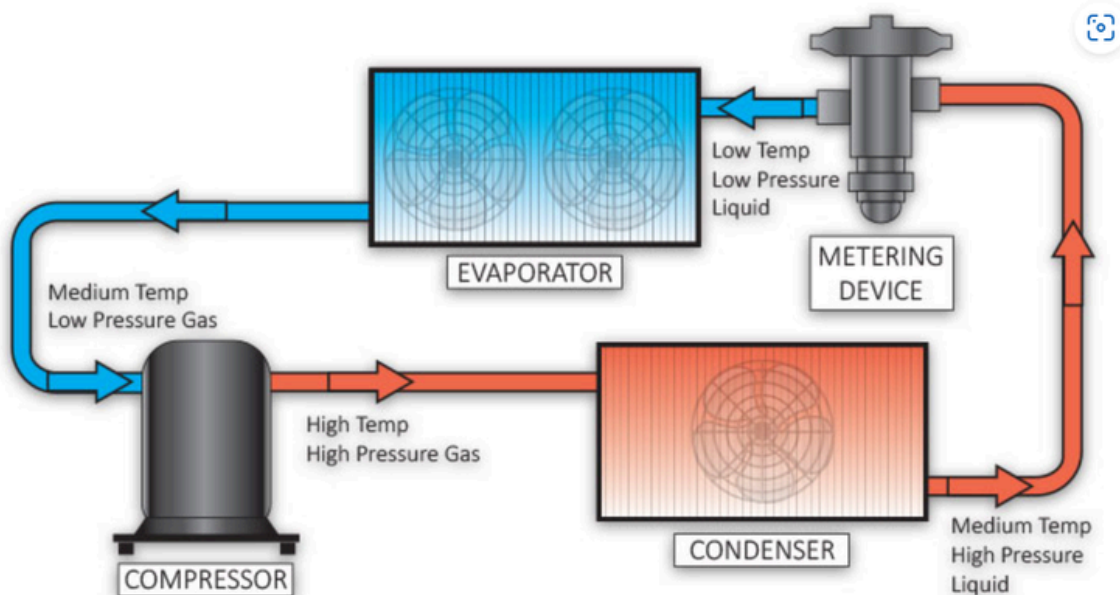
A compressor is the heart of an HVAC or refrigeration system. Its primary functions is to compress refrigerant vapor and circulate it throughout the system, enabling the refrigeration cycle to operate effectively.



2. Why is the Compressor Important?

The compressor plays a critical role in system performance by:

- Maintaining refrigerant flow
- Creating the pressure difference required for refrigeration
- Supporting heat transfer within the system
- Ensuring proper cooling operation



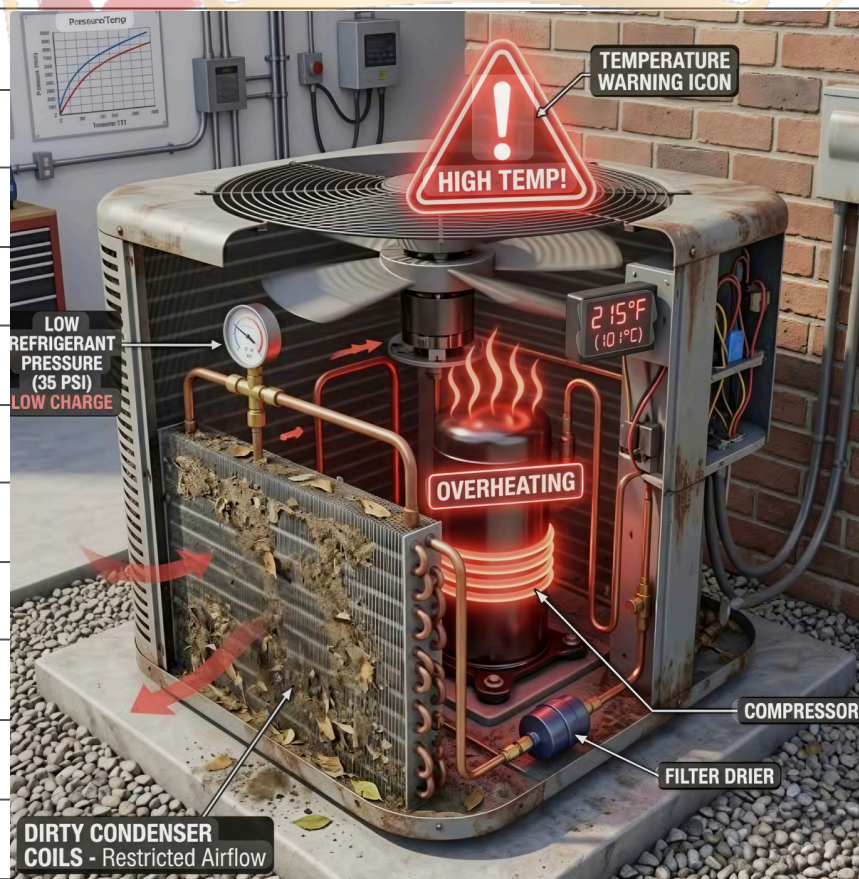
3. Common Reasons for Compressor Failure

A. Overheating

When a compressor operates at excessive temperatures, internal components can become damaged, leading to failure.

Common Causes:

- Dirty condenser coils
- Low refrigerant charge
- Poor ventilation around the unit



B. Low Refrigerant Charge

Insufficient refrigerant can cause higher compressor operating temperatures and reduced cooling performance.

Effects:

- Compressor overheating
- Poor system efficiency
- Reduced cooling capacity



C. Electrical Problems

Electrical issues can damage or burn out the compressor motor.

- Low supply voltage
- Voltage imbalance between phases
- Loose or damaged electrical connections

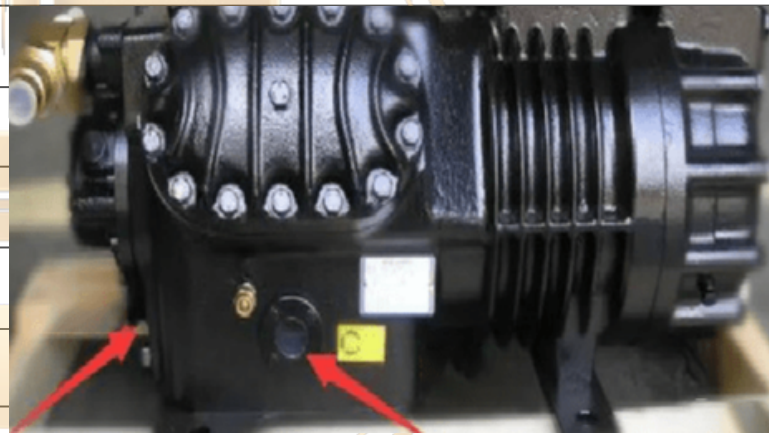


D. Lack of Lubrication

Compressor oil lubricates moving parts and reduces friction.

Problems Caused by Low Oil:

- Excessive wear of components
- Increased operating temperature
- Bearing failure
- Compressor seizure

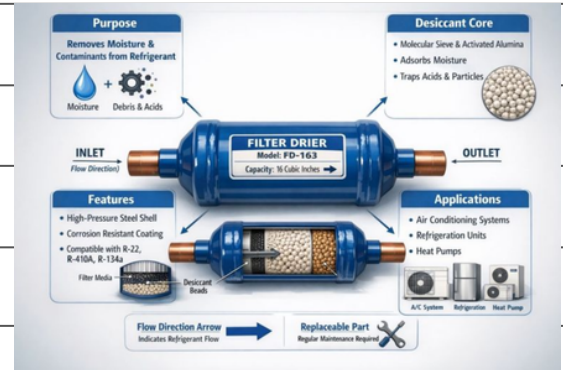


E. Moisture and Dirt Contamination

Moisture, dirt, and other contaminants can damage compressor components and affect system performance.

Possible Results:

- Acid formation
- Blocked expansion devices
- Internal component wear



4. Signs of Compressor Failure

Watch for these warning signs:

- Compressor fails to start
- High current draw (high amperage)
- Unusual noise or vibration
- Poor cooling performance
- Frequent overload trips
- Excessive operating temperature

5. How to Prevent Compressor Failure

Preventive maintenance can significantly extend compressor life.

Recommended Practices

- ✓ Perform regular maintenance inspections
- ✓ Keep condenser coils clean
- ✓ Verify correct refrigerant charge
- ✓ Monitor voltage and electrical connections
- ✓ Replace filter driers when required
- ✓ Check oil levels and lubrication system
- ✓ Maintain proper airflow and ventilation



6. Conclusion

Most compressor failures result from overheating, electrical faults, refrigerant-related issues, contamination, or inadequate maintenance. Regular inspections and preventive maintenance practices can greatly improve reliability, efficiency, and compressor lifespan.



WHY COMPRESSORS FAIL (Part 2: Advanced Compressor Failures)

Introduction

In Part 1, we covered the basic causes of compressor failure. In this section, we will examine advanced compressor failures commonly encountered in HVAC and refrigeration systems. Understanding these failures helps technicians diagnose problems accurately and prevent costly equipment damage.

1. Liquid Slugging

What is Liquid Slugging?

Liquid slugging occurs when liquid refrigerant enters the compressor cylinders instead of vapor refrigerant. Since liquids cannot be compressed, severe mechanical damage can result.

Effects

- Bent connecting rods
- Broken valve plates
- Damaged pistons
- Mechanical compressor failure

Common Causes

- Faulty expansion valve
- Excess refrigerant charge
- Low evaporator load
- Defective control settings



2. Refrigerant Floodback

What is Floodback?

Floodback occurs when liquid refrigerant returns to the compressor during normal system operation.

Effects

- Oil dilution
- Bearing wear
- Reduced lubrication
- Premature compressor failure

Common Causes

- Oversized expansion valve
- Low evaporator load
- Incorrect superheat setting
- Poor airflow across the evaporator

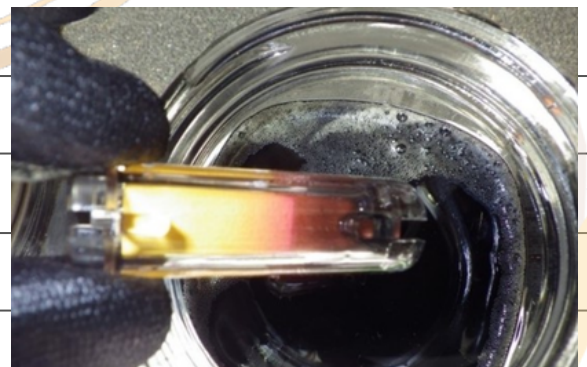
3. Acid Formation

What is Acid Formation?

Moisture entering the refrigeration system can react with refrigerant and compressor oil, producing harmful acids.

Effects

- Copper plating on internal components
- Motor winding damage
- Internal corrosion
- Compressor burnout



Warning Signs

- Dark or discolored oil
- Burnt odor
- Failed acid test
- Repeated compressor failures

4. Winding Burnout

What is Winding Burnout?

Compressor motor windings overheat and fail due to excessive electrical or thermal stress.

Common Causes

- High discharge temperature
- Voltage imbalance
- Low voltage
- Locked rotor condition
- Frequent short cycling

Effects

- Complete compressor failure
- Acid contamination throughout the refrigeration system
- Extensive system cleanup requirements



5. Oil Return Problems

What is Oil Return?

Compressor oil circulates with refrigerant through the system and must return to the compressor for proper lubrication.

Problems Caused by Poor Oil Return

- Low compressor oil level
- Bearing damage
- Increased friction
- Compressor seizure

Common Causes

- Improper pipe sizing
- Poor piping design
- Low refrigerant velocity
- Incorrect oil trap installation

6. High Compression Ratio

What is Compression Ratio?

Compression ratio is the relationship between discharge pressure and suction pressure.

Effects

- Increased motor load
- Higher operating temperatures
- Reduced compressor efficiency
- Shortened compressor life

Common Causes

- Dirty condenser coils
- High condensing temperature
- Low suction pressure
- Restricted refrigerant flow

7. Reverse Rotation (Three-Phase Compressors)

Reverse rotation occurs when a three-phase compressor rotates in the wrong direction because of an incorrect phase sequence.

Effects

- Reduced cooling capacity
- Excessive noise and vibration
- Poor oil circulation
- Possible internal damage

Effects

- Verify phase sequence before startup
- Use a phase rotation meter during commissioning

8. Contaminated Compressor Oil Common Sources of Contamination

- Moisture
- Carbon particles
- Metal particles
- Acid contamination
- System debris after repairs

Effects

- Bearing wear
- Valve damage
- Reduced lubrication quality
- Increased compressor wear

Prevention

- Replace filter driers when necessary
- Perform proper evacuation procedures
- Conduct regular oil analysis
- Maintain system cleanliness during servicing

Key Diagnostic Indicators

Technicians should investigate advanced compressor problems when they observe

- Repeated compressor failures
- Abnormal oil condition
- Excessive discharge temperature
- Unusual noise or vibration
- Low oil level
- High compression ratio
- Evidence of acid contamination



Conclusion

Advanced compressor failures are often caused by improper design, contamination, operating conditions, or inadequate maintenance practices. By understanding liquid slug floodback, acid formation, winding burnout, oil return issues, and other advanced failure modes, HVAC technicians can diagnose problems more effectively and prevent expensive compressor replacements.

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THANK YOU

for reading this

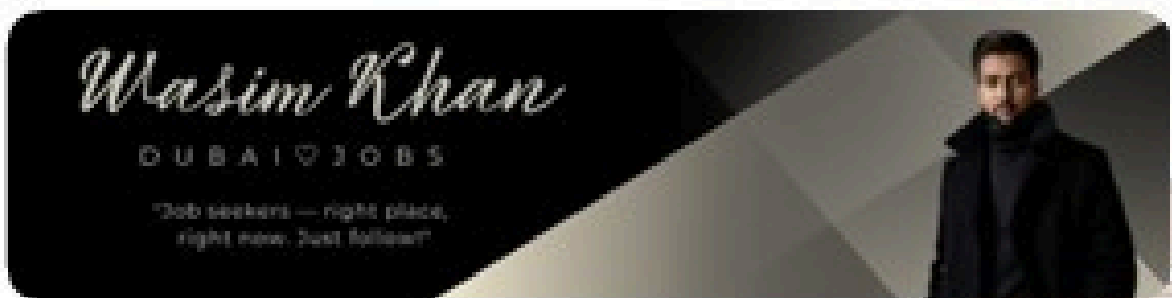
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