Engineering Applications of Nanotechnology: From Energy to Drug Delivery (Topics in Mining, Metallurgy and Materials Engineering)

ISSN 2364-3293 ISSN 2364-3307 (electronic)
Topics in Mining, Metallurgy and Materials Engineering
ISBN 978-3-319-29759-0 ISBN 978-3-319-29761-3 (eBook)
DOI 10.1007/978-3-319-29761-3

Library of Congress Control Number: 2016949582

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

kind of heat transfer fluid formed by dispersing nano-scaled metallic or nonmetallic particles in base fluids (water, ethylene glycol, and oil). Energy transport of the nanofluid is affected by the properties and dimension of nanoparticles as well as a solid volume fraction. Some experimental investigations have revealed that the nanofluids have remarkably higher thermal conductivities than those of conventional pure fluids and have great potential for heat transfer enhancement. The addition of nano-sized particles is very proper to augment heat transfer as compared to the adding millimeter or micrometer sized to liquids with little penalty in pressure drop. A possible effective method for heat enhancement is to include high thermal conductivity particles in the liquid. Some general examples of applications that can benefit from this technology include home heating and cooling appliances, automotive radiator systems, power plant cooling systems, and computer processing cooling equipment, and more examples including heat are transferred from one medium to another. The use of high conductivity heat transfer materials will lead to benefit fully the available energy of a system which will reduce the environmental footprint of companies as well as their operating costs. It is believed that the most important reasons to enhance heat transfer of the nanofluids may be from the intensification of a turbulence eddy, repression, or interruption of the boundary layer as well as nanoparticles suspension. Therefore, the convective heat transfer coefficient of nanofluids is a function of properties, volume fraction of suspended nanoparticles, and dimension as well as the flow velocity. Taking advantage of the nanoparticles in the liquid causes the particles to stay in the solution for a long time.

Another feature is that these particles have large surface area for thermal conductivity than ordinary liquids. From an engineering point of view, forced convection utilizing liquid coolants in laminar or turbulent flow regimes is always a key heat transfer solution. The better convective heat transfer performance means higher values of heat transfer coefficient. There are a number of techniques to enhance heat transfers such as modified heat transfer surface roughness, fins (extended surfaces), and injection. However, these techniques have led to higher pressure drop and hence lift pumping power requirement. Also, with low thermal conductivity and high viscosity of conventional heat transfer fluids such as water, ethylene glycol, oil, and ammonia, the convective thermal performance created barriers in designing small heat-rejecting devices. Therefore, an innovative coolant with improving heat transfer properties is required. The solid particles usually exhibit high thermal conductivity than liquids, and one approach to enhance thermal conductivity of liquids is by using suspensions, which contain dispersed particles into base fluids. One of the pioneering researchers of stationary, dilute dispersions of solid spheres has been studied by Ahuja (1975) performed number of tests on thermal conductivity and heat transfer coefficients of 40–100 μm-sized polystyrene–water-based solutions with 1-mm inside tube. Furthermore, the effective thermal conductivity of the suspension increases with the increasing of Reynolds number and nanofluid volume fraction. Because of shortage of available technology in those years, the particles size was large (in micro-scale). So this size has led to two penalties: The first on are not stable enough, and other are the larger particles can easily cause erosion to flow loop components.