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Letter to the Editor

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It is a great pleasure for me to write some ideas of the modeling and simulations for this journal. I would like to write about modeling and simulation of the nanofluids.

The term nanofluids means presence of two components—a base fluid and a fraction of nano particles. Once they coexist together, the resulting uniform solution is called nanofluid. The base fluid can be water, ethylene glycol etc. and the type of nano particles could be copper, aluminium oxide, titanium oxide etc. The preparation of nanofluids can be done in several ways. The two-step method is the most widely used method for preparing nanofluids. At first, nanoparticles are produced as dry powders by chemical or physical methods. Then, the nanosized powder is dispersed into a fluid in the second processing step with the help of intensive magnetic force agitation, ultrasonic agitation, high-shear mixing, homogenizing, and ball milling. Two-step method is the most economic method to produce nanofluids in large scale, because nanopowder synthesis techniques have already been scaled up to industrial production levels. Due to the high surface area and surface activity, nanoparticles have the tendency to aggregate. The important technique to enhance the stability of nanoparticles in fluids is the use of surfactants. Due to the difficulty in preparing stable nanofluids by two-step method, several advanced techniques are developed to produce nanofluids such as the one step method.

The one-step process consists of simultaneously making and dispersing the particles in the fluid. In this method, the processes of drying, storage, transportation, and dispersion of nanoparticles are avoided, so the agglomeration of nanoparticles is minimized, and the stability of fluids is increased. The one-step processes can prepare uniformly dispersed nanoparticles, and the particles can be stably suspended in the base fluid. The vacuum-SANSS (submerged arc nanoparticle synthesis system) is another efficient method to prepare nanofluids using different dielectric liquids and can result in nanoparticles of several shapes. The nanoparticles prepared exhibit needle-like, polygonal, square, and circular morphological shapes. The method avoids the undesired particle aggregation fairly well.

The concept of how nanofluids behave and the role that they can play in engineering applications is a very hot topic now in the engineering arena. The most tempting aspect of nanofluids is the possibility of using them as coolants due to the fact that they exhibit a higher thermal conductivity and heat transfer rate than purefluids. Nanofluids can come in handy for a network of chips/resistors or even a huge telecommunication system or data centers requiring bulk cooling. This cooling can be achieved using either direct or indirect cooling. In case of direct cooling, the heated device is submerged into the fluid whereas in indirect cooling the fluid is made to pump through channels where it collects heat from hot spots and then this hot fluid is cooled after which the cooled fluid again flows in the hot spots regions hence setting up a looping procedure.

Before any practical approach can be taken to introduce a concept, it is of utmost importance for one to mathematically model it and study its behaviour using computer simulation. This modelling of nanofluids behavior will begin by developing a set of equations known as governing equations. The governing equations have their basis on the law of conservation of mass, Newton's second law of motion and the First law of Thermodynamics. After the proper derivations once the final form of governing equations arrives, it is necessary to discretize using the finite difference (FD), finite volume (FV), Finite element (FE) methods for getting the set of system linear equations. The solving of the linear equations requires applying appropriate boundary conditions.

Widespread research of nanofluids will affect the engineering industry in a great manner. If based on such research it becomes feasible to use nanofluids commercially then it will of course cut down costs of telecom industries. Large data centers are billed for a huge amount of money per month on running huge air coolers that keep the server racks cool and these air coolers even occupy a certain area of space in the center which means there can only be a limited number of server racks in a center. If a nano fluid cooling technique is used the number of huge chillers can be cut down and this will not only reduce the cost of electric bills but also help data centers serve more customers because a lot of space is going to be saved for placement of more server racks. Several countries worldwide already have employed several fluid cooling techniques to cool server racks but the fluid used have mostly been purefluids. A manufacturing company named ASETEK has developed and started commercially selling a fluid cooling apparatus called Rack-CDU. Rack-CDU removes heat from CPUs, GPUs, Memory modules and other hot spots within servers and takes it all the way out of the data center using liquid. Free ambient outdoor air cools the water returning to the data center, meaning no power is used to actively chill the water. The water leaving the data center is hot enough to enable waste heat recycling, further increasing energy cost savings, reducing carbon footprint and resulting in cooling Energy Reuse Efficiencies (ERE) below 1! Rack-CDU is deployed at a rack/server level providing maximum scalability. The system consists of a zero-U rack level CDU mounted in a 10 inch (250 mm) rack extension that includes space for 3 additional PDUs, and direct-to-chip cooling loops within each server. The direct-to-chip cooling loops are drop in replacements for the existing air heat sinks, with tubes exiting through an unused PCIe (Peripheral Component Interconnect express) slot. The benefits of Rack-CDU include cooling energy savings exceeding 50%, increment of rack level density by approximately 2.5 times and so forth. Since use of a purefluid cooling system is found to have such a desired outcome so it is needless to say that if nanofluids, which are superior to purefluids regarding heat transfer, are used instead of purefluids then the benefits are going to be even higher. From my research experience, we have found that the nanofluids are superior to the pure fluids in terms of the heat transfer through the fluids.