USE OF NDT APPROCHES FOR RADIATOR FABRICATION AND RELIABILITY FOR NANO FLUIDS- A STUDY

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ABSTRACT:

The purpose of industrial non-destructive testing (NDT) method is to identify defects or flaws in industrial parts, which are difficult to detect for the human eye. X-ray testing is a traditional method for the evaluation and detection of defects in castings and welds, therefore digital image processing and computational intelligence can be used to automate this process. Automated visual inspection of industrial parts can be used as a quality control task to determine automatically weather it complies with a given set of product and product safety specifications. NANO fluids are potential heat transfer fluids with enhanced thermo physical properties and heat transfer performance can be applied in many devices for better performances (i.e. energy, heat transfer and other performances). Evaluating the heat transfer enhancement due to the use of NANO fluids has recently become the centre of interest for many researchers. Because of its smaller particle size of NANO's the fabrication play an important role. This paper discuss about the fabrication techniques as well as non destructive testing methodologies of heat exchangers like radiators.

Keywords: *NDT, Radiators, Fabrication techniques.*

INTRODUCTION:

Heat transfer is one of the most important processes in many industrial and consumer products. The inherently poor thermal conductivity of conventional fluids puts a fundamental limit on heat transfer. Therefore, for more than a century since Maxwell, scientists and engineers have made great efforts to break this fundamental limit by dispersing millimetre- or micrometre-sized particles in liquids. However, the major problem with the use of such large particles is the rapid settling of these particles in fluids, clogging and erosion of pipes and channels. As extended surface technology has already been adapted to its limits in the designs of thermal management systems, technologies with the potential to improve a fluid's thermal properties are of great interest once again. The concept and emergence of nano fluids is related directly to trend in miniaturization and nanotechnology. Maxwell's concept is old, but what is new and innovative in the concept of nano fluids is the idea that particle size is of primary importance in developing stable and highly conductive nano fluids

Ultrahigh-performance cooling is one of the most vital needs of many industrial technologies. However, inherently low thermal conductivity is a primary limitation in developing energy efficient heat transfer fluids that are required for ultrahigh-performance cooling. Nano fluids are engineered by suspending nano particles with average sizes below 100 nm in traditional heat transfer fluids such as water, oil, and ethylene glycol. Nano fluids (nanoparticle fluid suspensions) is the term coined by Choi to describe this new class of nanotechnology based heat transfer fluids that exhibit thermal properties superior to those of their host fluids or conventional particle fluid suspensions. Nano fluid technology, a new interdisciplinary field of great importance where nano science, nanotechnology, and thermal engineering meet, has developed largely over the past decade. The goal of nano fluids is to achieve the highest possible thermal properties at the smallest possible concentrations preferably.

1.2 Objectives and Scope of the Present Study

1. Synthesize ultrafine Al, Cu and Al-Cu alloy particles through mechanical alloying process by 50 hours of planetary ball milling.
2. Characterize the ultrafine particles by different characterization techniques like XRD, SEM, TEM, and Particle size analyzer.
3. Preparation of Al, Cu and Al-Cu based Nano fluids by dispersing particles in base fluid with the help of ultrasonic probe and magnetic stirrer.
4. Study of dispersion stability of Al, Cu and Al-Cu alloy ultrafine particles in base fluid by Nano zeta meter at different pH with and without addition of surface.

1.3 scope of study

The development, concept of nano fluids, theoretical study, potential benefit, applications and methods of producing nano fluids are provided. It also provides a description of the milling experiments for the synthesis of Al, Cu, Al-Cu ultrafine particles, different characterization techniques and synthesis of Al, Cu, Al-Cu based nano fluids. Characterization of the ultrafine particles synthesized from elemental Al and Cu powder is presented. This chapter also provides the dispersion stability of ultrafine particles in base fluid. While there have been many studies focused on detecting defects in reinforced concrete structures, the problem of defect quantification in cementations materials like reinforced concrete structures was tackled only by few researcher groups. Many safety-relevant cases of damage in concrete structures originate from defects that are close to the surface, e.g., voids and honeycombing in the top layer of reinforcement, delamination's of carbon-fiber-reinforced plastic (CFRP) laminates used for strengthening of concrete structures, delamination's of protective coating systems as well as surface and subsurface cracks [3]. Therefore, active thermography is very well suited for condition assessment, damage evaluation and quality assurance of the built infrastructure. The purpose of this paper is to provide an overview on the state-of-the-art regarding the use of active IRT for detection and characterization of defects in reinforced concrete. It was realized that there is much knowledge available in the literature that can be gathered in one review paper. Nevertheless, research groups often start from scratch, dealing with the same problems that were already investigated. This paper would thus provide a starting point for future researchers, giving them viable directions of research in the field of IRT in concrete structures. This work also presents the fields of applicability of IRT with a focus on the aspects related to reinforced concrete structures, as well as the advantages, limitations and potential sources of errors of active IRT employment. Additionally, previous NDT studies.

LITERATURE BACKGROUND

Since Nobel prize winner Richard P. Phillips Feynman given the idea of small machines in his seminal speak, "There's lots of space at the Bottom—An invite to Enter a replacement Field of Physics," in Gregorian calendar month 1959 at the annual meeting of the yankee Physical Society at the Golden State Institute of Technology, shrinking has been a significant trend in fashionable science and technology. In 1962, the Japanese physical science Kubo showed that the electronic level of a fine gold-bearing grain may modification in line with the distinction within the particle size. Gerd Binnig and Heinrich Rohrer of the IBM laboratory in European country developed a replacement scanning tunnelling research (STM) technology in early 1980, developing pictures of the atomic structure on the surface of objects that enabled any development for the inspiration of nanomaterials. Nobel Prize winner, H. Rohrer, given the probabilities and challenges of the "nano-age". Nano could be a prefix that means billionth, thus a metric linear unit is billionth of a meter. engineering science is that the creation of practical materials, devices, and systems by dominant matter at the nano scale level, and therefore the exploitation of their novel properties and phenomena that emerge at that scale. The steady shrinking trend has born from the metric linear unit scale of the first Nineteen Fifties to the current atomic scale. Nano fluid technology can so be a rising and exciting technology of the 21st century. With the continued shrinking of technologies in several fields, Nano fluids with a capability of cooling high heat fluxes prodigious a thousand w/cm2 would be dominant within the advancement of all engineering

METHODOLOGY:

Combining NDT Methods: In order to be accepted as a viable NDT technique in the field of civil engineering, more specifically in the field of reinforced and pressurised concrete structures, IRT has to also be compared with other NDT techniques that are already accepted. Additionally, a combination of few NDT methods can potentially increase the reliability of inspection results for damage identification. This motivated researchers to do laboratory and in-situ testing comparing IRT with other electromagnetic and ultrasound methods. The research of Meola et al. uses a multi-methodological approach to NDT of architectural structures. They use three different techniques such as IRT, ultrasonic and electric-type geophysical methods to acquire information for a synergic use of the different methods, which can allow for more reliable test results. Sequences of thermal images were acquired with the FPA IR camera, while thermal stimulation was performed with two lamps (1 kW each) in the reflection setup. It was concluded from the research in that several factors influence defects visibility: defects size and nature, depth, plaster consistency and the type of support. In general, it is said that a large defect is better distinguishable than a smaller one. A deep defect seems defocused as a result of the thermal dispersion within plaster becomes a lot of vital because the plaster thickness will increase. additionally, a compact plaster favours defect visibility whereas a porous plaster hinders the defect visibility, thanks to the thermal physical phenomenon of compact plaster, that is over that of air whereas the porous plaster has lower thermal physical phenomenon. Meola et al. concludes that this impact contrasts the visibility of the defects that ar simply made from air.

Characterization techniques used

X-Ray Diffraction (XRD) analysis: As a non-destructive testing technique, x-ray diffraction is a powerful tool for the analysis of crystalline structure. X-ray has wavelengths comparable to the crystalline lattice constants, thus it can be used for the accurate measurement of lattice parameter, crystallite size, lattice strain etc. X-ray diffraction of the as milled powder samples were performed using the diffract meter. X-ray diffraction patterns were recorded from 30˚ to 110˚ with a PAN analytical system diffract meter using Cu Kα (λ=1.542Ao) with an accelerating voltage of 40 KV. Data were collected with a counting rate of 3˚/min. The Kα doublets were well resolved.

PANalytical system diffractometer (Model: DY-1656)

Scanning electron microscopy (SEM) study: The SEM micrographs of as received powder, milled powder samples were obtained using the scanning electron microscope. The images were taken in both secondary electron (SE) and back scattered electron (BSE) mode according to requirement. Microscopic studies to examine the morphology, particle size and microstructure were done by a JEOL 6480 LV scanning electron microscope (SEM) equipped with an energy dispersive X-ray (EDX) detector of Oxford data reference system. Micrographs are taken at suitable accelerating voltages for the best possible resolution using the secondary electron imaging.

JEOL JSM-6480LV scanning electron microscope.

Transmission electron microscopy (TEM): study the instrument used for our TEM analysis was FEI QUANTA model. The TEM micrographs of the milled powder were obtained to determine the true size of the particles. The operating voltage was 200 KV. The samples of TEM have been prepared by mixing the powder with a small amount of pure acetone and stirring for 15 minutes. Two or three drops of the 25 suspension were placed on carbon coated Cu grid and then well dried for 10 minutes before mounting the grid onto the TEM sample holder.

FEI QUANTA transmission electron microscope.

Particle size analysis: Particle size of the milled powder was measured by Malvern particle size analyzer (Model Micro-P, range 0.05-550 micron). Firstly, the liquid dispersant containing 500 ml 0f distilled water and 25 ml of sodium hexa met phosphate was kept in the sample holder. Then the instrument was run keeping ultrasonic displacement at 10.00 micron and pump speed 1800 rpm. A pinch of powders was added to the liquid dispersant so that the obscuration value varies between 10 to 30% and the residual below 1%.

Malvern particle size analyzer (Model Micro-P, range 0.05-550 micron)

Nano ZS: The particle size in nanometre range and dispersion stability of ultrafine particles in Nano fluids was measured by Nano zeta sizer (Model: Nano ZS, Malvern). The sample was prepared by dispersing small amount of ultrafine particles in deionized water with constant ultra-sonication and magnetic stirring for 30 minutes each. Then the sample was kept in a sample holder with the help of syringe and analyzed.

Nano zeta sizer (Model: Nano ZS, Malvern instrument)

SUMMARY:

Characterization of ultrafine particles through X-ray diffraction (XRD) analysis, particle size analysis, scanning microscopy (SEM) study, and transmission microscopy (TEM) study is conferred additionally provides the dispersion stability of ultrafine particles in base fluid.

Nano fluids appear to be potential replacement of standard coolants in engine cooling system. Recently there has been sizeable analysis findings rumored that highlights superior heat transfer performances of Nano fluids. Nano fluids are potential heat transfer fluids with increased thermo physical properties and warmth transfer performance. It may be applied in several devices for higher performances (i.e. energy, heat transfer and alternative performances). Nano fluids ar fashioned by suspending bimetal or non-metallic compound nanoparticles in ancient heat transfer fluids. This new introduced class of cooling fluids containing ultrafine nanoparticles (1–100 nm) has displayed attention-grabbing behaviour throughout experiments together with enlarged thermal conduction and improved heat transfer constant compared to a pure fluid. The utilization of nano fluid as coolants would leave smaller size and higher positioning of the radiators. It additionally will increase the potency of the system with less quantity of fluid. It results that fluid pumps may be shrunken and engines may be operated at higher temperatures. These novel and advanced ideas of coolants provide exciting heat transfer characteristics compared to standard coolants.

Types of Nano fluids: There are various metallic, non-metallic nanoparticles and multivalued carbon nanotubes (MWCNT) which are currently used with base fluids to enhance the thermal performance of the cooling systems. Common base fluids are water, ethylene glycol and oil. The metallic nanoparticles like Cu, Fe, Au, Ag etc. and non metallic particles or compounds like Al_2O_3 (Alumina), CuO, SiC, TiO_2, Fe_3O_4 (Iron Oxide), ZrO_2 (Zirconia), WO3 (Tungsten trioxide), ZnO, SiO_2 etc. are generally used with base fluids

CONCLUSIONS:

This review has highlighted the different methodologies that use natural excitation sources as well as active infrared thermography methodologies that are currently being researched and applied in the field of reinforced and pre-stressed structures, and has verified the effectiveness and usefulness of IRT as a NDT tool in structures. It can be said that by using IR camera for the NDT of structures, the amount of time needed to inspect the structure can be significantly reduced. This is because the result of IRT, the thermo grams, which are screening of potential concrete defects in subsurface, can pinpoint the defected areas in the structures and thus reduce the amount of time to inspect compared to sounding test, since there is no need to inspect spot by spot. The thermal image analysis methods that follow an IRT inspection have also been reviewed, and the future trends of thermal imaging of structures have been outlined. It can be concluded that while IRT is a useful tool in NDT of structures, there is great prospect for the development of more advanced, effective and accurate techniques that will employ a combination of the available thermography approaches. To increase the reliability, for enhancing the accuracy of quantitative results, for unambiguous data interpretation and for taking advantage of different and, in some instances, complementary physical effects, it is useful to combine complementary NDT methods.

Long Term Stability of Nanoparticles Dispersion Preparation of homogeneous suspension remains a technical challenge since the nanoparticles always form aggregates due to very strong van- der Waals interactions. Generally, long term stability of nano particles dispersion is one of the basic requirements of nano fluids applications. Stability of nano fluids have good corresponding relationship with the enhancement of thermal conductivity where the better dispersion behaviour, the higher thermal conductivity of nano fluids. However the dispersion behaviour of the nanoparticles could be influenced by period of time. As a result, thermal conductivity of Nano fluids is eventually affected.

From the above study of nano fluids, following brief conclusions can be drawn.

1. It has been seen that nano fluids can be considered as a potential candidate for Automobile application.

2. Automobile radiators can be made energy efficient and compact as heat transfer can be improved by nano fluids. Reduced or compact shape may results in reduced drag, increase the fuel economy, and reduces the weight of vehicle.

3. Exact mechanism of enhanced heat transfer for nano fluids is still unclear as reported by many researchers.

4. There are different challenges of nano fluids which should be identified and overcome for automobile radiators application. Nano fluids stability and its production cost are major factors that hinder the commercialization of nano fluids. By solving these challenges, it is expected that nano fluids can make substantial impact as coolant in heat exchanging devices.

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