

Accumulators have long been recognized by the industry as an effective means of maintaining good system balance by storing excess refrigerant as the condenser or evaporator load varies. It is necessary to recognize the requirements placed on the accumulator as applied to different applications. This Engineering Recommendation will outline the various application requirements and provide the recommended procedures for selection of the proper accumulator to keep liquid refrigerant from the compressor.

1.0 Basic Accumulator Functions:

1.1 Store Excess Refrigerant - During Typical Operations - such as:

1.1.1 Low Load - Dirty Filter - Improper Air Flow and Light Evaporator Loading.

1.1.2 Maintain System Balance - Reverse Cycle Heat Pump.

1.1.3 Minimal System Overcharge - Field installations or service adjustments.

1.2 Store Excess Refrigerant - During Off Cycle -

1.2.1 Migration due to natural temperature changes or crankcase heat.

1.2.2 Cleaning Cycles - Bulk Milk Coolers.

1.3 Control Floodback to Compressor - During Start-Up & Running -

1.3.1 Supplement Motor Cooling - Heating Mode Low Ambient, High Compression Ratio Operation.

1.3.2 Help control oil pump-outs.

1.3.3 Help maintain oil quality.

1.3.4 Help maintain system efficiency.

1.3.5 Help return refrigerant to system as needed.

1.3.6 Help control surge such as during heat pump defrost, ice maker harvest, and normal thermostat cycles.

2.0 Accumulator Location:

In general, the accumulator should be located on the same level and adjacent to the compressor in order to minimize the suction line length between the accumulator and compressor. In this location, crankcase heaters are very effective in their ability

to move liquid refrigerant from the compressor to the accumulator during prolonged off cycle.

Accumulators located in the low side must be on the same level or below the compressor in order to allow proper crankcase heater operation.

Reverse cycle heat pumps must locate the accumulator between the reversing valve and the compressor in order to always be in the suction line regardless of operation mode. Short coupled systems may locate the accumulator in the low side area to reduce radiation losses. Another means of reducing radiation losses is to insulate the accumulator.

3.0 Accumulator Requirements:

Accumulators must be designed to -

- 3.1 Return to the compressor a CONTROLLED amount of liquid refrigerant to maintain proper compressor oil quality as well as allow maximum flow of refrigerant back to the system. See Chart 1, page 8.
- 3.2 Retain maximum amounts of liquid refrigerant during defrost and thermostat cycles.
- 3.3 Continually blend liquid refrigerant and oil to assure maximum oil return to the compressor.
- 3.4 Return oil to the compressor when the accumulator has superheated gas passing through it.
- 3.5 Minimize pressure drop.
- 3.6 Hold up to 70% of the DESIGN system charge in factory charged equipment and provide for overcharge in field charged systems.

4.0 Accumulator Selection:

4.1 Selection of an Accumulator is based on -

- 4.1.1 Design system charge shall not exceed accumulator rating as published by the accumulator manufacturer. Accumulator selection must be tested in the application under expected system operation, both normal and abnormal, for final approval. Refer to page 8, Chart I for minimum performance levels.
- 4.1.2 Tube size to match compressor fitting. Exception - Today's designs toward higher efficiency have higher refrigerant charges and sometimes the result is that the accumulator as limited by tube size match is too small.

A review of accumulator designs indicates that the tube size rule may be relaxed by one tube size. For example, a compressor with a 7/8 suction could be matched with an accumulator having 1 1/8 tubes. The reverse, however, is not permissible.

This allowance to relax the rule can be clarified by describing flow rate limits for each size accumulator.

1. The proper size (rating) of the accumulator remains dependent upon:

THE TOTAL SYSTEM REFRIGERANT CHARGE

2. Flow Rate Limits -

There are limits, however, as to minimum and maximum flow rate - BY VOLUME - through the accumulator.

Minimum -Ft.³/Hr. must be of adequate quantity, hence velocity, to assure ability to carry oil and thus avoid trapping oil from compressor.

Maximum -Ft.³/Hr. must be properly below the quantity, hence velocity, so as to avoid excessive sound level.
 (3000 Ft./Min. Max.)

TABLE OF LIMITS						
Minimum & Maximum Flow Rates (Ft.³/Hr.)						
Inlet & Outlet Connector Size	1/2"	5/8"	3/4"	7/8"	1 1/8"	1 3/8"
Minimum Flow Rate	50	50	125	125	395	565
Maximum Flow Rate	190	300	450	605	1030	1570

3. Calculating Flow Rate - BY VOLUME - @ Saturated Vapor Conditions

Example using an R22 compressor data

1st @ 0°F E_T and 100°F C_T

From curve read 260#/Hr. flow rate by weight
To convert to Ft.³/Hr.:
260#/Hr. X 1.3723 Ft.³/# (vapor @ 0°F) = 357 Ft.³/Hr.

2nd @ 30°F E_T and 130°F C_T

From curve read 521#/Hr. flow rate by weight
To convert to Ft.³/Hr.:
521#/Hr. X 0.78208 Ft.³/# (vapor @ 30°F) = 408 Ft.³/Hr.

3rd 55°F E_T and 130°F C_T

From curve read 925#/Hr. flow rate by weight
To convert to Ft.³/Hr.:
983#/Hr. X 0.51238 Ft.³/# (vapor @ 55°F) = 504 Ft.³/Hr.

4. Matching Compressor & Accumulator -

The operational conditions window is determined by the application.

If **heat pump** (air to air) the minimum flow rate by volume is probably at 0° E_T.

Therefore the 1st example above when compared to the table in b.) is limited to match up with the 7/8" tube tank.

If **straight cool**, the minimum flow rate by volume is say at 30°F E_T.

Therefore, the 2nd example above when compared to the table in b.), the 7/8 tube is adequate.

In our 3rd example @ 55°F E_T, the 7/8 tube is also adequate for the flow rate. However, if additional volume is required for the refrigerant charge, go to the 1 1/8" tube.

5. Conclusion -

It is obviously possible to combine a certain compressor with a certain accumulator in a certain application and have undesirable results. i.e.: compressor too small and therefore oil may trap in accumulator, or compressor too large and therefore creates excessive or unsatisfactory sound level and/or pressure drop. This can be predetermined by applying the simple calculation and comparison steps as outlined above.

4.1.3 If field refrigerant overcharging is probable, then the accumulators must be sized to accommodate 100% of the overcharge.

4.1.4 Proper Orifice Size:

The minimum orifice size will allow compressor cooling under low load conditions so as not to exceed discharge values outlined in EP-4, Table 1 (attached to Policy Bulletin No. 112.) The maximum orifice size will not allow the ΔT (oil pan temperature minus saturated evaporator temperature) to fall below the shaded line in Chart I. The dotted line on Chart I is an example of a compressor in a heat pump, operating in the heating mode. The application must be so tested.

4.1.5 Surge Retention - During Heat Pump Defrost:

Testing has indicated that up to 65% of the design system charge could be in the accumulator prior to defrost and again at defrost termination. A minimum of 75% of the liquid in the accumulator must be retained during valve reversal surge to prevent possible compressor oil pump out and/or slugging.

To test for surge retention - install a sight glass in the suction line between the accumulator and compressor. During the valve reversal of a normal defrost, observe -

1. Solid liquid refrigerant passing through the sight glass to last no longer than 2 to 3 seconds.
2. A change in the compressor running sound from normal pumping sound to a quieter muffled sound (due to oil foam filling the housing) and then finally a higher than normal tinny sound (due to most of the oil having been pumped out).
3. Audible slugging.
4. NOTE: If one or more of the above symptoms are observed, the surge retention ability of the accumulator chosen for valuation is inadequate.

4.1.6 Oil Return

It is necessary to have a sight glass fitted to the lower portion of the accumulator in order to observe -

1. If the liquid refrigerant and oil are properly blended into a homogeneous mixture for return to the compressor. If the liquid remains placid, stratification of the oil and refrigerant will occur with the refrigerant rich mixture being on the bottom near the orifice. This situation is unacceptable.
2. If the oil tends to trap above the orifice level during operation having superheated gas (no liquid) returning, the indication would be that the accumulator being evaluated has insufficient pressure drop to return the oil properly.

4.2 Special Application Accumulators -

Cube ice makers with hot gas defrost will dump large quantities of the refrigerant charge into the compressor at the beginning of the harvest cycle. This surge can cause slugging, oil pump out, oil dilution, and rapid uneven bearing cooling which can lead to bearing wear, broken valves and excessive oil in the system. Accumulators for this application should be reviewed by Tecumseh Engineering.

5.0 Accumulator - as a Suction Line Trap may need to be replaced:

The location of the suction line accumulator automatically places it into position to "catch" any debris such as copper oxide, flux, metal slivers and/or contaminants, foreign materials, etc. which are returning from the low side of the system or from the high side upon switching of the heat pump reversing valve.

If and when this sort of entrapment does occur, the probabilities are that the screen which protects the orifice area will become clogged. This is especially apt to happen if there is sludge due to burnout and/or bearing wear being moved thru the system without the adequate protection of a suction line strainer or filter designed to handle such conditions.

The point being made is that, in view of the foregoing, it is highly recommended that:

With each change out of a compressor a very close examination of the other evidences should be made to determine the possible need for the replacement of the accumulator as well.

These other evidences are -

- 5.1 Substantial loss of oil in the compressor being removed. (If questionable, pour out and measure.)

- 5.2 Oily soot coating in the discharge and/or suction connections (tubes) of the compressor being removed.
- 5.3 Contaminated oil due to motor burnout and/or bearing wear in the compressor being removed.
- 5.4 Visible contaminants inside of the reversing valve. This condition obviously calls for valve replacement also.

This subject should be treated in any and all field service type publications and instructions.

SUMMARY: The selection and application of an accumulator shall be a part of the OEM system development and design program, i.e.: it is expected that the foregoing shall be used to aid in such work, however the final decision is the responsibility of the OEM. Also, in the event there are other known potentially unusual situations which have not been covered in the above recommendations, those too should be simulated and tested.

CHART 1

