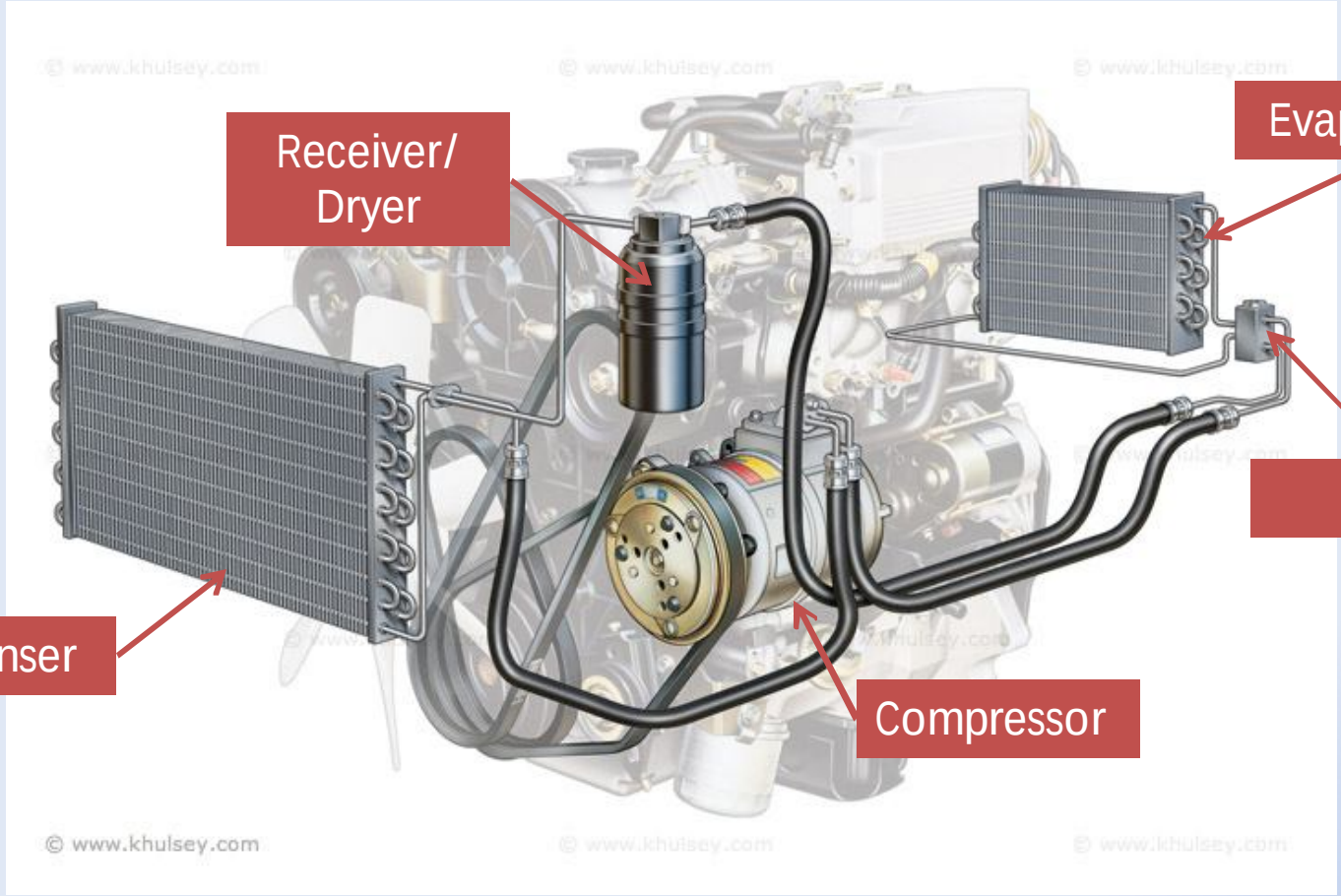
Troubleshooting Guide

Review of AC System and components.

AC System and its Components



Equipment Needed

Refrigerant gauge set

Thermometer

Multimeter

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

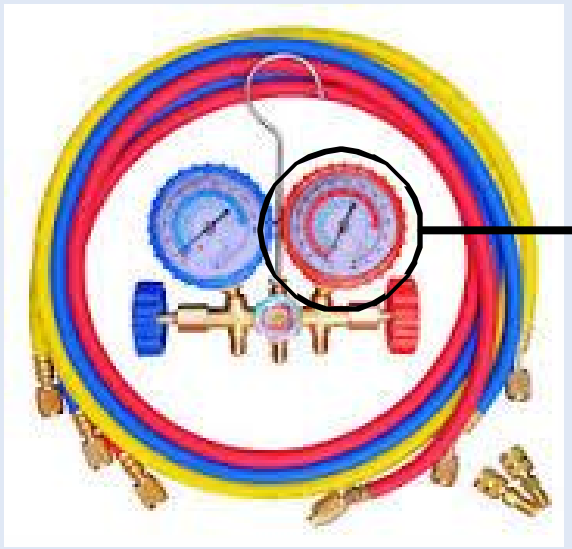
Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Troubleshooting worksheet

Gauge Set



Understanding the Gauge

The gauge tells us two important things

1: Pressure of the gas

2: Saturation temperature of the gas

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Understanding the Troubleshooting sheet

In order to service a system, there are a few pieces of information we need.

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Compressor Outlet Pressure
(Discharge Pressure)
Measured using the high pressure service port

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Compressor Outlet Temperature
(Discharge Temperature)
Measured using a thermometer and the skin temperature of the metal part of the discharge line

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Condenser Outlet Temperature (Condenser Discharge Temperature) **Measured using a thermometer and the skin temperature of the metal part of the discharge line.**

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Compressor inlet Pressure
(Suction Pressure)
Measured using the Low pressure service port

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

Compressor Inlet Temperature
(Suction Temperature)
Measured using a thermometer and the skin temperature of the metal part of the Suction line.

AC System and its Components

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	PSI
Compressor Outlet Temperature (T_d)	°F
Condenser Outlet Temperature (T_{cd})	°F
Compressor Inlet Pressure (P_s)	PSI
Compressor Inlet Temperature (T_s)	°F
Calculated Item	Value
Condenser Subcooling (T_{sc})	°F
Evaporator Superheat (T_{sh})	°F
Compressor Superheat (T_{csh})	°F

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

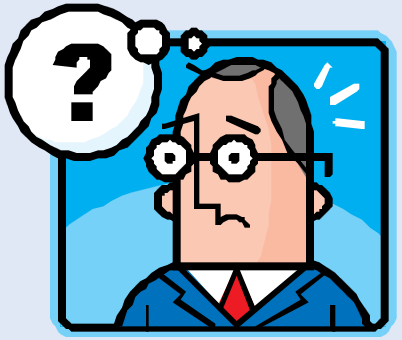
Condenser Subcooling

Tells if the condenser is performing its job, and it liquid is going to the expansion device.

Evaporator Superheat

Tells us if the evaporator is doing its job and if the compressor is receiving in liquid or gas

How to determine Saturation Temperature



There are 2 ways to determine ***Saturation Temperature***

1. Using the Gauge
2. Using a Saturation Table

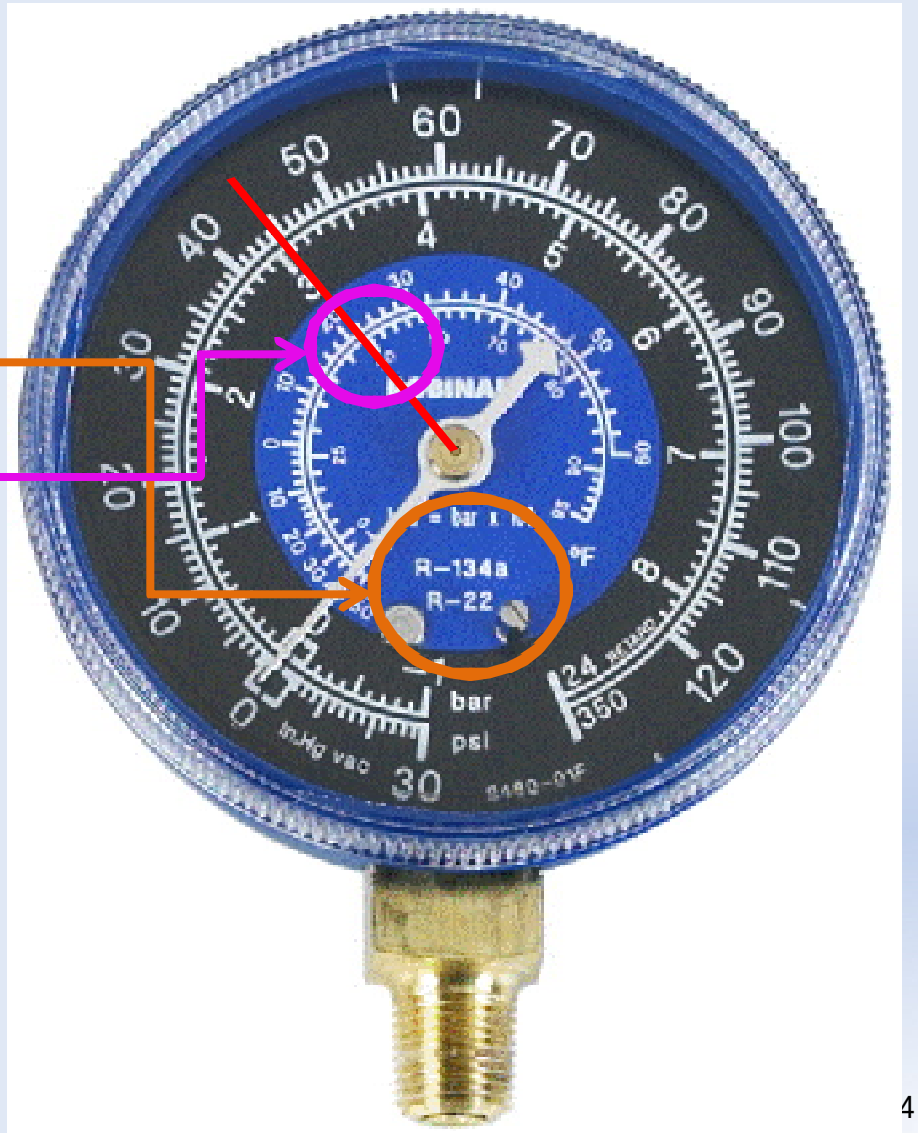
How to determine Saturation Temperature

There are 2 ways to determine ***Saturation Temperature***

1. Using the Gauge
2. Using a Saturation Table

How to use the gauge to determine ***Saturation Temperature***

1. Identify the type of gas you are working with
2. Read the measurement



Results

Pressure: 45PSI
Saturation Temperature: 50°F

How to determine Saturation Temperature

There are 2 ways to determine ***Saturation Temperature***

1. Using the Gauge
2. Using a Saturation Table

How to use the gauge and saturation chart to determine ***Saturation Temperature***

1. Read Pressure

Results

Pressure: 45PSI

How to determine Saturation Temperature

There are 2 ways to determine ***Saturation Temperature***

1. Using the Gauge
2. Using a Saturation Table

How to use the gauge and saturation chart to determine ***Saturation Temperature***

1. Find pressure on chart and look up temperature

Pressure Gauge				Temperature	
PSI	Bar	kPa	Mpa	°F	°C
0	0.00	0.0	0.000	-14.9	-26.1
5	0.34	34.5	0.034	-3	-19.4
10	0.69	68.9	0.069	6.7	-14.1
15	1.03	103.4	0.103	14.9	-9.5
20	1.38	137.9	0.138	22.2	-5.4
25	1.72	172.4	0.172	28.7	-1.8
30	2.07	206.8	0.207	34.5	1.4
35	2.41	241.3	0.241	39.9	4.4
40	2.76	275.8	0.276	44.9	7.2
45	3.10	310.3	0.310	49.6	9.8
50	3.45	344.7	0.345	53.9	12.2
55	3.79	379.2	0.379	58	14.4

Results

Saturation Temperature: 49.6°F

Saturation Temperature

Gauge Vs. Saturation Chart

	Gauge	Saturation Chart
Pros	• Quick reference • Less material to maintain	• More accurate • Better Results
Cons	• Less accuracy • Difficult to read when not an even number	• More time consuming • More difficult to read

Common Issues with AC system

1. Undercharge
2. Overcharge
3. Non - Condensable in system
4. Restricted expansion device
5. Dirty or restricted air flow over condenser
6. Restricted air flow over evaporator
7. Clutch not engaging

Undercharge: Not enough gas in the system

1. Medium to high compressor discharge temperature
    I. The reason this happens is because the fluid coming into the compressor is hot. Part of the function of the suction gas is to cool the compressor. If the gas starts hotter than normal, it will also be hotter than normal when it exist.
2. High suction superheat
    I. The reason you will have higher superheat is because the expansion device will be starved of liquid due to the undercharging. When the expansion device is starved, it will pass both liquid and vapor and will not be able to control superheat.
3. Low condenser subcooling
    I. The condenser will have low subcooling because there will not be enough time for the gas to exchange heat because of the demand of the system. Also, as the compressor runs with low gas, the discharge temperatures will became hotter, this also increase the temperature of the gas existing the condenser.
4. Low suction pressure
    I. Suction pressure will become lower because of the demand the compressor requires. Compressor will act like a vacuum pulling the gas though the evaporator causing low suction pressures.

Overcharge: Too much gas in the system

1. High compressor discharge temperature
    I. The higher discharged temperature is caused by the increase of the discharge pressure.
2. High discharge pressure
    I. The subcooled liquid will back up in the condenser and reduce the amount of surface area for the gas to cool. This will cause higher pressures.
3. High condenser subcooling
    I. Because of the backed up liquid at the bottom of the condenser, this will cause the liquid to reach high subcooling temperatures.
4. Normal superheat
    I. The TXV will control the superheat. There may be a slight variation during the initial opening, but it will self-correct and control the superheat.

Non-Condensable in System: Air in system

1. High compressor discharge temperature
    I. The higher discharged temperature is caused by the increase of the discharge pressure.
2. High discharge pressure
    I. The subcooled liquid will back up in the condenser and reduce the amount of surface area for the gas to cool. This will cause higher pressures.
3. High condenser subcooling
    I. Because of the backed up liquid at the bottom of the condenser, this will cause the liquid to reach high subcooling temperatures.
4. Normal Superheat
    I. The TXV will control the superheat. There may be a slight variation during the initial opening, but it will self-correct and control the superheat.
5. Localized cooling
    I. The non condensable will cause localized cooling or freezing on line. Typically, near expansion device.

Restricted Expansion Device: Blockage in TXV

1. Low Suction Pressure
    I. Suction pressure will become lower because of the demand of refrigerant the compressor requires. Compressor will act like a vacuum pulling the gas though the evaporator causing low suction pressures.
2. High Superheat
    I. The reason you will have higher superheat is because the expansion device will be starved of liquid due to the restriction. When the expansion device is starved, it will pass both liquid and vapor and will not be able to control superheat.
3. High discharge temperatures
    I. Discharge temperatures will be higher because of the higher superheat.

Dirty or restricted air flow over condenser: not enough heat transfer

1. High compressor discharge pressure
    I. Discharge pressure will be high because the area available for the transfer of heat will be much less.
2. Low condenser subcooling
    I. Because less area for heat transfer is available, subcooling will not be able to be reached.
3. High compressor discharge temperature
    I. As pressure increase so will temperature, this is due to the higher compression ratio.

Dirty or restricted air flow over evaporator: not enough heat transfer

1. Low compressor discharge pressure
    I. The restricted air flow on the evaporator will reduce the heat load which will cause the refrigerant to not fully vaporize. This causes lower temperature because the inlet temperature will be lower causing the condenser to cool the refrigerant to lower temperatures which result in lower pressures.
2. Low superheat
    I. Superheat will be lower because the heat transfer in the evaporator will be less. No heat load no superheat.
3. Cold compressor crankcase
    I. The suction refrigerant will still be cold because of no heat transfer. This will cause the crankcase to become cold.

Clutch not engaging: compressor will not turn on

1. No voltage to coil
2. Relay switch broke
3. Clutch coil is brunt
4. Air gap too big

The table below shows a summary of the common issues with a AC system

Items	Compressor Discharge		Comrpessor Suction		Condenser	Evaporator	Special Notes
	Temperature	Pressure	Temperature	Pressure	Subcool	Superheat	
Underchargeed	High	-	-	Low	Low	High	-
Overcharged	High	High	-	-	High	Normal	-
Non-Condensable in System	High	High	-	-	High	Normal	Localized Cooling No Pressure/Temperature Correlatioin
Restricted Expansion Device	High	-	-	Low	-	High	-
Dirty or restricted air flow over condenser	High	High	-	-	Low	-	-
Dirty or restricted air flow over evaporator	-	Low	-	-	-	Low	Cold Crankcase
Suction line restriction	-	Low	-	Low	Normal	High	-

Now, lets test our knowledge

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	12.66 Kg/cm^2
Compressor Outlet Temperature (T_d)	104 °C
Condenser Outlet Temperature (T_{cd})	49.7 °C
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
Condenser Subcooling (T_{sc})	°C
Evaporator Superheat (T_{sh})	°C
Compressor Superheat (T_{csh})	°C

Now, lets test our knowledge

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	12.66 Kg/cm^2
Compressor Outlet Temperature (T_d)	104 °C
Condenser Outlet Temperature (T_{cd})	49.7 °C
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
Condenser Subcooling (T_{sc})	°C
Evaporator Superheat (T_{sh})	°C
Compressor Superheat (T_{csh})	°C

1: Solve for subcooling

2: Solve for superheat

Solving for Subcooling

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	12.66 Kg/cm^2
Condenser Outlet Temperature (T_{cd})	49.7 °C
Calculated Item	Value
Condenser Subcooling (T_{sc})	°C

Solving for Subcooling

1: Identify items you will need to use

2: Calculate saturated Temperature

Solving for Subcooling

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value	
Compressor Outlet Pressure (P_d)		12.66 Kg/cm^2
Condenser Outlet Temperature (T_{cd})		49.7 °C
Calculated Item	Value	
Condenser Subcooling (T_{sc})		°C

Solving for Subcooling

1: Find pressure on saturation chart

2: Go across the table and find the saturation

3: Saturation Temperature = 50.7

Pressure Gauge					Temperature	
PSI	Bar	kg/cm^2	kPa	Mpa	°F	°C
175	12.07	12.30	1206.6	1.207	121.4	49.7
180	12.41	12.66	1241.1	1.241	123.3	50.7
185	12.76	13.01	1275.5	1.276	125.1	51.7
190	13.10	13.36	1310.0	1.310	126.9	52.7

Solving for Subcooling

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	12.66 Kg/cm^2
Condenser Outlet Temperature (T_{cd})	49.7 °C
Calculated Item	Value
Condenser Subcooling (T_{sc})	°C

Solving for Subcooling

1: Identify formula needed
2: Plug numbers into equation
3: Evaluate results

High - - Normal - - Low

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

$$T_{sc} = 50.7 - 49.7 = 1$$

Now, lets test our knowledge

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	12.66 Kg/cm^2
Compressor Outlet Temperature (T_d)	104 °C
Condenser Outlet Temperature (T_{cd})	49.7 °C
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
Condenser Subcooling (T_{sc})	1 °C
Evaporator Superheat (T_{sh})	°C
Compressor Superheat (T_{csh})	°C

1: Solve for subcooling 

2: Solve for superheat

Solving for Superheat

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
Compressor Superheat (T_{csh})	°C

Solving for Superheat

1: Identify items you will need to use

2: Calculate saturated Temperature

Solving for Superheat

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
Compressor Superheat (T_{csh})	°C

Solving for Superheat

1: Find pressure on saturation chart

2: Go across the table and find the saturation

3: Saturation Temperature = -19.4

Pressure Gauge					Temperature	
PSI	Bar	kg/cm^2	kPa	Mpa	°F	°C
0	0.00	0.00	0.0	0.000	-14.9	-26.1
5	0.34	0.35	34.5	0.034	3	-19.4
10	0.69	0.70	68.9	0.069	6.7	-14.1
15	1.03	1.05	103.4	0.103	14.9	-9.5

Solving for Superheat

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
[redacted]	
Compressor Inlet Pressure (P_s)	0.35 Kg/cm^2
Compressor Inlet Temperature (T_s)	0 °C
Calculated Item	Value
[redacted]	
Compressor Superheat (T_{csh})	°C

Solving for Superheat

1: Identify formula needed
2: Plug numbers into equation
3: Evaluate results

High - - Normal - - Low

Troubleshooting Reference Calculations

Calculated Item	Formula
Condenser Subcooling (T_{sc})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Evaporator Superheat (T_{sh})	$T_{sc} = T_{Sat.Discharge} - T_{CD}$
Compressor Superheat (T_{csh})	$T_{sc} = T_d - T_{Sat.Discharge}$

$$T_{sh} = 0 - (-19.4) = 19.4$$

Practice Problem

Results

Compressor Discharge		Compressor Suction		Condenser	Evaporator
Temperature	Pressure	Temperature	Pressure	Subcool	Superheat
High	-	-	Low	Low	High

Items	Compressor Discharge		Comrpessor Suction		Condenser	Evaporator	Special Notes
	Temperature	Pressure	Temperature	Pressure	Subcool	Superheat	
Underchargeed	High	-	-	Low	Low	High	-
Overcharged	High	High	-	-	High	Normal	-
Non-Condensable in System	High	High	-	-	High	Normal	Localized Cooling No Pressure/Temperature Correlatioin
Restricted Expansion Device	High	-	-	Low	-	High	-
Dirty or restricted air flow over condenser	High	High	-	-	Low	-	-
Dirty or restricted air flow over evaporator	-	Low	-	-	-	Low	Cold Crankcase
Suction line restriction	-	Low	-	Low	Normal	High	-

Now, lets test our knowledge

Sanden International

AC System Troubleshooting Sheet

Troubleshooting Sheet

Measured Item	Value
Compressor Outlet Pressure (P_d)	21.09 Kg/cm^2
Compressor Outlet Temperature (T_d)	140 °C
Condenser Outlet Temperature (T_{cd})	89.1 °C
Compressor Inlet Pressure (P_s)	2.81 Kg/cm^2
Compressor Inlet Temperature (T_s)	12.8 °C

Calculated Item	Value
Condenser Subcooling (T_{sc})	18 °C
Evaporator Superheat (T_{sh})	5.6 °C
Compressor Superheat (T_{csh})	°C

Practice Problem

Results

Compressor Discharge		**Compressor Suction**		**Condenser**	**Evaporator**
Temperature	Pressure	Temperature	Pressure	Subcool	Superheat
High	-	-	Low	Low	High

Items	Compressor Discharge		Comrpessor Suction		Condenser	Evaporator	Special Notes
	Temperature	Pressure	Temperature	Pressure	Subcool	Superheat	
Undercharged	High	-	-	Low	Low	High	-
Overcharged	High	High	-	-	High	Normal	-
Non-Condensable in System	High	High	-	-	High	Normal	Localized Cooling No Pressure/Temperature Correlatioin
Restricted Expansion Device	High	-	-	Low	-	High	-
Dirty or restricted air flow over condenser	High	High	-	-	Low	-	-
Dirty or restricted air flow over evaporator	-	Low	-	-	-	Low	Cold Crankcase
Suction line restriction	-	Low	-	Low	Normal	High	-


THE END!