



Refrigerant Charge Indicator

Sensor technology to maintain heat pump/AC efficiency

Undercharged HVAC systems

Having the correct amount of refrigerant in heat pumps, air conditioners and other types of space conditioning systems is very important to their operation. Research has shown that typical undercharged refrigerant levels in HVAC systems can produce efficiency losses of 30%. Under low charge conditions, the equipment continues to run but at reduced capacity, run times are longer, extra energy is consumed, and the customer remains largely unaware of the loss in efficiency and extra energy consumption. This loss in performance is particularly egregious where customers may have paid a premium for a high-efficiency heat pump or air conditioner, yet the efficiency benefit is not delivered due to improper refrigerant charge.

Undercharged HVAC systems are apparently commonplace: surveys of systems in randomly selected homes have shown that 50 to 80% of homes have AC or heat pump systems that are improperly (primarily under) charged. It seems clear that homeowners are unaware of the issue and the significance that refrigerant charge has on performance and operating costs. The design for the refrigerant charge indicator addresses this lack of awareness by having an LED visible to the homeowner that indicates low charge and potentially other systems problems. This gives the homeowner the indication needed so that he/she can take action to address the problem. With DOE support, ORNL is developing this charge indicator device.

How it works:

The charge indicator works by sensing and monitoring temperatures at key locations in the heat pump or air conditioner over all working conditions. We have determined that, depending on the type of HVAC system and in particular on the type of expansion device used, temperature measurements at 2-5 locations are needed for the indicator. We have also found that if interpreted appropriately, information from simple, low-cost temperature sensors (e.g. thermistors and thermocouples) can be used to determine refrigerant over- or undercharging as well as to indicate need for an air filter replacement. Through a number of parametric measurements on split system heat pumps and air conditioners over a range of refrigerant charge and airflow conditions in the laboratory, we have developed algorithms that take information from the temperature sensors to produce an output to drive a series of LEDs (warning lights). The warning light assembly may be incorporated into the whole house thermostat or on the indoor unit as appropriate.

Benefits:

- Non-intrusive to a sealed refrigeration system; therefore easily incorporated into new products by the HVAC manufacturer or as a retrofit item;
- Dual alert function: refrigerant charge as well as air filter condition;
- Potentially inexpensive: logic and LEDs to be incorporated on a small chip; low accuracy (inexpensive) temperature sensors will do the job;
- To the customer: reduced HVAC operating costs;
- To the utility: reduced summer peaks by having HVAC systems operating at highest delivered efficiencies.

Progress:

The concept for the charge airflow indicator as well as the algorithms for the device are being developed in ORNL's Engineering Science and Technology Division. Patents are in the application process.

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