TTLB-0074

Basic Knowledge of Air Conditioner

Hitachi Construction Machinery Co., Ltd Technical Training Center

How air conditioner works?



When liquid changes to gas (evaporation), it draws heat from its environment. Thus the temperature decreases.

(Example) When sterilize your injection area with a alcohol swab, you may feel the area cold. This is because the temperature of your skin decreases due to the alcohol evaporation.



Configuration and function of air conditioner cycle

Component	Compressor	Condenser	Receiver Drier	Expansion valve	Evaporator
Function	Compression	Condensation	Ablation	Low- pressure refrigerant	Evaporation
Forms of refrigerant	Liquid to Gas	Gas to Liquid	Liquid	Liquid to Liquid or gas	Liquid or gas to Gas
Example Relation between temperature and pressure	(°C) Temperatu	55	50		
	Ire (MPa) Pressure 0. 19	1. 37			0

Function of major component

Compressor: Compresses gas-refrigerant to be easy to liquefy in normal temperature. **Condenser: Cools down the refrigerant by ambient air in** order to change from gas to liquid. **Receiver Drier:** Removes moisture and foreign matter in the refrigerant by drier and filter, and discharges air free liquid refrigerant. **Expansion value:** Expands the liquid refrigerant by letting through a orifice to be easy to evaporate. The low pressure/temperature misty **Evaporator:** refrigerant passes through a tube. The entire refrigerant becomes gas at the end of the tube.





- Mechanism of the Variable displacement

The variable displacement is adjusted with the angle α of the wobble plate by sliding the hinge-ball on the drive shaft. When the wobble plate is inclined, the piston available stroke will increase, resulting in increase the discharging capacity. On the other hand, when the wobble plate turns out, the available stroke decreases and the discharge capacity will be reduced.

Variable displacement mechanism and operation of compressor

- Operation of the Variable displacement

The angle α of the wobble plate is defined by pressure balance of a discharge/suction pressure applied at upper piston, and a pressure in the wobble chanber. The pressure in the wobble can be controlled by a control valve, of which opening amount is defined by suction pressure (thermal loading).





T-type

Receiver drier (Liquid tank)

[Remarks]

The refrigerant level can be checked at the sight glass with conventional refrigerant of CFC-12 (R-12). Since oil separation temperature of new refrigerant HFC-134a (R-134a) is low, the refrigerant level can not be checked at the sight glass. To check the refrigeration level, it is needed to draw out all the refrigerant from the cooler cycle, and then, fill some amount of refrigerant if needed.

Flat head-Type



Expansion valve

When temperature rises, pressure and flow rate increase





Other components and their functions (1)

Blower motor:	The motor forcibly blows outside/inside air. Motor speed can be adjusted in 4 steps by changing resistances (manual control), continuously changed by using power transistor (Auto-control)				
Blower fan:	The fan discharges inside/outside air into a chamber. Since it utilizes centrifugal force, the air indrawn parallel to the rotation axis is blown out perpendicular to the rotation axis.				
Actuator:					
Mode: Intake:	Change outlet ports Change inside air / Outside air				
Air mix:	According to the preset temperature, move a door to the target position to adjust outlet temperature				
Heater core:	Increase ambient temperature by flowing warm water through a tube.				
Inside air sensor:	Monitoring inside air temperature				
Water temperatu	re sensor: Monitoring surface temperature of the heater core.				
Thermostat:	Monitoring the refrigerant temperature at outlet of the evaporator.				
Resister:	Change voltage according to the air flow rate at manual operation				
Transistor:	Change voltage according to the air flow at auto operation.				

Rear outlet

Front outlet

Unit (Top view)

Inside intake



Thermostat

Blower fan





Fan (blower)

Motor



Cooling unit

- When the surface temperature of the evaporator decreases under freezing point (0 degree C), internal condensed water may freeze and plug the air pass, resulting in deteriorate the cooling capability. To prevent this, a thermo-switch is installed in order to prevent evaporator freeze-up.

Unit (Right side)



Outlet change-over (Mode ACT.)



Intake (Intake change-over)

Air mix (Outlet temperature adjustment)

Mode (Outlet change-over)





Fan switch, Resister



Outside air inlet

Unit (Rear side)



Resister

Water temperature sensor (Heater core inside)

Front outlet

Unit (Front)



Foot outlet

Heater hose

Power transister

Other components and their functions (2)

Relay: Hi relay:		Hi relay makes the blower motor to maximum speed.			
	Low relay:	Low relay makes the blower motor to minimum speed.			
	A/C relay:	The relay switches a magnet crutch ON/OFF.			
Controller:		The controller send control signals such as temperature setting, outlet change-over and inside/outside air			
Ambient ai	ir Temp. sensor:	The sensor monitors ambient air temperature.			
Hose:		Connecting among the components in order to send refrigerant gas.			
		Compressor → (High pressure)			
		Unit \rightarrow (Compressor low pressure)			
Pressure switch:		The switch monitors refrigerant pressure and			
		controls On/OFF state of magnet crutch.			
Magnet crutch:		The crutch connects engine power from engine crank pulley, a belt to the compressor, to run the compressor accordingly. The compressor runs when current flows in a coil.			
Belt:		The belt transmit power force from engine to compressor.			
Tension p	ulley:	The pulley adjusts the belt for running the compressor.			

Unit (Door side)



Relay (Hi, Low, A/C)

Switch over inside/outside air (Intake ACT.)

Tension pulley







Controller



Self-Diagnosis

For ZEXEL: ZX200 to ZX330, ZX-US (For DENSO: ZX110, 120, ZX450 to ZX800, EX1200-5)

- (1) Start self-diagnosis: Turn the main key On while the key switch is turned OFF and pressing A/C SW and MODE SW.
- (2) Check the model: When the main key is ON in the item (1), [Sd] or [USr] will be displayed on the LCD.
- (3) Check display function: Entire LCD and LED will turn ON after five (5) second of the item (2), or when pressing FAN UP SW. (Turns ON: LCD part and inside / outside air, A/C and AUTO for LED part.)
- (4) Diagnosis for the current condition: By pressing FAN UP SW to display[2], and then display error number after self-diagnosis is finished.
- (5) Checking error history: By pressing FAN UP SW, error number of past malfunction will be displayed.

Deleting the passed error codes:

By pressing A/C SW more than 3 second, the passed error codes will be deleted. Error codes

Dosition	Current condition		Passed condition		Domorlza
	Open	Short	Open	Short	
MIX ACT	21		31		
MODE ACT	22		32		
Inside air sensor	23	-23	33	-33	
Outside air sensor	24	-24	34	-34	
Water temperature sensor	25	-25	35	-35	US will not detected
Solar insolation sensor	26	-26	36	-36	
In the normal condition	20		30		

Failure example (1)

- Phenomenon: The air conditioner temperature of ZX200 indicates [71].
- Cause: The Fahrenheit is displayed instead of the Celsius. The Fahrenheit and Celsius can be switched over during the self-diagnosis procedure.
- For ZEXEL: Fahrenheit and Celsius can be switched by pressing A/C SW and FAN UP SW simultaneously after pressing FAN UP SW twice after finishing Passed error check procedure. It can also be switched by pressing outside air SW.
- For DENSO: Fahrenheit and Celsius can be switched by pressing temperature setting UP/DOWN SW for more than five second while the blower SW is in ON state.

Failure example (2)

Phenomenon: The air conditioner does not work. Since a hose has gas leakage, replace the hose with new one, and then the air conditioner properly worked. After several days, it fails working.

Cause: Burn out the compressor. Moisture in ambient air is absorbed into the drying agent of receiver/drier during gas leakage. After exchanging the hose, excessive moisture that the receiver/drier could not absorb was compressed at the compressor.

Countermeasure: When gas leakage occur, it is suggested to exchange receiver/drier as well as the hose.

(1) Necessary requirement for the compressor oil

In general, the compressor oil should satisfy the following specifications.

	Necessary requirement for the compressor oil	Remarks
1	Having good resolvability with the refrigerant	If the oil has good resolvability, it will easy to be resolved and separated. And has good lubricity.
2	Having wide temperature range for operation	Inside the cooler cycle has large temperature variation.
3	Having good thermal instability	Do not generate sludge at high temperature portion such as compressor outlet valve
4	Having very few moisture content	Moisture will cause oil oxidation and deterioration.
5	Having chemically stable nature	Chemically unstable oil may generate harmful material in a chemical reaction with the refrigerant.
6	Having good resistance to corrosion with metal or rubber	To prevent abrasion, damage and deterioration of components of cooler cycle

(2) Type of the compressor oil

A variety of compressor oil that has different specification is used according to the type of compressor and refrigerants.

	Compress			
Compressor type	For HFC-134a (R-134a)	For CFC-12 (R-12)	Remarks	
Crank type (DKP)	ZXL-100PG (DH-PS)	SUNISO 5GS	Oil for CFC-12 will	
		FREOL DS-83P	be changed from	
Swash plate type	ZXL-100PG (DH-PS)	SUNISO 5GS	SUNISO 5GS to FREQL DS-83P	
(DKS)		FREOL DS-83P		
Wobble plate type	ZXL-100PG (DH-PS)	D-90PX		
(DCV)				
Vane rotary type	ZXL-200PG (DH-PR)	D-90PX		
(DKV)				