Increasing energy costs, global warming and other environmental impacts, in combination with the relatively low energy efficiency of heating systems that operate on fossil fuels and electrical resistance heating make heat pumps an attractive alternative technology. HFC-134a, HFC-245fa and CFC-114 have high global warming potential and CFC-114 also has a high ozone depletion potential. There is a need for low global warming potential, low ozone depletion potential working fluids for use in high temperature heat pumps. Fluids that enable operation of existing heat pump equipment designed for CFC-114 or HFC-245fa at higher condenser temperatures while still attaining an adequate heating capacity would be particularly advantageous.

SUMMARY OF THE INVENTION

Use of Z-HFO-1336mzz in high temperature heat pumps increases the capability of these heat pumps because it allows operation at condenser temperatures higher than achievable with working fluids used in similar systems today. The condenser temperatures achieved with HFC-245fa and CFC-114 are the highest achievable with current systems.

In one aspect, there is provided a method of raising the maximum feasible condenser operating temperature in a high temperature heat pump apparatus comprising charging the high temperature heat pump with a working fluid comprising Z-1,1,1,4,4,4-hexafluoro-2-butene, wherein the maximum feasible condenser operating temperature is raised to a temperature greater than about 120°C.

In another aspect, there is provided a composition comprising: (a) Z-1,1,1,4,4,4-hexafluoro-2-butene; (b) 2-chloropropane; and (c) at least one lubricant suitable for use at a temperature of at least about 150°C; wherein the 2-chloropropane is present in an amount effective to form an azeotrope or azeotrope-like combination with the Z-1,1,1,4,4,4-hexafluoro-2-butene.

Also dDisclosed herein is a method for producing heating in a high temperature heat pump comprising condensing a vapor working fluid comprising 1,1,1,4,4,4-hexafluoro-2-butene, in a condenser, thereby producing a liquid working fluid.

Also disclosed herein is a method of raising the maximum feasible condenser operating temperature in a high temperature heat pump apparatus suitable for use with a first working fluid selected from the group consisting of CFC-114, HFC-134a, HFC-236fa, HFC-245fa, CFC-11 and HCFC-123 relative to the maximum feasible condenser operating temperature when the first working fluid is used as the heat pump working fluid, comprising charging the high temperature heat pump with a second working fluid comprising Z-1,1,1,4,4,4-hexafluoro-2-butene.