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A/C System
Repair - Flushing

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Air Conditioning (Vapor Compression) Systems are used in many Military, Commercial, Helicopter, and Business Aviation applications to cool avionics and other computer systems; as well as Passenger, Crew, and Ground Support Vehicle Climate Control Systems.

As an A/C system ages, the oils that migrate through the system with the refrigerant; will breakdown and begin to loose some of their lubricity. As the compressor wears it puts fine wear particles into the system that on their own are small enough to pass through most screens, orifices, and expansion valves. When these fines combine with the degrading oil, this is where the problems begin. The orifices and screens will begin to clog; the lack of clean oil and the effects the contaminated “Goo” will have on the compressor begins the “Domino” effect towards catastrophic compressor failure. A low refrigerant charge is the number one cause that will accelerate such a lack of lubrication failure. There is only one way to know exactly how much oil to put back in a system, and that is to start with a clean and dry system. This can only be accomplished by total system replacement or by the use of an effective and proven flushing method.

To maintain their warranty, it is required by most component suppliers and compressor manufacturers, that you properly flush the system when you make repairs and/or replace components. Effective heat exchanger cleaning eliminates the need for extensive interior removal and other labor intensive efforts to access and replace expensive components when a system repair has become necessary.

The technician must evaluate and understand the specifics of each individual failure like a crime scene investigator. You can pick up enough trace evidence here and there, which can paint a mental picture of what has happened; and what conditions exist internally that you wish to remedy. You must understand the severity of the failure and the debris load that may be present; as well as other dirt, contamination, and residues to be removed; to meet the goal of a clean component.

Complete or partially assembled systems cannot be flushed. You must always isolate the heat exchangers and flush through the most direct and unrestricted path to obtain the most satisfactory flushing results. You cannot flush through check valves, filters, orifices, or any device that would slow or restrict the heat exchanger flushing process.

The chemical properties of a solvent or cleaner will displace, dissolve, or in some way chemically alter the contamination on a surface. The physical properties of a solvent such as surface tension effects the fluids ability to penetrate small spaces, cracks, holes, and get between the contaminant and the surface to displace the contaminant.

The commercial solvent chosen must be 100% volatile for it to completely evaporate and be removed. Oil based flushes usually have a solvent component that will evaporate and leave the oil base behind. This is why we emphasize the importance of studying and understanding the chemical product. Remember, you must be “Smarter than the Label”.

Whatever chemical you choose to use, it is your professional responsibility to:

- Obtain a MSDS with sub component CAS numbers. It is extremely important you know what you are using.
- Understand the effectiveness of both the chemical and physical properties of the product you chose to use.
- Know how and why this chemical will remove the undesirables (or paint).
- Know how this chemical will be removed from the system when cleaning is completed.
- Know it is compatible with the metal and elastomer materials of the system, components, and the flushing equipment.
- Know the toxicity, hazardous classification, flammability, combustibility, and proper handling.
- Know the local, state, and federal regulations regarding the use and disposal of the products you choose.

It is globally accepted that industry standard methods to clean heat exchangers in aircraft, refineries, oil rigs, heavy equipment, trucks, and automobiles will require some form of appropriate cleaning chemical, velocity, and agitation. Systems for the most part are designed for smooth linear flow without cavitations or vibration, and therefore will require some turbulence in order to provide effective cleaning. Linear flow allows for swirls, eddies, and pools to occur in the corners and crevices of the heat exchangers where residues will accumulate and trap or bind debris. This is why simple circulating equipment will not get heat exchangers completely clean.

Even the best suited chemicals for the job will produce poor results; if not introduced with the adequate energy components necessary to scrub the internals and to dislodge trapped debris and carry it away. It is just like holding a dirty part under your parts washer outflow; you know the cleaning will be accelerated and improved when you add your scrub brush. Some form of mechanical energy is almost always used to enhance a solvent cleaning process. Agitation, pulse, vibration, and ultrasonic; are some examples of typical methods that are used to apply energy to enhance a cleaning process. The multiple passageways common to heat exchangers used today, will allow for a simple flowing cleaner to take paths around a restriction. Mechanical energy must be used to overcome the “path of least resistance” rule.

Velocity is another energy component that is critical to successful heat exchanger cleaning. The solvent must be introduced with adequate velocity to completely flood the component. Velocity is the necessary energy component needed to carry away weighted debris. Velocity cannot be sustained if the solvent is not introduced with an adequate volume to support it. Solvent volume is critical; there must be enough solvent supplied to support the velocity of the flushing process and there must also be enough solvent supplied to effectively do its job at dissolving the residues. This is why aerosol cans and 1qt. flush guns will not work.

Identifying the component designs, when you can; is also beneficial to understanding the challenges they may present. For years, customers using our methods have been very successful at flushing Condensers. There has never been any real issues with flushing the simple single pathway of the “Tube & Fin” designed Condensers. The “Serpentine” design has multiple tubes weaving back and forth like a “Tube & Fin” and when applying adequate solvent velocity; this design has also not been a problem to flush. The most common Condenser design used today, and the most challenging debris and solvent removal flushing problems, are associated with “Parallel Flow” Condensers (PFC). A PFC will have the same multi tube paths as a “Serpentine” design but the ends of the multi tube paths are now connected with header chambers that are fed by many of these multi tube horizontal (rarely vertical) paths. Condensers receive debris from a compressor failure directly to the inlet and it is usually slammed in with some velocity given the high side pressures.

The Evaporator of a TXV system will see lots of contaminated oil and debris is limited from entering the evaporator through the high side filter. However, in the case of a catastrophic internal compressor failure, with nothing (some suction hoses will have mufflers) between the evaporator and the compressor on the low side; rapid pressure equalization can blow large compressor debris back into the evaporator. This is not a theory; we have seen the evidence to confirm it as fact.

Flush can pool and become difficult to remove from the "well" found in the bottom of many “open chamber” evaporators as well as the header chambers of “parallel flow” evaporators and condensers. Be aware that there may be extra effort required in the critical solvent removal and verification steps. The goal is a clean and DRY component; leaving residual flush in the system will dilute the refrigerant oils and cause rapid compressor failure.

The hard carbonized oils from a severe burnout will not be removed by refrigerant or commercial flushing chemicals; if this buildup is severe (chunks of hard black material), don’t bother. However, we have seen black and grey residues in late model systems, that seem to have adhered itself to the walls of the component similar to aluminum anodizing. We had this analyzed with Molecular Spectroscopy, which identified it to be carbonized or polymerized PAG oil. The OEM who supplied these components agreed to put them back in service after flushing; and after years of field testing, they confirm that this coating has negligible effects on heat transfer or system performance.

If you suspect sealers were in the system you just opened, it is critical to flush immediately before any remaining sealer tries to harden in the systems components. It is recommended that you use only flush and equipment that is approved for the removal of sealers. Yes, uncured silicate sealer can be removed but it will require an immediate flush, when the system is opened, before the product cures.

Some Recovery and Recycle manufacturers have added flush features to their equipment; but the process of flushing through the charging ports is not feasible. Flushing through the charging ports just pushes debris from component to component and does not provide for a clear (or large enough) path that debris can exit. Even when using processes that require the isolation of the heat exchanger, it still has flaws. Refrigerant Recovery equipment will not meet the need for agitation, volume, and velocity and although they claim to be effective on removing some oils, they cannot remove all the debris. Is trying to flush out contamination something you really want to do with such an expensive, required, and heavily used piece of service equipment?

HECAT has focused its 26 year history on research, development, and applying patented chemical and physical techniques in the manufacturing of effective equipment, processes, and procedures for cleaning the complex internals of compact heat exchangers used a many forms of transportation. HECAT has been recognized by many Automotive and Aerospace OEM’s, to be a valued supplier and consultant; by supplying solutions and meeting the various cleaning requirements in manufacturing and refurbishment of used heat exchangers in many Aircraft and Ground Support Vehicle applications. 800-380-9501. www.hecatinc.com