Carlyle

IDENTIFYING COMPRESSOR FAILURE MODES

Indicators, Symptoms, and Corrections

Replacement new or remanufactured compressors fail at four times the rate of original compressors. That indicates most compressors fail due to system malfunctions which must be corrected to prevent repeat failures. Field examination of the failed compressor often will reveal symptoms of system problems.

REFRIGERANT FLOODBACK

This is the result of liquid refrigerant returning to the compressor during the RUNNING CYCLE.
The oil is diluted with refrigerant to the point it cannot properly lubricate the load bearing surfaces.

- Open Drive Compressors
  Worn pistons and cylinders
  No evidence of overheating

The liquid washed the oil off the pistons and cylinder walls during the suction stroke causing them to wear during the compression stroke.

- Refrigerant Cooled Compressors
  Center & rear bearing worn/seized
  Dragging rotor, shorted stator
  Progressively worn crankshaft
  Worn or broken rods
  Possible worn piston rings

The liquid dilutes the oil in the crankcase and the refrigerant rich oil will be pumped to the rods and bearings through the crankshaft. As the refrigerant boils off, there will not be enough oil for proper lubrication at the bearings farthest from the oil pump. The center and rear bearings may seize or may wear enough to allow the rotor to drop and drag on the stator causing it to short or spot burn.

CORRECTION:
1. Maintain proper evaporator and compressor superheat 2. Correct abnormally low load condition
3. Install suction accumulator to stop uncontrolled liquid return

FLOODED STARTS

Worn or scored rods or bearings
Rods broken from seizure
Erratic wear pattern on crankshaft

This is the result of refrigerant migration to the crankcase oil during the OFF CYCLE. When the compressor starts, the diluted oil cannot properly lubricate the crankshaft load bearing surfaces causing an erratic wear or seizure pattern.

CORRECTION:
1. Locate the compressor in a warm ambient or install continuous pumpdown
2. Check crankcase heater operation (Should be energized during off cycle)
3. Operate with minimum refrigerant charge

LIQUID SLUGGING

Broken reeds, rods, or crankshaft
Loose or broken backer bolts
Blown gaskets

This is the result of trying to compress liquid in the cylinders. Slugging is an extreme floodback in the first stage of compound or in open drive compressors, and a severe flooded start in the second stage of compound or in refrigerant cooled compressors

CORRECTION:
1. Maintain proper evaporator and compressor superheat 2. Correct abnormally low load conditions
3. Locate the compressor in a warm ambient or install continuous pumpdown
4. Proper oil management piping sized properly

HIGH DISCHARGE TEMPERATURE

Discolored valve plate
Burned reed valves
Worn pistons, rings and cylinders
Stator spot burn from metal fragments

This is the result of temperatures in the compressor head and cylinders becoming so hot that the oil loses its ability to lubricate properly. That causes pistons, rings and cylinder walls to wear resulting in blow by, leaking valves and metal fragments in the oil.

CORRECTION:
1. Correct high compression ration from low load conditions, high discharge pressure conditions
2. Check low pressure switch setting 3. Insulate suction lines
4. Provide proper compressor cooling/motor cooling. Excessive motor heat can overheat refrigeration

LOSS OF OIL

All rods and bearings worn or scored
Crankshaft uniformly scored
Rods broken from seizure
Little or no oil in crankcase

This is a result of insufficient oil in the crankcase to properly lubricate the load bearing surfaces. When the flow of refrigerant is too low to return oil as fast as it is being pumped out, a uniform wearing of all load bearings will result.

CORRECTION:
1. Check oil failure control operation if applicable 2. Check system refrigerant charge
3. Correct abnormally low load situations or short cycling
4. Check for improper line sizing and improper traps 5. Check for inadequate defrosts

ELECTRICAL FAILURES

Motors are generally damaged as a result of mechanical failures but some are true electrical failures.

GENERAL or UNIFORM BURN

Entire motor winding is uniformly overheated or burned.

CORRECTION:
1. Check for high or low voltage 2. Check for unbalanced voltage 3. Check for rapid compressor cycling

SINGLE PHASE BURN

A result of not having current through the unburned and overloading the other two.

Two phases of a three phase motor are overheated or burned.

CORRECTION:
1. Check for proper motor protection 2. Check contactor contacts and mechanical condition
3. Check terminal and wiring condition 4. Check for unbalanced voltage 5. Check for blown fuses

HALF WINDING SINGLE PHASE BURN

This occurs when one half of a PART WINDING START motor has a single phasing condition.
Two contactors are used in the PART WINDING START and a problem exists with one.

CORRECTION:
1. Check both contactors, one will be defective 2. Check sequence timer for one second or less total time

HALF WINDING BURN

Half of all phases on a PART WINDING START motor are burned or overheated.

CORRECTION:
1. Check for electrical feed back circuit energizing a contactor holding coil
2. Replace contactors with ones properly sized

PRIMARY SINGLE PHASE BURN

Only one phase of a three phase motor is overheated or burned as the result of the loss of a phase in the primary of a Δ to Y or Y to Δ transformer configuration.

CORRECTION:
1. Check transformer for proper voltage incoming and outgoing

START WINDING BURN

Only the start winding is burned in a single phase motor due to excessive current in the start winding.

CORRECTION:
1. Check proper C, S and R wiring of the compressor
2. Check start capacitor and start relay 3. Check for overloaded compressor

RUN WINDING BURN

A localized burn within the winding, between windings, or from winding to ground. Can be electrical failure or possible mechanical failure resulting from foreign materials in motor winding. Only the run winding is burned in a single phase compressor.

CORRECTION:
1. Check start relay 2. Check run capacitor 3. Check supply voltage

Saturated Temperature			R134a	R513A	R22	R407C	R744
		GWP	1430	631	1810	1624	1
°F	°C	ODP	0	0	0.04	0	0
-50	-45.6		18.7	16.5	6.1	11.0	103.4
-45	-42.8		16.9	14.4	2.7	8.0	116.6
-40	-40.0		14.8	12.0	0.6	4.6	131.0
-35	-37.2		12.5	9.4	2.6	0.9	146.5
-30	-34.4		9.8	6.5	4.9	1.6	163.1
-25	-31.7		6.9	3.2	7.4	3.9	181.0
-20	-28.9		3.7	0.2	10.2	6.5	200.2
-15	-26.1		0.0	2.1	13.2	9.3	220.8
-10	-23.3		1.9	4.3	16.5	12.3	242.7
-5	-20.6		4.1	6.6	20.1	15.7	266.1
0	-17.8		6.5	9.2	24.0	19.4	291.0
5	-15.0		9.1	12.0	28.3	23.5	317.6
10	-12.2		11.9	15.1	32.8	27.9	345.7
15	-9.4		15.0	18.4	37.8	32.7	375.6
20	-6.7		18.4	22.0	43.1	37.9	407.2
25	-3.9		22.1	25.9	48.8	43.5	440.7
30	-1.1		26.1	30.1	55.0	49.6	476.1
35	1.7		30.4	34.6	61.5	56.1	513.4
40	4.4		35.0	39.5	68.6	63.2	552.9
45	7.2		40.1	44.7	76.1	70.7	594.5
50	10.0		45.4	50.3	84.1	78.8	638.3
55	12.8		51.2	56.3	92.6	87.5	684.4
60	15.6		57.4	62.7	101.6	117.9	733.1
65	18.3		64.0	69.6	111.2	128.9	784.2
70	21.1		71.1	76.8	121.4	140.5	838.1
75	23.9		78.7	84.5	132.2	152.8	894.9
80	26.7		86.7	92.7	143.6	165.8	954.9
85	29.4		95.2	101.4	155.7	179.6	1018.4
90	32.2		104.3	110.6	168.4	194.1	***
95	35.0		113.9	120.4	181.8	209.4	***
100	37.8		124.2	130.7	195.9	225.5	***
105	40.6		135.0	141.6	210.8	242.4	***
110	43.3		146.4	153.1	226.4	260.3	***
115	46.1		158.4	165.2	242.8	279.0	***
120	48.9		171.2	178.0	260.0	298.6	***
125	51.7		184.6	191.4	278.0	319.2	***
130	54.4		198.7	205.5	296.9	340.7	***
135	57.2		213.6	220.3	316.7	363.3	***
140	60.0		229.2	235.9	337.4	386.9	***
145	62.8		245.7	252.2	359.0	411.7	***
150	65.6		262.9	269.4	381.7	437.5	***
155	68.3		281.0	287.4	405.3	464.4	***
160	71.1		300.0	306.2	430.1	492.6	***

Gray shaded cells indicate vacuum pressures in inches of Mercury

Blue shaded cells represent saturated vapor pressures

Orange shaded cells represent saturated liquid pressures

*** Denotes pressures above critical point of the refrigerant

CONSULT CARLYLE FOR DETAILED RETROFIT RECOMMENDATIONS

Retrofit Conversions		Approximate impact to system performance					
		Capacity	Mass Flow	Power	Discharge Pressure	Discharge Temp	Oil Change
R22 to R407C	HT	↓~5%	↓~6%	↓~2%	↑~10 psi	↓~19°F	MO → POE 3 oil flushes
R134a to R513A	HT	↓~1%	↑~17%	↑~2%	↑~7 psi	↓~11°F	POE 1 oil flush

Saturated Temperature			R404A	R448A	R449A	R407A	R407F
		GWP	3922	1273	1282	2107	1825
°F	°C	ODP	0	0	0	0	0
-50	-45.6		0.1	7.6	7.4	9.0	7.8
-45	-42.8		2.0	4.2	3.9	5.7	4.4
-40	-40.0		4.3	0.4	-0.1	2.0	0.5
-35	-37.2		6.8	1.9	2.0	1.0	1.9
-30	-34.4		9.6	4.2	4.4	3.3	4.2
-25	-31.7		12.7	6.8	6.9	5.8	6.8
-20	-28.9		16.0	9.6	9.8	8.5	9.7
-15	-26.1		19.7	12.7	12.9	11.5	12.9
-10	-23.3		23.6	16.1	16.3	14.9	16.4
-5	-20.6		27.9	19.8	20.0	18.5	20.2
0	-17.8		32.6	23.9	24.1	22.5	24.4
5	-15.0		37.7	28.3	28.5	26.9	28.9
10	-12.2		43.1	33.1	33.3	31.6	33.9
15	-9.4		49.0	38.4	35.5	36.7	39.3
20	-6.7		55.3	44.0	44.2	42.3	45.1
25	-3.9		62.1	50.1	50.2	48.3	51.4
30	-1.1		69.3	56.6	56.8	54.8	58.2
35	1.7		77.1	63.7	63.8	61.8	65.5
40	4.4		85.4	71.2	71.4	69.4	73.4
45	7.2		94.2	79.3	79.5	77.4	81.8
50	10.0		103.6	88.0	88.2	86.1	90.8
55	12.8		113.6	97.3	97.4	95.3	100.5
60	15.6		126.0	128.0	127.9	125.2	131.7
65	18.3		137.3	139.6	139.4	136.7	143.7
70	21.1		149.3	151.9	135.4	148.8	156.4
75	23.9		162.0	164.9	164.6	161.7	169.9
80	26.7		175.4	178.6	178.3	175.3	184.1
85	29.4		189.5	193.1	192.7	189.7	199.1
90	32.2		204.5	208.4	208.0	204.8	215.0
95	35.0		220.2	224.4	224.0	220.8	231.7
100	37.8		236.8	241.3	240.8	237.6	249.3
105	40.6		254.2	259.1	258.6	255.3	267.8
110	43.3		272.5	277.8	277.2	273.9	287.2
115	46.1		291.8	297.4	296.7	293.5	307.6
120	48.9		312.0	317.9	288.5	314.0	329.0
125	51.7		333.3	339.4	338.6	335.4	351.5
130	54.4		355.6	362.0	361.0	357.9	375.0
135	57.2		379.1	385.5	384.5	381.5	399.7
140	60.0		403.7	410.2	409.0	406.2	425.4
145	62.8		429.6	435.9	434.7	431.9	452.4
150	65.6		456.8	462.8	461.4	458.9	480.6
155	68.3		485.5	490.8	489.3	487.0	510.0
160	71.1		515.8	519.9	518.3	516.4	540.7

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Retrofit Conversions		Approximate impact to system performance					
		Capacity	Mass Flow	Power	Discharge Pressure	Discharge Temp	Oil Change
R404A to R448A	LT	↓~7%	↓~31%	↓~13%	↓~23 psi	↑~41°F	POE 1 oil flush
	MT	↓~3%	↓~27%	↓~8%	↓~23 psi	↑~24°F	
R404A to R449A	LT	↓~12%	↓~34%	↓~18%	↓~37 psi	↑~38°F	
	MT	↓~7%	↓~31%	↓~13%	↓~31 psi	↓~22°F	