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Synthesis and Characterization of Nanofluids

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ABSTRACT: Nanofluids are suspensions of nanoparticles in base fluids, a new challenge for thermal sciences provided by nanotechnology. Nanofluids have unique features different from conventional solid-liquid mixtures in which mm or μm sized particles of metals and non-metals are dispersed. Due to their excellent characteristics, nanofluids find wide applications in enhancing heat transfer. Research work on the concept, heat transfer enhancement mechanism, and application of the nanofluids is still in its primary stage. This study provides a review of research in this field with focus on thermal conductivity studies of nanofluids.

I. INTRODUCTION

Currently there is no single internationally accepted definition of nanotechnology. Engineers and scientists working in this field simply describe it as “design and manufacture of artifacts in the range of 100 nanometers to 0.1 nanometers”.

Nanotechnology is a vast field, a super set of physics, chemistry, biology, engineering and lot of other fields of science. Upon its complete realization, it's going to change the way we see things, it's going to bring a whole new industrial revolution changing our life style forever.

WHAT IS NANOTECHNOLOGY?

Computers reproduce information at almost no cost. By treating atoms discretely, like computers treat bits of information. This would allow automatic construction of consumer's goods without traditional labor, like a Xerox machine produces unlimited copies without a human retyping the original information. Electronics is fueled by miniaturization. Working smaller has led to the tools capable of manipulate the atoms of soil, air and water to make copies of it.

The shotgun marriage of chemistry and engineering called “nanotechnology” is ushering in the era of self-replicating machinery and self assembling consumer goods made from cheap raw atoms (drexler, merkle paraphrased).

Nanotechnology is molecular manufacturing or, more simply, building things one atom of molecular at a time with programmed nanoscopic robot arms. A nanometer is one billionth of a meter {3 – 4 atoms wide}. Utilizing the well understood chemical properties of atoms and molecules {how they “stick” together}, nanotechnology proposes the construction of novel molecular devices possessing extraordinary properties. The trick is to manipulate atoms individually and place them exactly where needed to produce the desired structure. This ability is almost in our grasp. The real charm of nanotechnology lies in the “smaller, faster and cheaper.” Think of having Pentium-111 computer as a single component in our ring. And that computer helps us perform all our daily works, in the most organized way.

II. SYNTHESIS OF NANOFUIDS

Choi¹, *et al.* first prepared nanofluids by mixing nano particles with fluids. Since then, there has been rapid development in the synthesis techniques for nanofluids. However, there is not yet a standard preparation method for nanofluids. Different studies prepared nanofluids using different approaches. There are two fundamental methods to obtain nanofluids:

(a) two-step process¹⁷ in which nanoparticles are first produced as a dry powder, typically by an inert gas. The resulting nanoparticles are then dispersed into a fluid. This method may result in a large degree of nanoparticle agglomeration.

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(b) chemical approach^{18,19} using wet technology, a single-step approach, is emerging as a powerful method for growing nanostructures of different metals, semiconductors, non- metals, and hybrid systems.

III. THERMAL CHARACTERISATION OF NANOFLUIDS

Choi¹ established the field of nanofluids¹ in 1995, and in 2001 measured thermal conductivity enhancement of 160 per cent for MWCNT's dispersed in poly (α-olefin) oil. Several groups have measured thermal conductivities far in excess to those predicted by the Maxwell model, while it has been hypothesised that small particle size, and hence large surface area is important. Research conducted on copper oxide nanoparticles by two different groups reported that the nanofluid containing larger particles exhibited higher thermal conductivity. Das¹⁰ *et al.* reported that nanofluids exhibit a strong dependence on temperature, with a correlation between higher conductivities and higher temperatures.

The uniqueness of nanoparticles and nanofluids is that no current model, applicable to larger particles, can estimate the enhancement of nanoparticles because of the breakdown at continuum at the nano size.

IV. APPLICATIONS OF NANOFLUIDS

Very high thermal conductivity and extreme stability have always been desired for heat transfer fluids with particles. Fluids having this important combination of features did not exist till the advent of nanofluids. Nanofluid technology could make the process more energy efficient and cost effective.

These nanofluids could be used in a wide range of industrial applications. Demand for ultra-high-performance cooling in electronics has been increasing, and conventional enhanced surface techniques have reached their limit with regard to improving heat transfer.

Since nanoparticles are relatively much smaller than the diameter of microchannel flow passages, smooth-flowing nanofluids could provide the solution. Since nanofluids can flow in microchannels without clogging, they would be suitable coolants. These could enhance cooling of MEMS under extreme heat flux conditions.

V. CONCLUSIONS

Most systems/processes whose performance is affected by heat generation could benefit from nanofluid coolants. Nanofluids have great potential for thermal management and control involved in a variety of applications such as electronic cooling, microelectro mechanical systems (MEMS) and spacecraft thermal management. The miniaturisation of mechanical and electrical components creates a need for heat transfer fluids with improved thermal characteristics over those of conventional coolants. The significant growth in performance and functionality of microelectronics combined with a miniaturisation trend in MEMS has resulted in an unprecedented increase in heat loads that presents a great challenge to thermal engineers. Nanofluids have the potential to meet these challenges

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