Compressor-free refrigerator may loom in the future

August 7 2008

Refrigerators and other cooling devices may one day lose their compressors and coils of piping and become solid state, according to Penn State researchers who are investigating electrically induced heat effects of some ferroelectric polymers.

"This is the first step in the development of an electric field refrigeration unit," says Qiming Zhang, distinguished professor of electrical engineering. "For the future, we can envision a flat panel refrigerator. No more coils, no more compressors, just solid polymer with appropriate heat exchangers."

Other researchers have explored magnetic field refrigeration, but electricity is more convenient.

Zhang, working with Bret Neese, graduate student, materials science and engineering; postdoctoral fellows Baojin Chu and Sheng-Guo Lu; Yong Wang, graduate student, and Eugene Furman, research associate, looked at ferroelectric polymers that exhibit temperature changes at room temperature under an electrical field. These polarpolymers include poly(vinylidene fluoride-trifluoroethylene) and poly(vinylidene fluoride-trifluoroethylene)-chlorofluoroethylene, however there are other polarpolymers that exhibit the same effect.

Conventional cooling systems, -- refrigerators or air conditioners -- rely on the properties of gases to cool and most systems use the change in density of gases at changing pressures to cool. The coolants commonly used are either harmful to people or the environment. Freon, one of the fluorochlorocarbons banned because of the damage it did to the ozone layer, was the most commonly used refrigerant. Now, a variety of coolants is available. Nevertheless, all have problems and require energy-eating compressors and lots of heating coils.

Zhang's approach uses the change form disorganized to organized that occurs in some polarpolymers when placed in an electric field. The natural state of these materials is disorganized with the various molecules randomly positioned. When electricity is applied, the molecules become highly ordered and the material gives off heat and becomes colder. When the electricity is turned off, the material reverts to its disordered state and absorbs heat.

The researchers report a change in temperature for the material of about 22.6 degrees Fahrenheit, in today's (Aug. 8) issue of Science. Repeated randomizing and ordering of the material combined with an appropriate heat exchanger could provide a wide range of heating and cooling temperatures.

"These polymers are flexible and can be used for heating and cooling, so there may be many different possible applications," said Zhang, also a faculty member of Penn State's Materials Research Institute.

Besides air conditioning and refrigeration units, applications could include heating or cooling of a variety of clothing including cooling of protective gear for fire fighters, heating of mittens and socks or shoes for athletes, sportsmen and law enforcement officer and even cooling of mascot and cartoon character costumes. Another application would be in electronics, where small amounts of the polymers could effectively cool over heating circuit boards and allow closer packing, and therefore smaller devices.

Source: Penn State