Solving Lineset Retrofit Problems with Proper Flushing

By John Parris Frantz and Joel Olson, PH. D.

Sometimes lineset changeover is impossible during a retrofit, opening up opportunities for system contamination and breakdown. Understanding the proper way to flush the system, and the right products to use for the task, can be the difference between success and failure.

Retrofitting R-22 systems to accept R-410A is a fairly foolproof process – unless the linesets cannot be removed. A full retrofit should always include a complete component changeout, including the linesets, to assure residuals do not contaminate the new system. However, situations exist where it is uneconomical to remove linesets, such as when they are recessed inside finished walls, or under concrete foundations and/or slabs.

If a retrofitted system fails when linesets are left in place, the culprit is likely residual moisture, acid and/or mineral oil that has remained in the lineset, usually as a result of improper flushing techniques or flushing agents that are incapable of removing any one of the three residual components.

Whether it is due to the inefficacy of the flushing agent or improper flushing techniques, the lineset residuals will mix with the additive packages that polyolester (POE) oil manufacturers are putting into their products. This combination can propagate into a system-failing sludge.

Step by Step

1. Wear safety gear. All flushing agents have some degree of toxicity. Service technicians must wear gloves, safety glasses, and any other safety gear to minimize exposure.

2. Purge with nitrogen first.
Purging loose debris first with nitrogen allows the flushing agent to attack contaminants that adhere to the inner walls of the linesets. A good nitrogen regulator should enable the technician to achieve the recommended 120 psi. Oscillating the purge may also enable more contaminant to be dislodged.

3. Have enough flushing agent available.
Starting and stopping the flushing process because of a shortage of flushing agent will probably require more flushing agent in the long run than the amount originally required by the job. A good rule of thumb is one 2-pound canister of flush for a 7- to 10-ton refrigeration system. Extremely contaminated lines may need more than 2 pounds of flush. Since most flushing agent brands are sold in either 1- or 2-pound canisters (with the latter a better price value), it's more economical to flush a 5-ton system with one half of a 2-pound canister.

4. Remove obstacles.
Remove any expansion valves, filter driers and other obstacles.

5. Cut up linesets of 50 feet or longer.
A flushing agent works best and has more flushing pressure in shorter runs, or segment lengths. Therefore, lengths of 50, 75, or 100 feet or longer should be cut, flushed in sections, then soldered back together.

6. Restrict the opening.

Crimping the opposite end of the lineset will induce more pressure within the lineset and help dislodge additional contaminants.

7. Collect the debris.
Use a bucket at the receiving end to catch used flush. All flushing agents have some degree of toxicity, requiring the products to be disposed of according to the Material Safety Data Sheet (MSDS). Biodegradable flushes require the same disposal methods as used refrigeration oil. However, non-biodegradable or more toxic flushing agent brands may require disposal under the same guidance and expense as hazardous waste, which likely requires a hazmat company.

8. Flush in to out, high to low.
Always flush from inside of the mechanical room to outdoors to prevent contamination of occupied spaces. However, in cases where the mechanical room is lower than the exterior lineset terminating area, flush from the outside to inside, covering the lineset and bucket area with a towel to minimize splattering. Cover the floor of the mechanical room with a tarp.

9. Remember the access valve.
Many technicians, especially first-time users, might forget that an access valve/charging hose or injection kit (depending upon the brand) is needed to introduce the flush into the lineset. A good wholesale customer service representative should suggest that these necessary items accompany the purchase of any pressurized sealed flushing agent. Nonpressurized flushing agents should be avoided; their contents can introduce moisture to the linesets. All flushes are blends of many materials. Oxygen can be introduced into an unpressurized container and break down the effectiveness of these flushes.

10. Solder a flare fitting onto the lineset.
Several methods can be used to connect the flushing agent canister access valve/charging hose to the lineset. Some technicians use a conical rubber piece with a connection fitting. However, the best method to get maximum pressure is soldering a ¼-inch flare fitting onto the end of the lineset.

11. Flush until clear.
Don't stop flushing until the terminating liquid in the bucket becomes clear and particulate-free. Near the end of the flushing procedure, replace your bucket containing the dirty flushing agent with a clean bucket so you can determine when the flushing agent is clear.

12. Conclude with a nitrogen purge.
Soon after flushing, finish the cleaning by purging the lineset again with nitrogen before the flushing agent evaporates. Most flushing agents can evaporate in anywhere from 10 to 15 minutes.

Taking the Test

Flushing-solvent efficacy continues to be a critical issue in the HVACR industry's trend of converting hydrochloroflourocarbon (HCFC)/mineral-oil systems to hydroflourocarbon (HFC)/POE-oil systems. In light of this, Olson tested four different flushing agents to determine their effectiveness in removing residuals from a system:

- R-11 (trichlorfluoromethane), which before the ban on chlorofluorocarbon refrigerants was the flushing agent of choice by most service technicians and very highly regarded for its apparent efficacy;
- A popular flushing agent used in automotive industry A/C servicing
- A flushing agent whose primary ingredient is trans-1,2-dichloroethylene; and
- A biodegradable flushing agent recently introduced to the HVAC/R trade. (Qwik System Flush®)

All four flushing agents were tested for their efficacy in removing moisture, acid, and oil, as well as their ability to flush residual oil in the line. Each flushing agent was tested with the exact same procedure, minimizing any variables that could skew results. The moisture and acid-removal tests were conducted using titration methodologies. Titration is a very accurate quantitative testing technique in analytical chemistry that can determine how much water or acid a substance contains. The biodegradable flush absorbed more than twice as much water compared to the trans-1, 2-dichloroethylene based flushing agent, and more than 24 times as much water compared to the R-11 and the automotive flushing agent. The acid absorption produced similar results with the biodegradable flush outperforming the other three by five or more times.

The oil-absorption test was conducted using the gravimetric analysis method, which consists of adding oil drops into the flushing agent until a phase change is observed. The flushing agent is then weighed to determine the amount of oil it absorbed. Both the biodegradable agent and R-11 did not become saturated with oil and performed better than the trans-1, 2-dichloroethylene based flushing agent.

The oil-flushing test was actually completed using a heat exchanger coil, which comparatively is a more difficult test subject for flushing agents because of its smaller tubing and excessive numbers of elbows versus relatively straight lineset tubing. To test each flushing agent, 30g of mineral oil was injected into the heat exchanger, and nitrogen was then used to blow out all but a coating of oil on the tubing. The flushing agent was then applied. To determine the amount of oil left in the heat exchanger after each treatment, hexane was used to fully extract the remaining oil residue from the heat exchanger. The collected hexane/residual-oil mixture was collected in a beaker and heated. After the hexane evaporated, the remaining oil was weighed and recorded as the residual left in the heat exchanger after flushing:

Author's Note: Hexane – a harsh organic solvent that is excellent in removing oil in laboratory conditions – was used to assure the heat exchanger was clean of any residual oil before and after each individual test. However, technicians should never use hexane in the field because of its toxicity.

Theoretically, some contaminant will always be left in a system regardless of the amount of flushing. Ideally, service technicians should use a product that eliminates the most contaminants with the least amount of flushing. The flushing tests found that the biodegradable agent removed the most contaminants, followed by the trans-1, 2-dichloroethylene-based, automotive, and R-11 flushes.

Observations during the test indicate that the rapid evaporation of two flushing agents, R-11 and the trans-1,2-dichloroethylene-based product, inhibit their contaminant removal abilities. All the tested products will evaporate eventually and leave little, if any, of their own residue. A product that evaporates too quickly, however, has a shortened contact time with the contaminant. Additionally, it also could absorb a contaminant, vaporize and then transport that contaminant elsewhere in the system. R-11 typically boils near 48°C (118°F) and the trans-1,2-dichloroethylene-based product boils at 42°C (108°F) – one reason neither flushing agent performed well versus the biodegradable flushing agent, which has a higher boiling point of 88°C (190°F).

In conclusion, there is a tremendous difference in the performance of common flushing agents available to service technicians. Technicians should do their homework to understand the efficacy of different agents and the types of systems they will be used in. While most flushing agents eventually eliminate contaminants, many do not remove acid or water. Clearly, use of the proper flushing agent will save money, time, and labor; while assuring that contamination, acid, and water are all removed.