

I. Control of Liquid Migration to the Compressor During Shutdown

A. Liquid Refrigerant Mitigation to Compressor During Shutdown

Liquid refrigerant migration to the compressor is a natural occurrence within refrigeration and air conditioning systems (see Figure 6-1). The amount and severity of this liquid refrigerant migration depends on several things, such as the size of refrigerant and oil charge and the length of shutdown interval.

This discussion shows that while Tecumseh compressors enjoy a fine reputation for reliability and long life, there are application safeguards that can be employed to increase compressor life and eliminate unnecessary service calls. These action photographs

(see Figures 6-2 to 6-4) were taken in the engineering laboratories of Tecumseh Products Company. A five ton split air conditioning system was used with a four inch sight glass installed in the compressor housing. The condensing unit and evaporator section were connected by approximately 25 feet of suction and discharge tubing. The first internal view shows the system shut down for a week-end. The temperatures of the compressor and evaporator are the same, 76°F.

Even at this condition, the fluid in the evaporator, which is mostly refrigerant, has a higher vapor pressure than the fluid in the crankcase, which is mostly oil. This difference in vapor pressure acts as a driving force for the refrigerant to migrate to the crankcase—to become absorbed in the oil until the pressures are equalized and saturation has been reached.

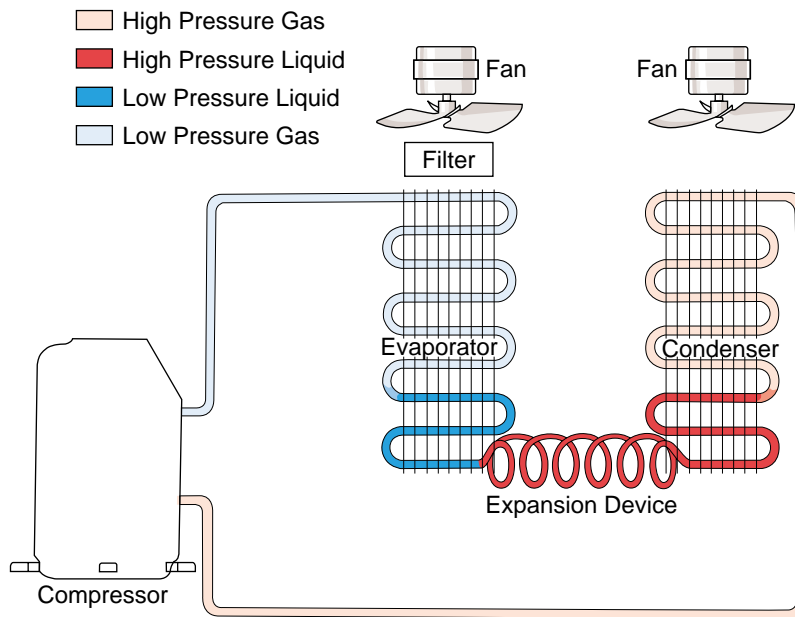


Figure 6-1. Liquid refrigerant migration to compressor.

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Figure 6-2. Refrigerant and oil mixture fill sight glass after week-end shutdown.

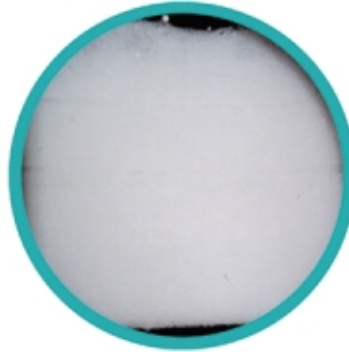


Figure 6-3. Five seconds after start-up, violent foaming action fills sight glass as refrigerant boils away taking oil charge with it.



Figure 6-4. More than 60 seconds after start-up, oil level is well below normal operating levels—a condition that is an important factor in compressor bearing wear.

Note: This page is designed to be in color

B. Crankcase Heater Prevents Liquid Migration

This sequence (see Figures 6-6 and 6-7) shows the effects of an electric strap-on crankcase heater applied to the compressor (also see Figure 6-5). The system was again shutdown for a week-end under identical conditions, with the exception that the heater was energized throughout the shutdown period. By raising the temperature of the oil we have reduced its ability to attract and hold refrigerant.

Note that liquid refrigerant accumulation in the compressor can also be caused by liquid floodback under certain conditions while operating. This condition can be controlled by the application of a suction line accumulator. Crankcase heat does nothing to prevent liquid floodback and an accumulator does nothing to prevent refrigerant migration. Each without the other is half a job—both together provided balanced compressor protection.

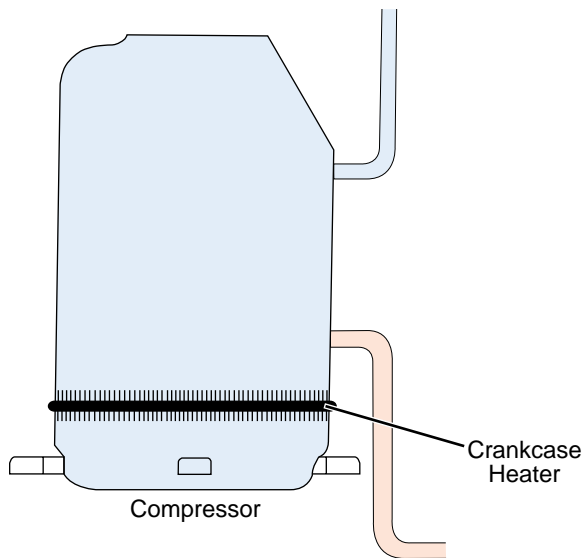


Figure 6-5. When applied to a compressor with a low pressure housing, an electric strap-on crankcase heater prevents liquid migration.

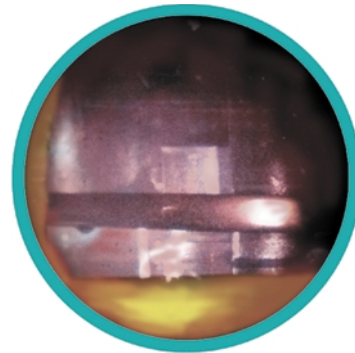


Figure 6-6. View through sight glass shows that the crankcase heater effectively prevents migration of liquid refrigerant to the compressor.

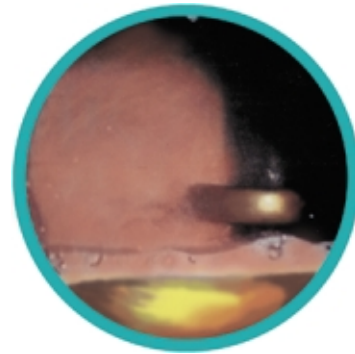


Figure 6-7. Normal run with heat. Oil level is maintained thereby assuring effective lubrication for compressor bearings.

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II. Crankcase Heaters

When most air conditioning and commercial systems are started up for the first time each season, a large part of the system refrigerant charge is in the compressor. On startup, the refrigerant boils off taking the oil charge with it, and the compressor is forced to run for as long as 3 or 4 minutes until the oil charge circulates through the system and returns to the crankcase.

Obviously this is not good for the compressor and definitely shortens its service life.

The initial solution is to charge the system so that little or no refrigerant collects in the crankcase and to operate the crankcase heater at least 12 hours before startup or after a prolonged shutdown.

Three types of crankcase heaters are in common use on Tecumseh compressors: wrap-around resistance heater (belly band), immersion type integral heater, and the run capacitance off-cycle heat.

The wrap-around heater should be strapped to the housing below the oil level and in close contact with the housing. A good heater will maintain the oil at least 10°F above the temperature of any other system component and (when the compressor is stopped) desirably at or above a minimum temperature of 80°F.

The immersion type heater is factory assembled and is presently used with AB, AW, AG, AV, and AN compressors. It is self-regulating and energy efficient.

In the run capacitance off-cycle heat method used by some OEM, single phase compressors are stopped by opening only one leg (L_1) and thus the other power supply leg (L_2) to the run capacitor remains “hot.” A trickle current through the start windings results, thereby warming the motor windings and thus the oil on the “off-cycle.”

WARNING! *Before servicing systems with off-cycle run capacitor type heaters, be sure to disconnect ALL power supplies. Make sure that all power legs are open. Failure to do so can result in serious injury or death from electric shock.*

Capacitance crankcase heat systems can be recognized by one or more of the following:

- Contactor or thermostat breaks only one leg to the compressor (and condenser fan).
- Equipment should carry a notice indicating power is on compressor when it is not running and that main breaker should be opened before servicing.
- Run capacitor is sometimes split (3 terminals) so that only part of the capacitance is used for off-cycle heating. NOTE: Use exact replacement when changing such dual purpose run capacitors. Capacitor must be fused and carry a bleeder resistor across the terminals. See Figure 6-8 for the basic wiring diagram for a PSC compressor with run capacitance off-cycle heat.

III. Starting a System with Liquid Refrigerant in the Compressor

When most air conditioning and commercial systems are started up for the first time each season, a large part of the system refrigerant charge is in the compressor. If there is no crankcase heater or the heat is not operating properly and the unit must be started at the time of the service, then follow these guidelines:

- DO NOT attempt to heat the crankcase by applying a flame to the compressor. Not only is this process slow and likely to be ineffective, it may damage electrical wires, paint, and the oil.

- If there is no evidence of a compressor electrical problem (for example, tripped breaker or blown fuse, or reports of such), then “jog” the compressor. To “jog” the compressor apply power for one to two seconds, then wait 1 to 2 minutes. After 3 or 4 jogs, apply power continuously.

WARNING! *Jogging a compressor that has an electrical problem can increase the likelihood of terminal venting. To reduce the risk of serious burns or death from terminal venting with ignition, you must FIRST check for a ground fault whenever you suspect an electrical problem. See “Identifying Compressor Electrical Problems” on page 47 for additional information.*

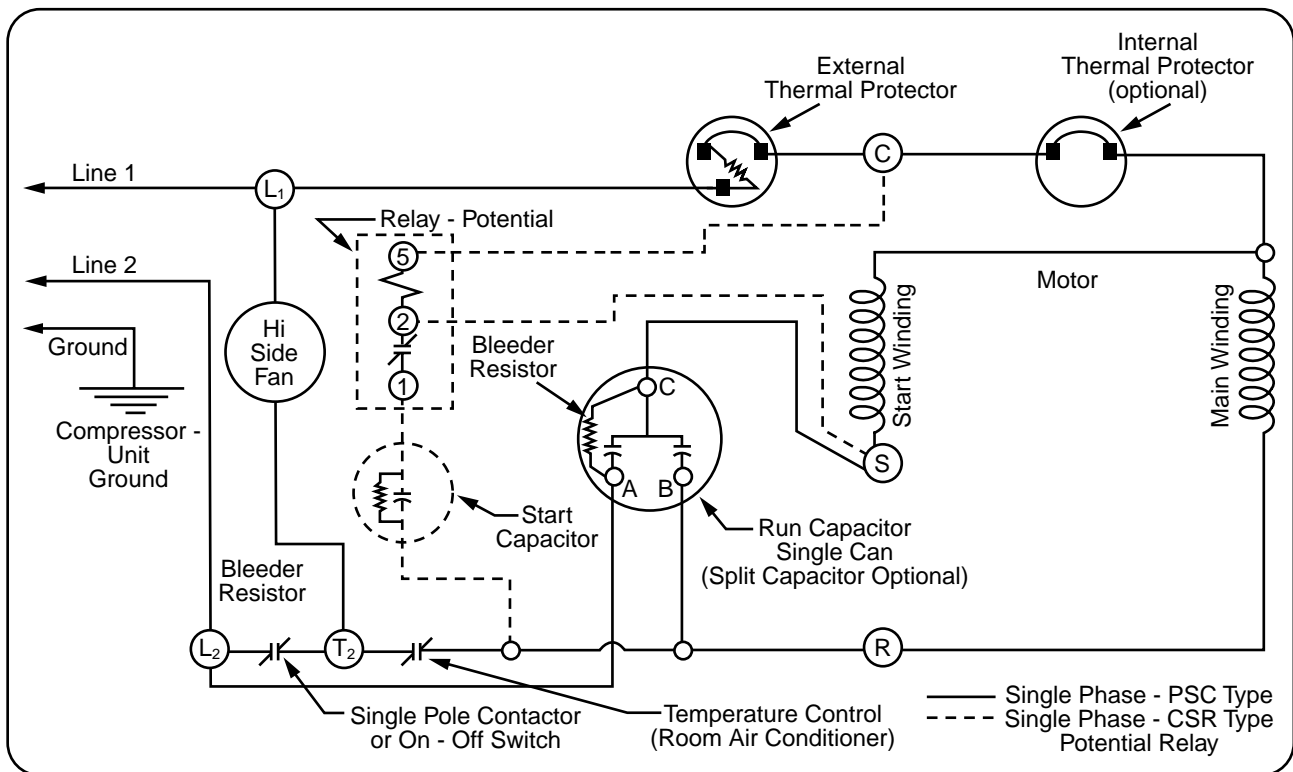


Figure 6-8. Wiring diagram for PSC compressor with run capacitance off-cycle heat.



IV. Control of Liquid Refrigerant Floodback to the Compressor During Operation

Liquid floodback during operation (see Figure 6-9) can be caused by fan failure or dirty clogged filters that can reduce the heat transfer rate to such a point that the liquid refrigerant floods through, instead of vaporizing. When this situation occurs, liquid refrigerant may enter the compressor under conditions which result in separation of the oil and refrigerant.

This separation may result in an accumulation of the refrigerant under the oil (see Figure 6-10). Thus, when the compressor is started, the first liquid to be pumped to the bearings will probably be refrigerant, *not* oil. Even if this oil-refrigerant separation does not occur, the large amount of liquid refrigerant in the crankcase will instantly vaporize and boil away the oil charge when the compressor starts (see Figure 6-11). Thereby leaving the compressor oil-starved for many seconds (see Figure 6-12).

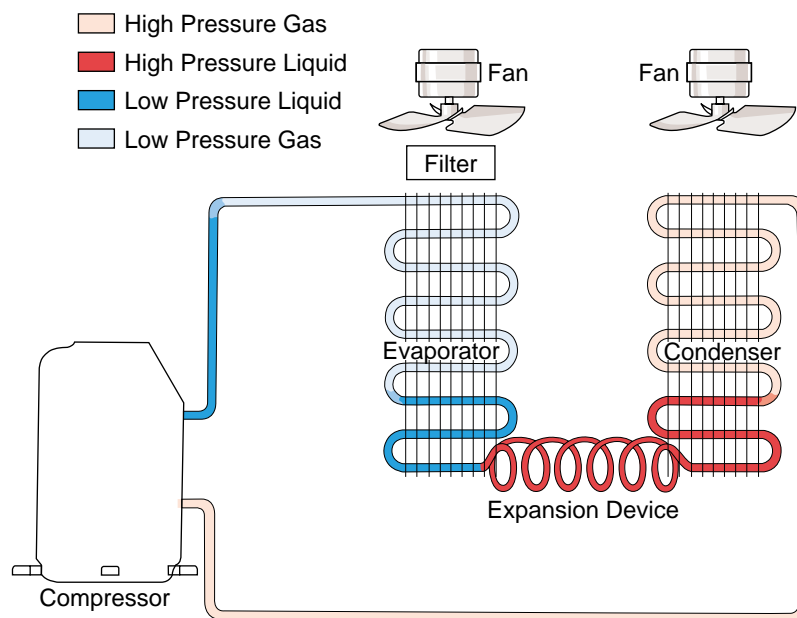


Figure 6-9. Liquid refrigerant floodback to the compressor.

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Figure 6-10. Liquid refrigerant enters compressor and settles to the bottom, below the oil.

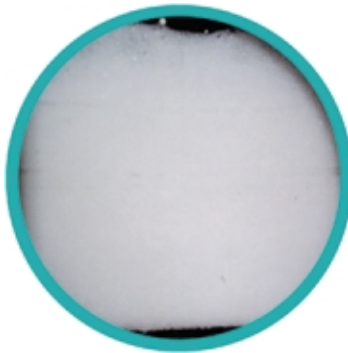


Figure 6-11. Five seconds after start-up, violent foaming action fills sight glass as refrigerant boils away taking the oil charge with it.



Figure 6-12. More than 60 seconds after start-up, oil level is well below normal operating levels—a condition that is an important factor in compressor bearing wear.

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Liquid floodback can be prevented by the application of a properly designed and sized suction line accumulator (see Figures 6-13 and 6-14 below and “Accumulator Selection Data” on page 118). Tecumseh engineers have designed a suction line accumulator available in eight basic sizes covering a full range of system applications and refrigerants. When properly selected based upon system charge, a suction line accumulator will improve compressor reliability and endurance by preventing

damaging liquid refrigerant floodback. Note that liquid refrigerant accumulation in the compressor can also be caused by liquid migration to the compressor during periods of shutdown. This condition can be controlled by the application of a crankcase heater. A suction line accumulator does nothing to prevent liquid migration and a crankcase heater does nothing to prevent liquid floodback. Each without the other is half a job—both together provided balanced compressor protection.

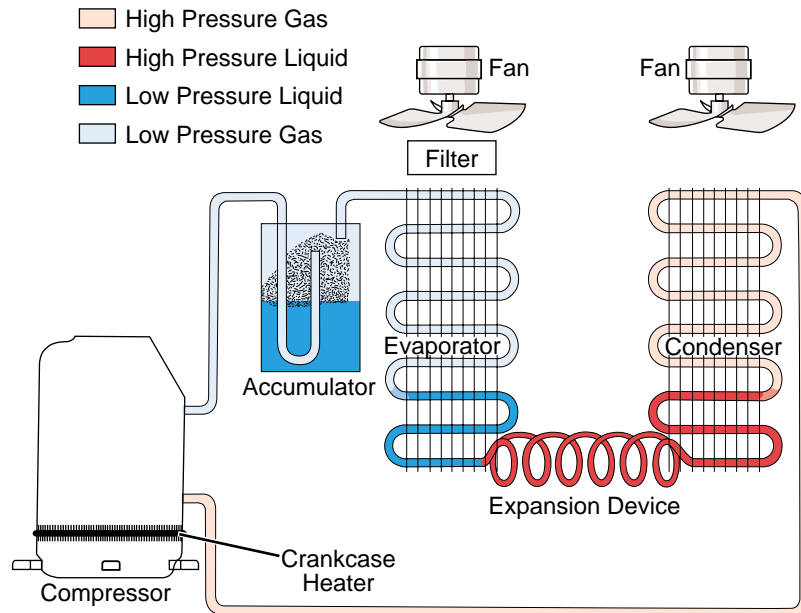


Figure 6-13. Application of a properly designed and sized suction line accumulator.



Figure 6-14. A suction line accumulator prevents damaging liquid refrigerant floodback.

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V. Accumulator Selection

Selecting the proper size is of primary importance. Only one factor need be considered in order to assure the correct accumulator for a particular system: the total refrigerant charge in that system.

It is not necessary to know the holding capacity of the accumulator or system variants such as evapora-

tor temperature and capacity in tons of refrigeration. These factors were considered in the design and testing of the accumulator.

If on older systems, the system refrigerant charge is not known, consider the “rule-of-thumb” provided in Table 6-1 when selecting the correct size of suction accumulator:

Table 6-1: Selecting Correct Suction Accumulator

Application	Assumed System Charge
Air Conditioning & Heat Pump and High Evaporator Temperature	3# per “Horsepower”
Medium Evaporator Temperature	5# per “Horsepower”
Low Evaporator Temperature	7# per “Horsepower”



VI. Internal Pressure Relief Valves

Certain air conditioning compressors in the AJ, AB, AW, AH, AV, AG, and SF families are equipped with a unique internal pressure relief (IPR) valve.

The IPR valve is used in air conditioning and heat pump systems. It prevents abnormally high head pressures from developing if a condenser fan motor fails or air passages in the condenser coil become blocked by dirt, leaves, paper, etc. The IPR valve relieves pressure from the high pressure side to the low pressure side of the system. It does not relieve pressure from the system to the atmosphere.

The IPR valve may also open to relieve hydraulic pressures in the event of slugging. This is apt to occur on startup if refrigerant has been allowed to migrate to the compressor crankcase.

It is a characteristic of the IPR valve that once it has “popped,” it will not reset until the compressor has been stopped and the pressure allowed to equalize.

If a high to low side leak within the compressor is suspected, stop the system, equalize the pressures, permit the IPR valve to close, and restart the compressor to double check before deciding to change the compressor.

Table 6-2: Compressors Having IPR Valves

AG Models	AHA7521Z	SFA5560E
AHA4520E	AHA7524J	SFA5572E
AHA4522E	AJC5519E	SFA5581E
AHA4524E	AJD7520E	SFAA530Z
AHA4531E	AV Models	SFAA536Z
AHA4540E	AW Models	SFAA540Z
AHA7513Z	SFA5554E	
AHA7515J	SFA5558E	
