Refrigeration & Air Conditioning Technology
SIXTH EDITION

# SECTION 8
# AIR SOURCE HEAT PUMPS
# UNIT 43
# AIR SOURCE HEAT PUMPS



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Describe the operation of reverse-cycle refrigeration (heat pumps)
- Explain the function and operation of heat pump system components
- List heat sources commonly used in heat pump systems
- Discuss how heat pump efficiency is determined
- Explain the concepts of coefficient of performance and auxiliary heat
- Describe the control sequence of an air-to-air heat pump system
- Explain how heat pump efficiency can be increased
- Discuss preventive maintenance on a heat pump system

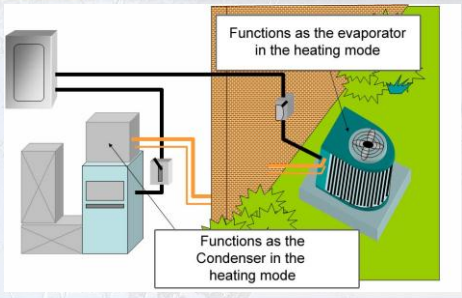


Refrigeration & Air Conditioning Technology
SIXTH EDITION

## REVERSE-CYCLE REFRIGERATION

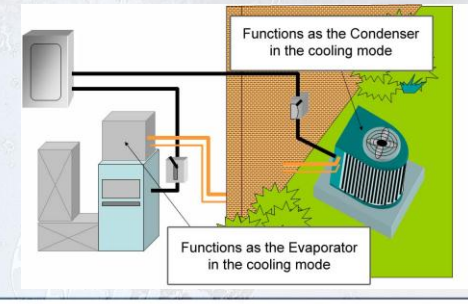
- Air-conditioning equipment can only pump heat in one direction
- Heat pumps can pump heat two ways
- Heat pumps have a four-way reversing valve
- Four-way reversing valves control the direction of flow of the heat-laden vapor between the low- and high-pressure sides of the system

Refrigeration & Air Conditioning Technology
SIXTH EDITION






Refrigeration & Air Conditioning Technology
SIXTH EDITION






Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEAT SOURCES FOR WINTER

- Air conditioners pump heat from low temperature inside the structure to a higher temperature outside the house
- There is heat in a substance until it is cooled to -460° F
- At 0° F outside air temperature, there is still 85% usable heat in the air
- Heat pumps have the ability to absorb heat from the structure in the summertime and discharge it to the outside
- Heat pumps are able to absorb heat from the outside air and discharge it to the inside of the structure

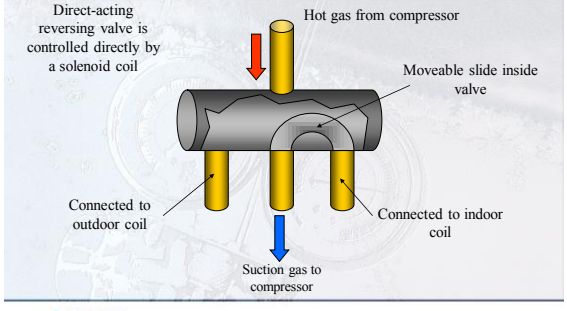
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE FOUR-WAY VALVE

- Allows the heat pump to pump heat in two directions
- Diverts the discharge gas to either heat or cool the conditioned space
- Refrigerant is directed from the compressor to the indoor coil in the heating mode
- Refrigerant is directed from the compressor to the outdoor unit in the cooling mode
- Controlled by the space temperature thermostat
- Pilot-operated valve
- Four piping connections on the valve

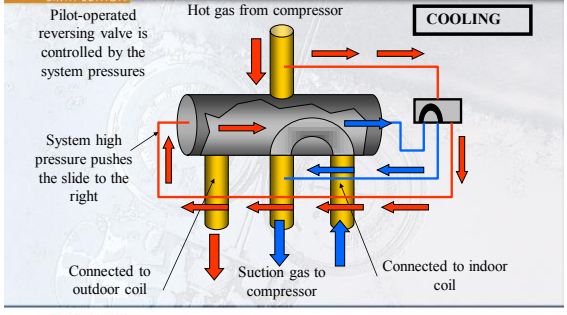


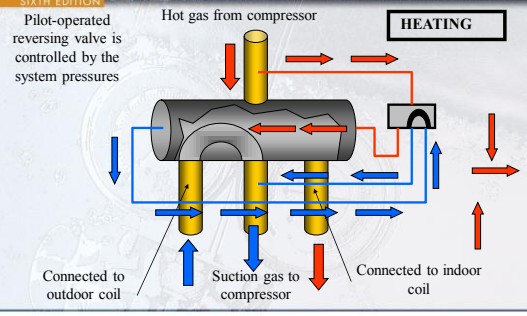
Refrigeration & Air Conditioning Technology
SIXTH EDITION






Refrigeration & Air Conditioning Technology
SIXTH EDITION








Refrigeration & Air Conditioning Technology
SIXTH EDITION

## TYPES OF HEAT PUMPS

- Air is not the only source from which a heat pump ban absorb heat, but it is the most popular
- Other heat sources for heat pumps include water and Earth
- A typical water-to-air heat pump uses 3 gallons of water per minute in the heating cycle and 1.5 gallons of water per minute in the cooling mode per ton of refrigeration



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SOLAR-ASSISTED HEAT PUMPS

- These pumps capture heat from the sun
- The heat is then brought to usable levels for heating homes
- Some systems are specially designed to operate in conjunction with solar heat

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE AIR-TO-AIR HEAT PUMP

- Most popular type
- Basic sealed system components of a heat pump are the same as an air conditioner, but the terminology changes
- In a heat pump, the terms indoor coil and outdoor coil are used
- The function of each coil changes as the operating mode of the heat pump changes



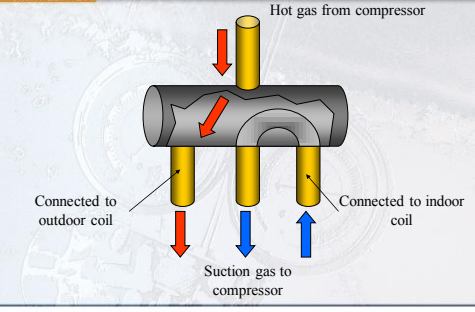
Refrigeration & Air Conditioning Technology
SIXTH EDITION

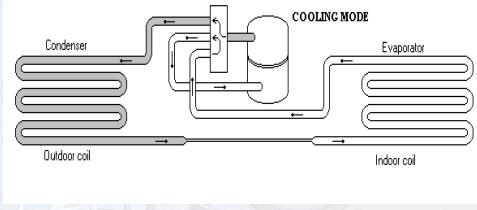
## THE AIR-TO-AIR HEAT PUMP

- Function of coils in the cooling mode
  - Indoor coil absorbs heat by boiling refrigerant at low temperature and pressure (evaporator)
  - Outdoor coil rejects heat by condensing a high-temperature and pressure vapor to a high-temperature and pressure vapor (condenser)
  - Refrigerant from the compressor is first pumped to the outdoor coil



Refrigeration & Air Conditioning Technology
SIXTH EDITION







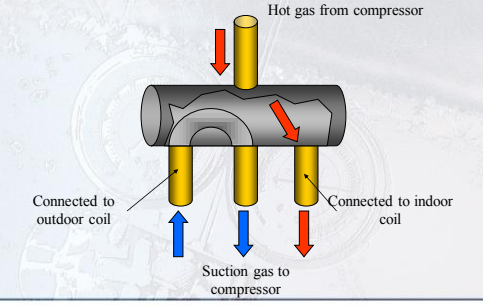

Refrigeration & Air Conditioning Technology
SIXTH EDITION

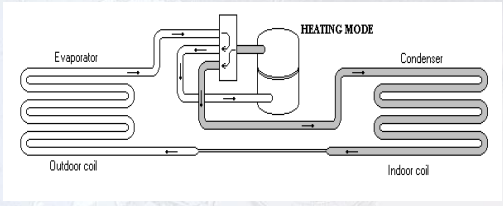
## THE AIR-TO-AIR HEAT PUMP

- Function of coils in the heating mode
  - Outdoor coil absorbs heat by boiling refrigerant at low temperature and pressure (evaporator)
  - Indoor coil rejects heat by condensing a high-temperature and pressure vapor to a high-temperature and pressure vapor (condenser)
  - Hot gas from the compressor is first pumped to the indoor coil



Refrigeration & Air Conditioning Technology
SIXTH EDITION








Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE AIR-TO-AIR HEAT PUMP

- Mode of operation is determined by which way the hot gas from the compressor is flowing
- Mode of operation can be determined by touching the gas line to the indoor coil
  - In the cooling mode, the gas line will feel cool
  - In the heating mode, the gas line will feel hot



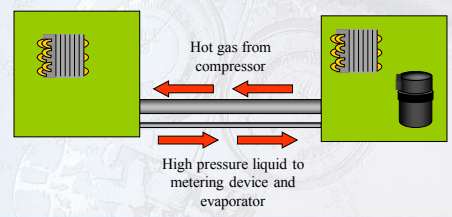
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## REFRIGERANT LINE IDENTIFICATION

- The large diameter line is called the gas line because only refrigerant vapor flows through it
- The gas line is a cold gas line in the summer and a hot gas line in the winter
- The smaller diameter line is called the liquid line because only liquid refrigerant travels through it
- During the cooling mode, the liquid travels to the indoor coil
- During the heating mode, the liquid travels to the outdoor coil

Refrigeration & Air Conditioning Technology
SIXTH EDITION

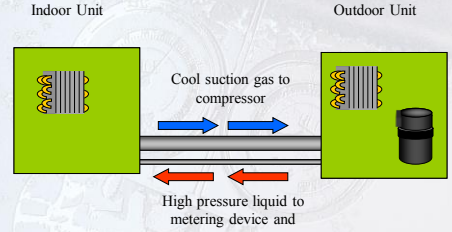
**HEAT PUMP OPERATING IN THE HEATING MODE**






Refrigeration & Air Conditioning Technology
SIXTH EDITION

**HEAT PUMP OPERATING IN THE COOLING MODE**






Refrigeration & Air Conditioning Technology
SIXTH EDITION

## METERING DEVICES

- Specially designed for heat pump applications
- There must be a metering device at the outdoor unit in the heating mode
- There must be a metering device at the indoor coil in the cooling mode

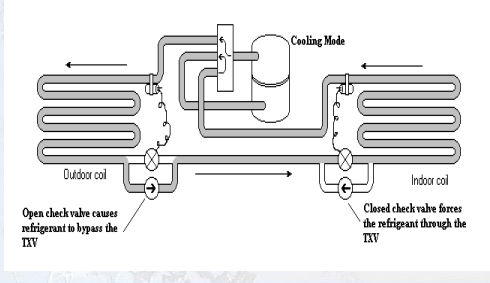
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THERMOSTATIC EXPANSION VALVES (TEV, TXV)

- Maintains Desired superheat in the evaporator
- Check valves are piped parallel to the TXV to allow refrigerant to bypass the control when needed
- Heating mode
  - The refrigerant flows through the TXV at the outdoor coil
  - The refrigerant bypasses the TXV at the indoor coil
- Cooling mode
  - The refrigerant flows through the TXV at the indoor coil
  - The refrigerant bypasses the TXV at the outdoor coil

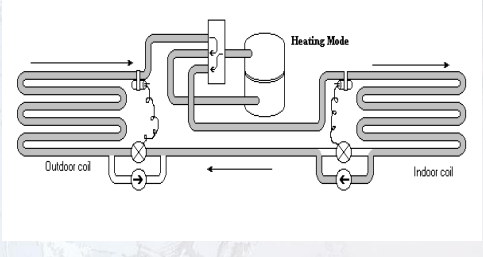


Refrigeration & Air Conditioning Technology
SIXTH EDITION




DELMAR CENGAGE Learning © 2008 Delmar, a part of Cengage Learning

Refrigeration & Air Conditioning Technology
SIXTH EDITION




DELMAR CENGAGE Learning © 2008 Delmar, a part of Cengage Learning

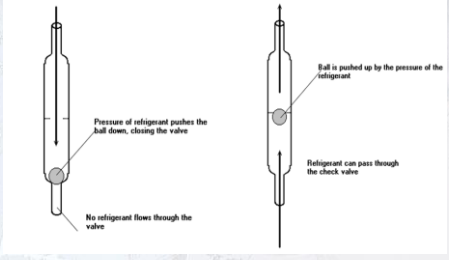
## THE CAPILLARY TUBE

- Commonly used on heat pumps
- Will allow refrigerant to flow in both directions
- Sometimes two capillary tubes are used with check valves
- There must be a drier/strainer at the inlet of the capillary tube to ensure that the tube does not get clogged





Ball-type Check Valve








## COMBINATIONS OF METERING DEVICES

- Uses the capillary tube at the indoor coil
  - Used in the cooling mode
  - Load is relatively constant in the warmer months
- Uses a thermostatic expansion valve at the outdoor coil
  - Used in the heating mode
  - Allows system to reach maximum efficiency quickly

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## ELECTRONIC EXPANSION DEVICES

- Can meter refrigerant in both directions
- If indoor and outdoor coils are close together, one device can be used
- The correct superheat will be maintained in both heating and cooling modes



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## ORIFICE METERING DEVICES

- Used in conjunction with check valves
- One device is located at each coil
- The bore at the indoor coil is larger than the bore at the outdoor coil
- Normally used with a bi-flow filter drier



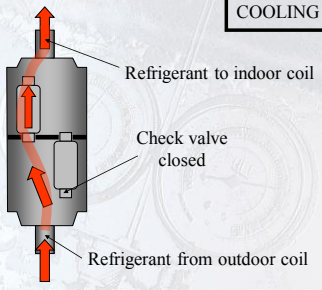
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## LIQUID LINE ACCESSORIES

- Two standard filter driers can be used on systems with check valves
  - Only one drier will be in the refrigeration circuit at a time
  - They are installed with the arrows pointing in the same direction as the check valves
- Bi-flow filter driers
  - Two driers in one
  - Designed for heat pump applications

Refrigeration & Air Conditioning Technology
SIXTH EDITION

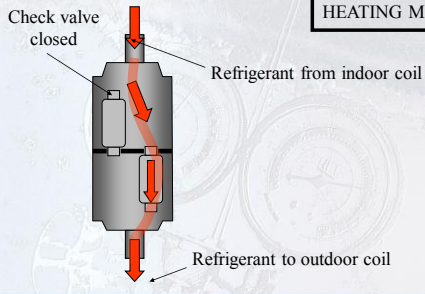
COOLING MODE




DELMAR CENGAGE Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION

HEATING MODE




DELMAR CENGAGE Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION

## APPLICATION OF THE AIR-TO-AIR HEAT PUMP

- Usually installed in milder climates (temperatures as low as 10˚ )
- In the winter, the outdoor coil absorbs heat
- Difference between outdoor and evaporator temperature is about 25˚
- If outside temperature is 10˚ , the refrigerant boils at approximately -15˚
- The compressor and the system lose efficiency as the evaporator temperature goes down
- The system loses capacity as the outside temperature drops

DELMAR CENGAGE Learning

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## AUXILIARY HEAT

- Required when the heat pump cannot provide all the heat a structure needs
- The heat pump is the primary heat source
- Auxiliary heat could be electric, oil or gas
- Electric heat is the most common auxiliary heat used
- As the outside temperature drops, the structure requires more heat



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## BALANCE POINT

- Balance point occurs when the heat pump can pump in exactly as much heat as the structure is leaking out
- Above the balance point, the heat pump will cycle on and off
- Below the balance point, the heat pump will run continuously and second stage (auxiliary) heat will be energized



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## COEFFICIENT OF PERFORMANCE

- One watt of usable heat is supplied for each watt of energy purchased
  - Using electric resistance heat
  - This is called 100% efficient
  - Coefficient of performance (COP) of 1:1
  - The output is the same as the input
- Air-to-air heat pumps can have a COP of 3.5:1
  - When 1 watt of electrical energy is used by the compressor, it can furnish 3.5 watts of usable heat (COP is 3.5:1)

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## COEFFICIENT OF PERFORMANCE

- High COP only occurs during higher outdoor winter temperatures
- A heat pump's COP falls as the outdoor temperature falls
- A typical air-to-air heat pump has a COP of 1.5:1 at 0° F
- Some manufacturers have controls to shut off the compressor at temperatures of 0 to 10° F
- Water-to-air heat pumps might not need auxiliary heat since the heat source (water) temperature is constant
- Water-to-air heat pumps have a COP rating as high as 4:1



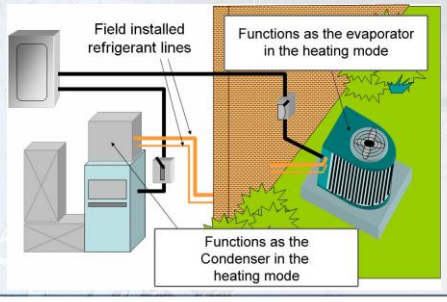
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SPLIT-SYSTEM AIR-TO-AIR HEAT PUMPS

- Air-to-air systems can be split or package type
- Both heat pumps and straight cooling units look identical
- Split systems require the installation of the gas and liquid refrigerant lines to connect the indoor and outdoor units



Refrigeration & Air Conditioning Technology
SIXTH EDITION



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE INDOOR UNIT

- The part of the system that circulates the air within the structure
- It contains the fan and coil and often the electric strip heaters
- The refrigerant coil must be located in the airstream before the auxiliary heating coil
- The indoor unit may be a gas or oil fired furnace



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE INDOOR UNIT

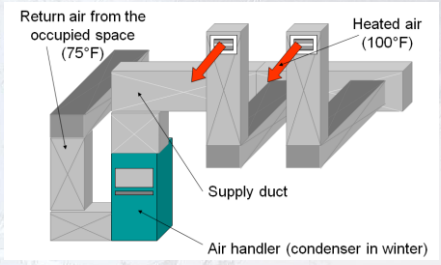
- If gas or oil furnace is the indoor unit, the coil must be located in the outlet airstream of the furnace
- If a gas or oil furnace is used, the heat pump will not operate when they are operating
- Heat pumps added to electric furnaces should have the coil located after the heat strips



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## AIR TEMPERATURE OF THE CONDITIONED AIR

- Air temperatures of a heat pump are not as hot as with fossil-fuel equipment
- Maximum heat pump air supply temperatures are around 100° F
- Most heat pumps require a minimum of 400 cfm per ton of refrigeration
- Supply air temperature will fall when outside air temperatures drop






Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE OUTDOOR UNIT INSTALLATION

- Much like a regular air-conditioning installation
- Must have good air circulation around it
- Prevailing winds affect performance
- In the wintertime, the outdoor coil will collect moisture and the moisture will freeze on the coil
- Outdoor coil should be installed so it is raised above the ground pad to allow defrost water to run to the ground
- A defrost system is provided to defrost the ice from the outdoor coil

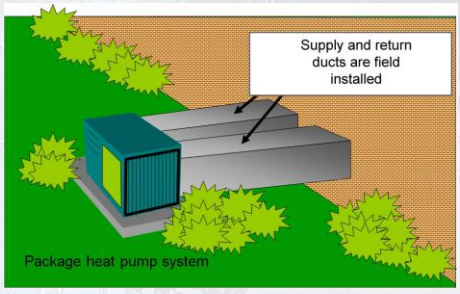


Refrigeration & Air Conditioning Technology
SIXTH EDITION

## PACKAGE AIR-TO-AIR HEAT PUMPS

- Has all the sealed system and electrical components in one housing
- Works much the same way as a packaged air-conditioning unit
- Only one power supply required
- Supply and return ductwork must be field installed

Refrigeration & Air Conditioning Technology
SIXTH EDITION






Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CONTROLS FOR AIR-TO-AIR HEAT PUMPS

- Controls are different than other heating/cooling equipment
- In a heat pump, there are two heating systems and one cooling system
- Auxiliary heating system must be operated as a system by itself in case the heat pump fails
- Auxiliary heat is referred to as emergency heat when used because of heat pump failure
- The space thermostat is the key to controlling the system
- Normally, a two-stage heating and two-stage cooling thermostat is used



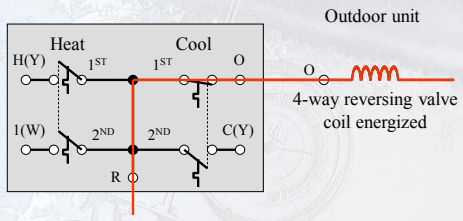
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CONTROLS FOR AIR-TO-AIR HEAT PUMPS

- Automatic changeover thermostat changes automatically between heating and cooling modes
- Cooling cycle controls
  - Thermostat contacts control the operation of the compressor, outdoor fan motor, and reversing valve coil
  - When the thermostat is satisfied, the compressor, outdoor fan motor, and indoor fan motor are de-energized
  - The reversing valve solenoid coil remains energized

Refrigeration & Air Conditioning Technology
SIXTH EDITION

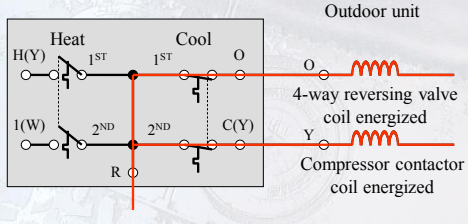
FIRST STAGE COOLING (SIMPLIFIED)






Refrigeration & Air Conditioning Technology
SIXTH EDITION

SECOND STAGE COOLING (SIMPLIFIED)

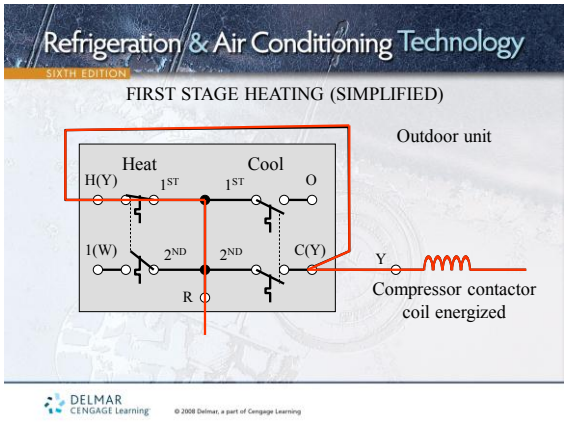


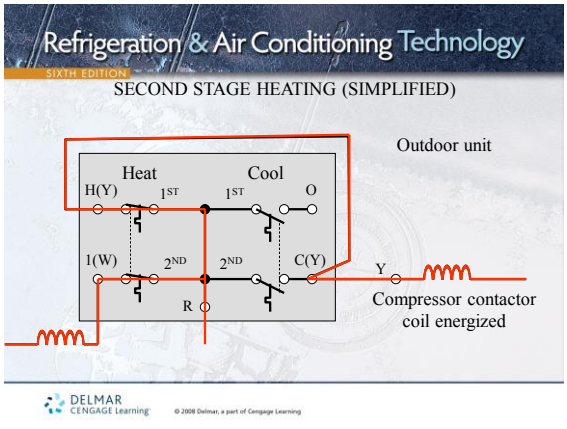


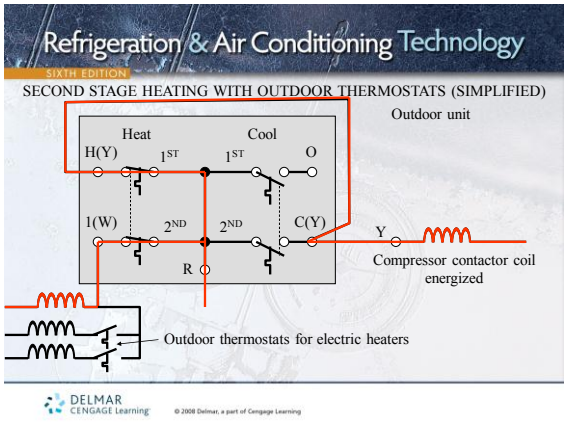

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CONTROLS FOR AIR-TO-AIR HEAT PUMPS

- Space heating control
  - Thermostat controls compressor, outdoor fan motor, and indoor fan motor operation
  - Excessively cold temperatures energize second-stage heat
  - Second-stage heat cycles on and off to assist the heat pump


Refrigeration & Air Conditioning Technology
SIXTH EDITION
FIRST STAGE HEATING (SIMPLIFIED)
Outdoor unit
Heat
Cool
H(Y)
1ST
1ST
O
1(W)
2ND
2ND
C(Y)
R
Y
Compressor contactor coil energized
DELMAR CENGAGE Learning
© 2008 Delmar, a part of Cengage Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION
SECOND STAGE HEATING (SIMPLIFIED)
Outdoor unit
Heat
Cool
H(Y)
1ST
1ST
O
1(W)
2ND
2ND
C(Y)
R
Y
Compressor contactor coil energized
DELMAR CENGAGE Learning
© 2008 Delmar, a part of Cengage Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION
SECOND STAGE HEATING WITH OUTDOOR THERMOSTATS (SIMPLIFIED)
Outdoor unit
Heat
Cool
H(Y)
1ST
1ST
O
1(W)
2ND
2ND
C(Y)
R
Y
Compressor contactor coil energized
Outdoor thermostats for electric heaters
DELMAR CENGAGE Learning
© 2008 Delmar, a part of Cengage Learning

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CONTROLS FOR AIR-TO-AIR HEAT PUMPS

- Balance point
  - Point at which the heat pump can satisfy the load without shutting down
  - May be multiple balance points
- Electric heaters are energized at different temperatures
  - Only the minimum number of heaters is energized at a time
  - Conserves energy
  - Auxiliary heat operation indicated by signal light on thermostat



Refrigeration & Air Conditioning Technology
SIXTH EDITION

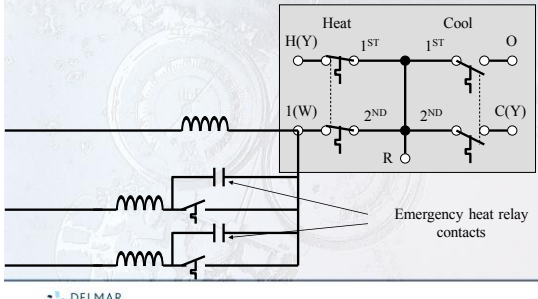
## CONTROLS FOR AIR-TO-AIR HEAT PUMPS

- Emergency heat mode
  - Used in the event of heat pump failure
  - All heating elements are energized
  - Signal light on thermostat
- Heat anticipators
  - Found on heat pump thermostats and conventional thermostats
  - Most heat pump thermostats are equipped with two



Refrigeration & Air Conditioning Technology
SIXTH EDITION

EMERGENCY HEATING (SIMPLIFIED)



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## THE DEFROST CYCLE

- Defrosts ice from outside coil during winter operation
- Outdoor coil operates below freezing anytime the outside air is below 45° F
- Outdoor coil operates 20° to 25° F below the outside air temperature
- The need for defrost varies depending on outside air temperatures and conditions
- The more moisture in the air, the more frost that forms on the outdoor coil
- Defrost affects the efficiency of the systems



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEATING SEASONAL PERFORMANCE FACTOR (HSPF)

- Seasonal performance for particular piece of equipment
- Breaks the country into six zones
- Used to calculate operation costs
- Considers average number and length of defrost cycles per year
- Considers whether auxiliary heaters are energized during defrost
- SEER and HSPF are results of federal energy policies



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEAT PUMP DEFROST

- Air-to-air heat pumps accomplish defrost by stopping the outdoor fan and cycling unit into cooling mode
- During defrost, one stage of strip heat is turned on
- The system is cooling and heating at the same time during defrost
- Demand defrost means defrosting only when needed
- Combinations of time, temperature, and pressure drop across the outdoor coil are also used in some systems to determine when defrost is needed

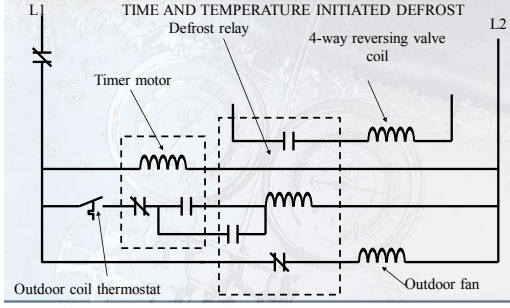
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## INITIATING THE DEFROST CYCLE

- Manufacturers design the systems to start defrost when frost affects performance
- Some use time and temperature initiated defrost systems
- Both conditions must be met before defrost will be activated
- Coil temperature sensing devices will close around outdoor coil temperature of 25˚
- Typically, the timer will run any time the compressor runs



Refrigeration & Air Conditioning Technology
SIXTH EDITION





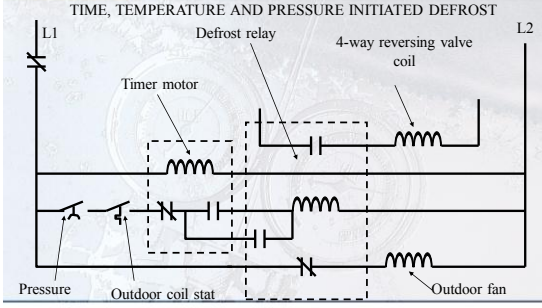

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## INITIATING THE DEFROST CYCLE

- Some systems will also include a pressure switch along with the temperature and timer function
- When ice forms on the coil, the pressure switch closes
- Time, temperature, and pressure defrost systems ensure that there is ice buildup on the outdoor coil

Refrigeration & Air Conditioning Technology
SIXTH EDITION

TIME, TEMPERATURE AND PRESSURE INITIATED DEFROST




DELMAR CENGAGE Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION

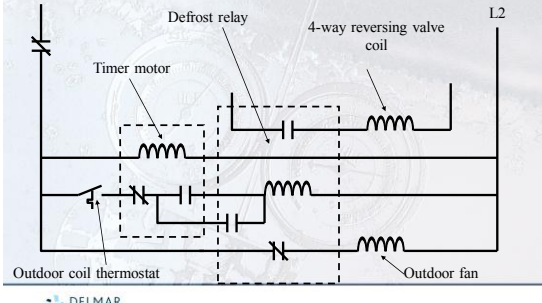
## TERMINATING THE DEFROST CYLE

- Stopping the defrost is as important as starting the defrost
- Time, temperature, and pressure can all be used to terminate the defrost cycle
- Temperature sensors used for the defrosting function will open at 50° F
- 10 minutes is the normal maximum time allowed for defrost cycle

DELMAR CENGAGE Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION

L1 TIME OR TEMPERATURE TERMINATED DEFROST




DELMAR CENGAGE Learning

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## ELECTRONIC CONTROL OF DEFROST

- Electronic timers and thermistors used to control defrost
- More accurate control than non-electronic methods
- Can incorporate time and temperature features into a single unit



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## INDOOR FAN MOTOR CONTROL

- In a heat pump, the fan must be started at the beginning of each mode of operation
- The indoor fan is started with the thermostat
- Fan switch terminal function is normally the G terminal on the thermostat
- The indoor fan motor often operates during defrost
  - Circulates air to prevent coil freezing
  - Air is tempered to prevent cold air from being introduced to the occupied space



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## AUXILIARY HEAT

- Usually accomplished with electric heat
- Required to assist the heat pump when it cannot provide all the heat the structure needs
- Also used as emergency heat when the heat pump needs service
- Heaters also energized during defrost

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SERVICING THE AIR-TO-AIR HEAT PUMP

- Much like servicing a refrigeration system
- During the cooling mode, system is operating as a high-temperature refrigeration system
- During the heating mode, system is operating as a low-temperature refrigeration system
- Servicing of the system is divided into electrical and mechanical
- The heat pump may run for days and not stop when outdoor temperatures are below the balance point



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## TROUBLESHOOTING MECHANICAL PROBLEMS

- Can be hard to identify in a heat pump, particularly in winter operation
- Summer operation of a heat pump is similar to an air-conditioning unit
- Mechanical problems are solved with gage manifolds, wet-bulb and dry-bulb thermometers, and air-measuring instruments



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## TROUBLESHOOTING THE FOUR-WAY VALVE

- Common problems: stuck valve, defection coil and internal leaks
- Check to see if coil is energized
- A warm coil indicates power is being supplied to the coil
- Place a screwdriver on the surface of the coil to sense magnetic field
- Check for voltage supplied to the coil
- Defective coils can be replaced without changing the entire valve

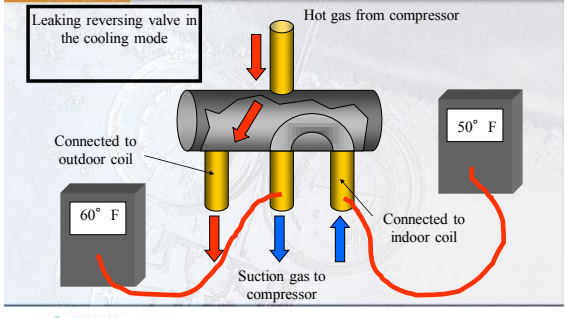
Refrigeration & Air Conditioning Technology
SIXTH EDITION

## TROUBLESHOOTING THE FOUR-WAY VALVE

- Four-way valves leaking through can be confused with a compressor that is not pumping to capacity
- Capacity of the system will not be normal in summer or winter cycles
- Check the temperature of the low-side line, the suction line from the evaporator, and the permanent suction line between the four-way valve and the compressor
- In this check, the temperature difference should not be more than about 3° F

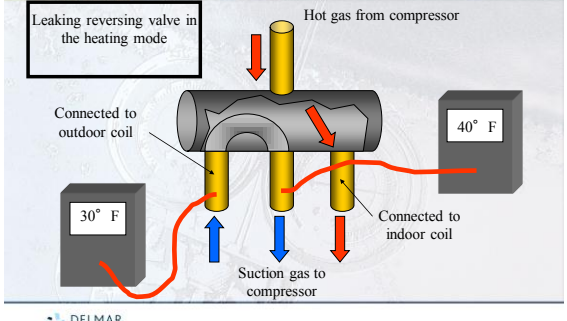


Refrigeration & Air Conditioning Technology
SIXTH EDITION






Refrigeration & Air Conditioning Technology
SIXTH EDITION



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CHECKING THE CHARGE

- Most heat pumps have a critical refrigerant charge
- If systems are low on charge, technicians must locate and repair leaks
- Caution should be taken when charging systems with suction accumulators
- Suction accumulators store part of the charge in the winter mode and will boil out later



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## CHECKING THE CHARGE

- Sweating suction-line accumulator
  - When checking or charging a system, heat the accumulator by running water over it to drive the refrigerant out of it
  - Often the accumulator will frost or sweat at a particular level if liquid refrigerant is contained in it



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SPECIAL APPLICATION FOR HEAT PUMPS

- Use of oil or gas furnaces for auxiliary heat
- More efficient applications than auxiliary electric heat
- The heat pump coil must be installed downstream of the oil or gas heat exchanger
- The air must flow through the furnace heat exchanger before the heat pump coil
- The oil or gas furnace must not operate at the same time that the heat pump is operating

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEAT PUMPS USING SCROLL COMPRESSORS

- Ideally suited for heat pump application because of its pumping characteristics
- Scrolls do not lose as much capacity as reciprocating compressors
- Scroll compressor pressures are about the same as reciprocating compressors
- Scroll compressors are discharge gas cooled,



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEAT PUMPS USING SCROLL COMPRESSORS

- Scroll compressors have a check valve in the discharge leaving the compressor to prevent pressures from equalizing through the compressor during the off cycle
- Scroll compressors normally do not require a suction-line accumulator because they are not as sensitive to liquid floodback



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## HEAT PUMP SYSTEMS WITH VARIABLE-SPEED MOTORS

- Use of variable-speed motors for the compressor and both fan motors is the method used to improve system efficiency in heat pump systems
- Sized closer to the heating requirements of the structure at full load and will run at part load and reduced power in warmer months
- Less auxiliary heat is required for these systems
- Variable speed is accomplished with electronically controlled motors

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 1

- Heat pumps can pump heat two ways to provide both heating and cooling
- Four-way reversing valves control the direction of flow of the heat-laden vapor between the low- and high-pressure sides of the system
- In the cooling mode, the outdoor coil functions as the condenser and the indoor coil functions as the evaporator
- In the heating mode, the outdoor coil functions as the evaporator and the indoor coil functions as the condenser



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 2

- Metering devices are located at the inlet of both the indoor and outdoor coils
- Check valves are used to bypass the metering device that should not be in the active refrigerant circuit
- Bidirectional or bi-flow filter driers are two driers in a single shell and are designed for heat pump applications
- In the heating mode, heat pumps lose efficiency as the outside ambient temperature drops
- Auxiliary heat is required when the heat pump cannot provide all the heat a structure needs



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 3

- Balance point occurs when the heat pump can pump in exactly as much heat as the structure is leaking out
- Coefficient of performance is the ratio of usable heat (in watts) produced from each watt of energy purchased
- In winter operation, the COP increases as the outside ambient temperature increases
- Split heat pump systems require the installation of gas and liquid lines to connect the indoor and outdoor units
- The indoor unit contains the fan and coil and often the electric strip heaters

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 4

- Maximum air supply temperatures are around 100° F
- Outdoor coil should be installed so it is raised above the ground pad to allow defrost water to run to the ground
- A defrost system is provided to defrost the ice from the outdoor coil
- Package heat pump systems have all system and electrical components in one housing
- There are two heating systems and one cooling system
- Auxiliary heating system must be operated as a system by itself in case the heat pump fails



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 5

- Automatic changeover thermostat changes automatically between heating and cooling modes
- Emergency heat mode is used in the event of heat pump failure
- The need for defrost varies depending on outside air temperatures and conditions
- The more moisture in the air, the more frost that forms on the outdoor coil
- Defrost affects the efficiency of the systems
- Air-to-air heat pumps accomplish defrost by stopping the outdoor fan and cycling unit into cooling mode



Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 6

- Combinations of time, temperature, and pressure drop across the outdoor coil are also used in some systems to determine when defrost is needed and when defrost is terminated
- Defrost can also be controlled electronically
- In a heat pump, the fan must be started at the beginning of each mode of operation
- The indoor fan motor often operates during defrost
- During the cooling mode, system is operating as a high-temperature refrigeration system

Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 7

- During the heating mode, system is operating as a low-temperature refrigeration system
- Common reversing valve problems include: stuck valve, defection coil and internal leaks
- Temperature readings of the reversing valve connections can be taken to evaluate the valve
- Most heat pumps are critically charged systems
- If the system operated correctly in at least one mode, the refrigerant charge is correct

DELMAR CENGAGE Learning


Refrigeration & Air Conditioning Technology
SIXTH EDITION

## SUMMARY - 8

- Oil or gas furnaces can be used for auxiliary heat
- The heat pump coil must be installed downstream of the oil or gas heat exchanger
- Scroll compressor is ideally suited for heat pump applications because of its pumping characteristics
- Scroll compressors normally do not require a suction-line accumulator because they are not as sensitive to liquid floodback
- Use of variable-speed motors for the compressor and both fan motors is the method used to improve system efficiency in heat pump systems

DELMAR CENGAGE Learning