Potential Applications of Nanofluids for Heat Transfer

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The explosive expansion of studies of the apparent thermal conductivity of fluids containing solid nanoparticles has fueled exaggerated claims of their potential to produce revolutionary improvements in heat transfer. It is now generally appreciated that the reality of enhancement is one order of magnitude smaller than the initial claims, and that the enhancements are broadly consistent with conventional theory put forward by Maxwell. In many cases the enhanced thermal conductivity of the fluid does not lead to an overall improvement in heat transfer, because the changes in other properties act in a direction to detract from the efficiency. There remains a need to improve heat transfer in a wide variety of applications so that it continues to be worthwhile to investigate the use of nanofluids recognising that the enhancement of the fluid thermal conductivity on addition of nanoparticles is rather modest. In this paper, we examine several potential applications of nanofluids to determine if there are circumstances under which they may provide significant improvement in heat transfer. These include constructing nanofluids that achieve maximum physical stability and a maximum enhancement of the thermal conductivity while minimising the effect upon viscosity. For this purpose, we use ideas from colloid science that have hitherto been overlooked in the field of nanofluids. We also consider the process of natural convective heat transfer which may have application in the cooling of solid state electronics, but where there is no bulk, pump-driven motion of the fluid so that the effect of viscosity is small. There are other cases too that we consider in less detail such as the particular case of fluids containing carbon nanotubes that may have a different behaviour from near spherical systems and those in which the nanoparticles undergo a phase change in the temperature range of the heat transfer process.