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New technologies enable vastly improved fluid mixing and artificial convection

James E. Martin
Sandia National Laboratories
Albuquerque, New Mexico 87185

Sandia National Laboratories has developed two new capabilities for stimulating fluid flow without making physical contact with the fluid, and without employing moving parts, pumps, seals etc. Both of these capabilities depend on adding magnetic nanoparticles to the fluids and subjecting them to time-varying magnetic fields. The key to these technologies is the nature of the particles and the way in which the direction and magnitude of the magnetic field changes with time. Both methods are easy to use, since the required magnetic fields are small enough that they can be generated with inexpensive, lightweight, copper coils. One of these new capabilities, which we call *vortex field mixing*, gives rise to vigorous fluid mixing that occurs uniformly throughout the sample volume, eliminating the stagnation regions that plague standard methods. This method is ideally suited for microfluidics applications, but can used for mixing at any scale. The second capability involves the stimulation of organized fluid flows that can efficiently transfer heat and mass along any desired direction. This *artificial convection* has the full functionality of natural convection, but because the effect does not depend on gravity or the existence of a thermal gradient, it can be used to stimulate flow where natural convection utterly fails. With this technology it is possible to cool under or beside a hot object, in the microgravity environments of space, and without any concern over the magnitude of the thermal gradient.

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