

Automatic Oil Return Systems: Why, When, and How?

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Safe oil draining is a subject that is well documented in IIR publications, and workshops dealing with proper oil draining are always well-attended. Removing oil from an ammonia refrigeration system is routine maintenance that nearly every ammonia refrigeration system operator will encounter sooner or later.

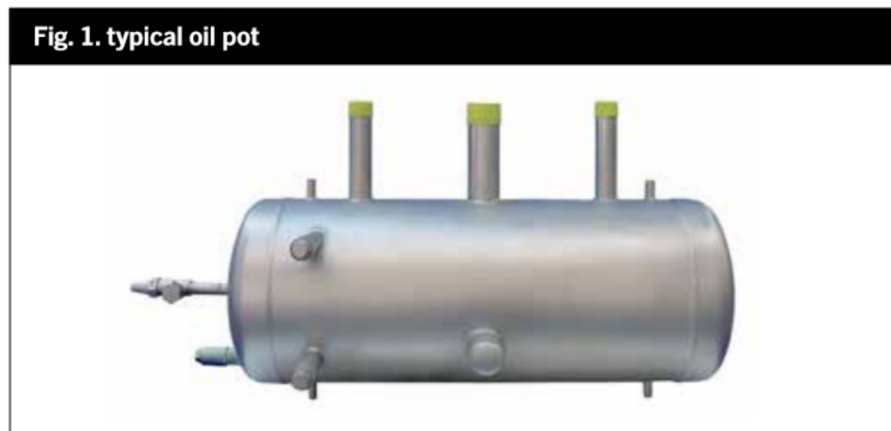
One major advantage of ammonia systems is that oils are not normally soluble with ammonia and will there-

part of the separator and route the ammonia/oil mixture to an oil drain vessel (oil pot) through a large connection on top of the oil drain vessel (refer to Fig. 1).

During normal operation, the refrigerant oil mixture enters through a sufficiently large valve (1), refer to Fig. 2. Generally, to remove the oil from the oil drain vessel, the supply line valve (1) and the equalizing line valve (3) are closed. Ambient heat will evaporate liquid ammonia and raise the pressure inside the oil collector vessel so oil can be drained

draining is a potentially hazardous activity.

One method of automatic oil return, for systems up to 2800 TR (10 MW) is described as follows (larger systems



fore collect at the lowest spot in the system. However, accumulation of oil is gradual, and the location for accumulation must be suitable, i.e., calm enough, such that oil gets a chance to settle. In some instances, the operator may only use visual indication such as of heavy ice build-up on the oil drain vessel to indicate oil draining is required.

These conditions are often underestimated. In some locations, oil cannot be drained because there is too much turbulence/boiling of the refrigerant-oil mixture, even though the conditions would seem to be ideal.

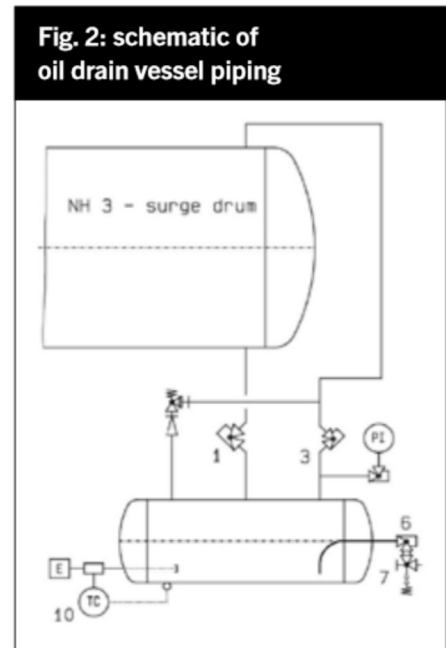
It is particularly hard to drain oil at heat exchangers (HX) because there is nearly always too much turbulence during operation. Sometimes it can take several days of idling and warming up until oil settles from the HX surfaces and collects at the lowest spot. It is therefore recommended that oil is removed before it can even enter the evaporator and start decreasing the heat transfer capability and overall system performance.

Traditional common practice has been to collect the oil in a sump or the lowest

through a stop valve (6) and a self-closing valve (7) into a suitable container. To speed up the process an electric heater element (10) can be used to evaporate the liquid refrigerant and increase viscosity. This is particularly helpful at low evaporating temperatures. The smell of ammonia usually cannot be completely avoided during the process of draining of oil. Drained oil is normally either discarded according to local environmental regulations or is recycled, but it is not normally re-used.

It is a good practice to dispose of the initial oil that is drained from a new system because it can contain dirt from piping and components that will be flushed out with the oil. Subsequently, the oil is mostly in good condition and could be re-used at least 2 to 3 times, depending on the outcome of the regular oil analysis that should be periodically conducted to check for contamination.

Using an automatic oil return system will not only save refrigerant oil (which has become quite costly) but also eliminates the need for manual oil draining. Overall safety is improved because oil



can be equipped with two or more oil return pots in parallel). A vessel with an integrated mechanical valve that is activated with hot gas will collect the oil, refer to fig. 3. Like a manual oil collection vessel, the refrigerant/oil mixture enters through the top connection. Over time, liquid refrigerant boils off and escapes through the equalizing line into the separator and the vessel gradually fills with oil. The hot gas solenoid valve is opened when the oil sensor at the upper level of the oil collector vessel is reached. The hot gas entering pushes the mechanical valve upwards and the content of the vessel is pushed out through the discharge connection back to the compressor, refer to fig. 4. It is important the discharge tube inside the oil collector vessel does not extend all the way to the bottom. This ensures there is enough space for debris that collect within the lower part of the vessel which should not be conveyed back to the compressor.

The mechanical valve inside the oil collection vessel is designed with damping that avoids being moved up too

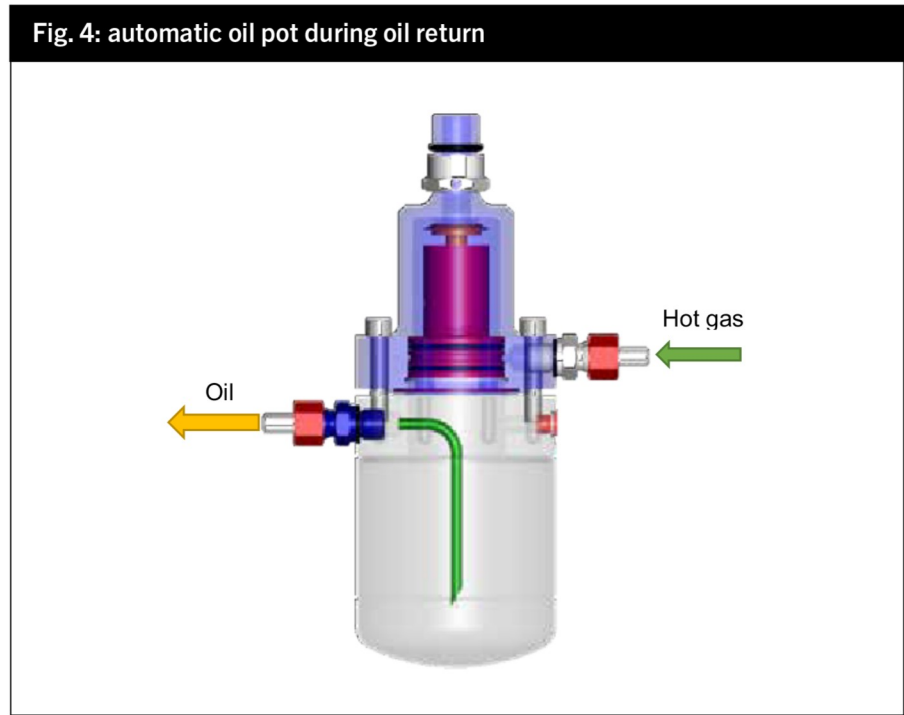
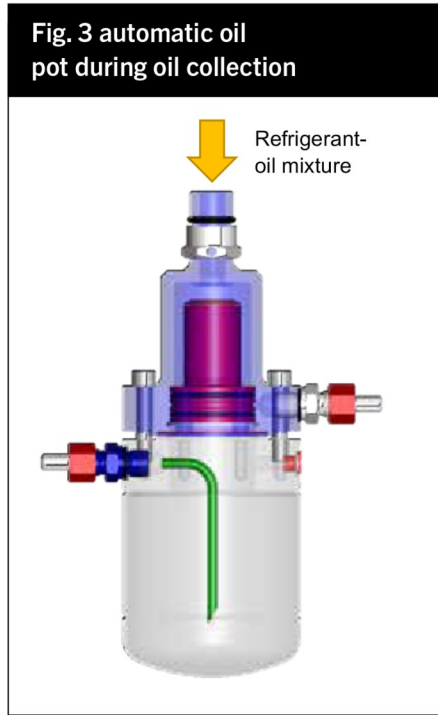
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quickly and protects against damage to internal components and seals. Once the oil has returned, the hot gas supply is stopped and an integrated hole in the mechanical valve will equalize the pressures between the separator and

tivity of hot gas at about 58-116 psig (4 – 8 barg) is taken to the BDP.

Although it is mostly oil that is pushed back to the compressor, there may still be some liquid refrigerant residue left in the returned oil. It is therefore recom-

a screw compressor (schematic B and C). An oil filter (OF) in the outlet of the heat exchanger will ensure only clean oil is returned. Optional sight glasses (SG) are available and allow the returned oil to be visually checked.

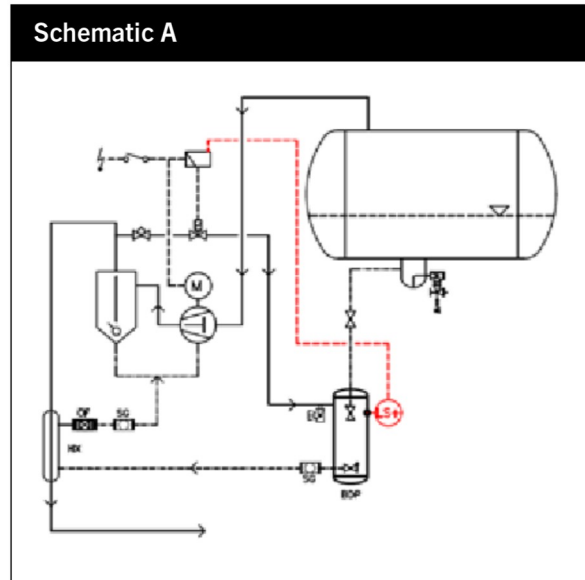


the oil collector vessel. This permits the mechanical valve to fall open by gravity and the cycle to commence again.

The selection of the correctly sized oil collector pot depends on the size of the system and the oil carry-over from the compressor. Unless otherwise declared, 15ppm oil carry-over can be assumed for new compressors and existing systems may go up to 30 ppm. While automatic systems could handle even more carry-over design improvements should be considered for a system that exhibits carry-over exceeding 30 ppm.

Activation of the hot gas supply can be accomplished with different methods, as shown in the following schematics A, B, and C. In all schematics, the oil collecting pot with an internal plug is shown as BDP.

Schematic A represents the most common method to activate the oil return cycle. This method uses an oil sensor (LS) installed at the upper level of the oil collector pot that activates the solenoid valve as mentioned above. The regulating valve behind the small line coming off the compressor discharge pipe will ensure that only a small quan-



mended that the drained oil be passed through a heat-exchanger, shown in the schematics as a tube-in-tube heat-exchanger with hot gas in the inner pipe (HX). Any remaining liquid refrigerant is evaporated before oil is returned to the crank case of a reciprocating compressor (schematic A) or into the suction line of

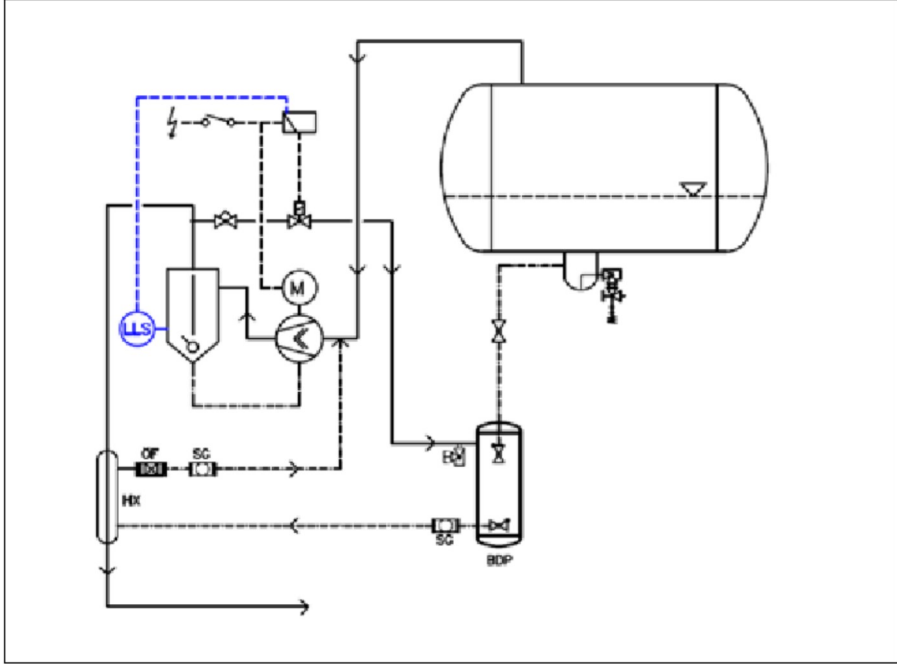
Another option to actuate the solenoid hot gas valve that supplies the BDP is by a sensor installed at the low point of the oil separator (LLS) as shown in schematic B.

It is also possible to simply activate the oil return once or twice a day without a need for an oil sensor by means of a simple time control (as in schematic C). Note that using time control or level control on the compressor's oil separator will always require a heat-exchanger (HX) to be included downstream of the return line because

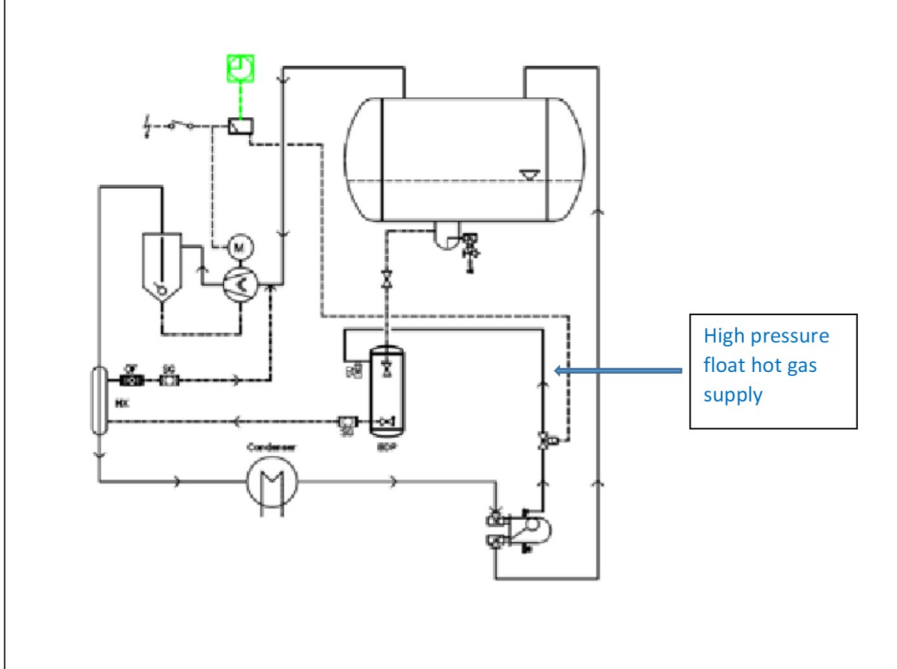
the amount of liquid refrigerant in the oil is undetermined.

The hot gas needed to activate the automatic oil return system can also be taken from the top service valve of a high side float regulator (as shown in schematic C) when it is more convenient for installation.

Schematic B – Liquid Level Sensor



Schematic C – Automatic Timer



An advantage of taking hot gas from the high side float regulator is the lower temperature, as the gas is no longer superheated. This extends the lifetime of sealing materials. However, superheated hot gas from the compressor works as well.

Although such a design should provide maintenance-free operation, experience has shown that it is good to allow access to the oil collector vessel when needed (e.g., for cleaning when there is

a high degree of oil contamination).

At evaporating temperatures below -22°F (-30°C) oil may not be viscous enough (like honey) and it has proven good practice to wrap self-regulating heat trace around the oil collecting pot to achieve higher oil viscosity.

In Europe, the use of automatic oil return systems typically pays back (or makes its ROI) after about two years of operation, just from the oil that is saved.



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