

## Low Global Warming Fluids for Replacement of HFC-245fa and HFC-134a in ORC Applications

**Gary Zyhowski<sup>\*</sup> and Andrew Brown<sup>†</sup>**

<sup>\*</sup>Honeywell, 20 Peabody St., Buffalo, NY USA 14210

e-mail: gary.zyhowski@honeywell.com

<sup>†</sup>Honeywell, Honeywell House, 856 Wilmslow Road, Didsbury, Manchester. M20 2HY

e-mail: andrew.brown@honeywell.com

### ABSTRACT

Organic Rankine Cycle system designs that operate with non-flammable hydrofluorocarbon working fluids such as HFC-134a (1,1,1,2-Tetrafluoroethane) and HFC-245fa (1,1,1,3,3-Pentafluoropropane) have been operating in the field for a number of years. Their growing use in geothermal, engine and industrial heat recovery organic Rankine cycle applications is notable. These systems have demonstrated environmental benefits that validate their current and future use. Even so, there is great interest among system OEMs, equipment end-users, regulatory agencies, and the public to embrace new low global warming working fluid technologies. Honeywell has developed a number of candidate fluids that can serve as replacements for HFC-134a and HFC-245fa in refrigeration, air-conditioning, foam expansion, aerosols, and organic Rankine cycle applications.

The two fluids that can serve as replacements for HFC-134a are hydrofluoroolefins HFO-1234yf (2,3,3,3-Tetrafluoroprop-1-ene) and HFO-1234ze (trans-1,3,3,3-Tetrafluoropropene). These two fluids are being commercialized for a number of applications. A third fluid, that is a potential replacement for HFC-245fa, is a candidate to replace HFC-245fa in organic Rankine cycle applications. The environmental and thermophysical properties of the fluids are reviewed. The theoretical thermodynamic efficiency, turbine size, speed, and mach numbers of the new fluids are compared to HFC-134a and HFC-245fa. Conditions for the organic Rankine cycle are those reflecting geothermal organic Rankine cycle applications. In the case of HFC-134a and potential replacements, both sub-critical and supercritical cycles are considered.