International Engineering Research Journal

Enhancement of Boiling Heat Transferand Critical Heat Flux by Using Binary Nanofluid – Review Paper

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Abstract

There are increasing researches in the field of heat transfer enhanceby using various types of nanofluids. In this paper will cover the advances nano - technological research in the field of Pool boiling and convection boiling, they can use nanofluids as working fluid. The data available in the literature review the term of CHF (Critical Heat Flux) enhancements and degradations of nucleate pool boiling. The entireresearchers are directly measuring the Critical Heat Flux enhancement by using single or binary nanofluids as a base fluid. The whole research has been affirmed by the expanding the grouping of nanofluids in the base liquids on the grounds that to upgrade the warmth exchange coefficient. The impact on size, shape and other parameter of the nanofluids on the BHT and CHF.

Keywords:*critical heat transfer, boiling heat transfer, pool boiling, nucleates boiling, nanofluids.*

1. Introduction

The Boiling Heat Transfer (BHT) is used in various applications such that industrial process, power generation, refrigeration, nuclear reactor & high power components (Electronics) for cooling purpose, heat exchangers. It is essential to enhancement the Boiling Heat Transfer process for such typical industrial applications and there previously large amount of energy saving. To reduce the energy losses and enhance heat transfer processes are the important work for particular with regarding to the prevailing energy crisis.

It is one method to save the energy by enhancement of heat transfer in the field processes. It can use of solid particles because they have higher thermal conductivity so they can use a conventional fluid, it has consider the enhancement in heat transfer for last several decades. There are pragmatic issues, for example, sedimentation because of the weight drop and fouling to build explore in the business for this procedure is never truly grabbing.

In last a few years the exploration in the nanotechnology to diminish the issue by utilizing different nanoparticles and delivering nanofluids in nanometer measure ranges. Nanoparticles are as strong to make an alternate class of liquids, called nanofluids. Nanofluids are as fluid position containing nanoparticles, which are littler size, for example, a 100 nm. Warm conductivity of nanofluids is essentially higher than that of the base fluids. These sorts of liquids are presently of incredible advancement or research is not just enhancing the attributes, for example, stream and twisting (rheological properties) and mass exchange additionally alter the Boiling Heat Transfer rate of liquid. [10]

2. CHF Enhancement

There are different techniques which are used to enhance the Critical Heat Flux and Boiling Heat Transfer can be divided in the two different types are:

1. Active Method
2. Passive Method

In Active Method they can use an external changes in the radiator surface and in the Passive Method they can't require any outer changes in the warmer surface. In the Active Method they can giving a vibration to the warmer surface in light of the fact that to expelling the rise from the warmed surface of the radiator so that ways the Active Method required an outer vitality. In the Passive Method they can't required an outside vitality since they can give a covering of a permeable layer on the grounds that to build the oxidization of warmed surface. [8]

A recent passive approach that has increased attraction worldwide is to create or generate a new fluid to mix solid nanoparticles in the base fluid, distilled or pure water called nanofluids. There are different materials are available for the selection of the chemically stable nanoparticle materials such as a metals such as Ag, Cu and Au and metal oxides such asSiO_2, Al_2O_3 and ZrO_2 and in the several form available a carbon such as Diamond Fullerene and Graphite. Boiling test result show that, most engineers are used nanofluids as a coolant because of their higher Critical Heat Flux this is generally range of enhancement in between 20% to 300% as compared to water.

Over the last few decades, let consider lots of research is carried out in the area of the Nucleate Pool Boiling and Critical Heat Flux by using different nanofluids. In the present review paper study the different parameter to enhance the Critical Heat Flux in Pool Boiling Heat Transfer by using different nanofluids as below are:

1. Nanoparticles effect on materials.
2. Nanoparticle effect on sizes.
3. Concentration effect.
4. Stabilizer effect.

5. Heater size and geometry effect.
6. Heater surface orientation effect.

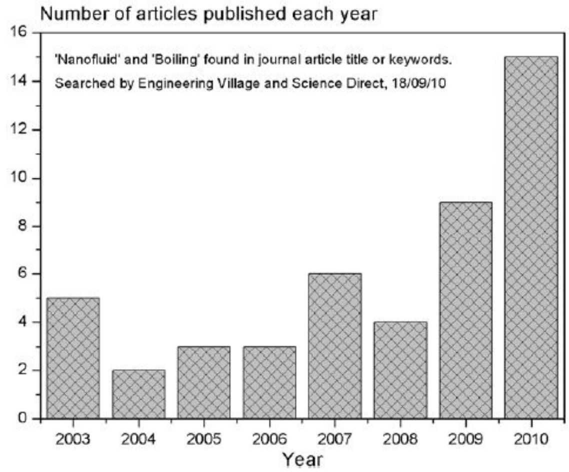

Fig. 1 Bar chart to illustrate the increasing treads in journal articles dedicate to nanofluids boiling in last few year

The articles demonstrated the bar outline in Fig. 1 are demonstrates that, the papers are distributed in the distinctive diary in the middle of from 2003to 2010 and there are no distributed in the diary articles on the bubbling and nanofluids before 2003. In the despise last some year consideration increment in nanofluids heating up this is doubtlessly because of the upgrade warm conductivity of the nanofluids and the generally expansive hole in the learning that exists, concerning the systems required in nanofluids bubbling improvement.

2.1 Convective Flow Boiling

In the convective stream, in most recent couple of years the bubbling has turned out to be most well known, in light of many smaller sizes cooling forms likewise the cooling of microelectronics parts for popularity of warmth flux for cooling reason. An exploratory review was directed investigate the favorable position by utilizing Alumina nanoparticles ($Al2O3$) with a water as a base liquid for cooling application, for example, smaller scale channel. It can found the improve warm move in a solitary stage laminar stream and the two stage area, the nanofluids in radiator surface statement in from of agglomerates and small scale channels, substantial bunches of nanoparticles have been shaped. The researched watery nanofluids with a 0.01% grouping of nanoparticles, the Critical Heat Flux was upgrade under the constrained convective stream and contrast and the state of with unadulterated water.

2.2 Pool Boiling

In the pool bubbling warmth exchange, the upgrade analyzes by utilizing diverse nanoparticles with water as a based nanofluids containing were lead by Kim et al. Once more, nanoparticle affidavit seen on the radiator surface not long after nanofluids bubbling was start; an unpredictable permeable structure was shape at the surface. This is fundamentally the same as with regards to the one that was seeing amid the convective stream bubbling of nanofluids introduced in the past area. Kim et al. explored this surface affidavit further and noticed an improvement in wettability. They examinations the changed Young's condition and presumed that wettability.

Improvement in the CHF because of the two consolidated reasons
1. The primary impact is that was increment an attachment strain.
2. The second impact is an expansion a surface harshness esteem.

The smaller scale pits is enactment the warmer surface to keep the nanoparticles on radiator surface so there abatement in contact edge of air pocket, so which prompts a diminish the air pocket nucleation in the nanofluids. So there impact of surface wettability on the Critical Heat Flux, the impacts happens at high warmth fluxes exchange when problem areas or dry patches are produced on the warmer surface; because of these dry spots can be irreversibly overheating or rewetted, bringing about Critical Heat Flux. [8]

3. Objectives

The objectives of this dissertation work is

1. To check boiling performance of water with and without binary nanofluids.
2. The effect of concentration of different binary nanofluids on the heat transfer characteristics.
3. To analyze the kinetics of boiling (bubble nucleation, growth and departure. (by high speed camera).
4. To develop predictive model.

4. LITERATURE REVIEW

J. Jung, E. S. Kim, Y. Nam, Y. T. Kang they can directed investigation to measured a Critical Heat Flux and Boiling Heat Transfer coefficient by utilizing $LiBr/H2O$ as a based parallel nanofluids. They can utilize a Polyvinyl Alcohol as a stabilizer to the settled scattering of the $Al2O3$ nanoparticles in the $LiBr/H2O$. The copper plate warmer size 10 X 10 mm2 was use as a bubbling surface. They can fluctuate the centralization of the nanoparticle from 0 vol.% to 0.1 vol.%, additionally the scattering in $LiBr/H2O$ arrangement. The outcome is demonstrates that the Boiling Heat Transfer coefficient is low as contrast with the base liquids so that the Critical Heat Flux winds up plainly higher. [1]

M. R. Raveshi, A. Keshavarz, M. S. Mojarrad, S. Amiri, they can depicted an a standout amongst the most critical strategy for the enhancing bubbling procedure by utilizing nanofluids. They can lead explore a research the nucleate bubbling warmth exchange by utilizing Alumina, Water and Ethylene Glycol nanofluid. For the comprehension of the bubbling warmth exchange components of twofold blend based nanofluids, the examinations was accomplished for the impact of alumina nanoparticles on the bubbling warmth exchange coefficient of alumina, water and ethylene glycol. The outcomes demonstrated that the basic upgrade up to 64% for the 0.75% nanoparticles volume focus. [2]

O. S. Prajapati, N. Rohatgi they are measured the impact of ZnO - water nanofluids on warmth move attributes in convection. Warm exchange rate expanding by 126% of water with connected weight and nanoparticle volume of ZnO - water nanofluid inside the given scope of warmth flux embraced. There is no weight drop change with water just it was see with low centralizations of nanofluid however weight drop increments 23% with convergence of 0.1% nanoparticlesis in the nanofluid. [3]

A. Kumar, U. K. Nayak, R. S. Prasad has concentrated on the impact of mass resistance on the warmth move rate in pool bubbling. The nucleate pool BHT coefficients for paired blend (Propanol – Water and Ethanol - Water) were measure at various centralizations of the more unstable segments. Basic warmth flux (CHF) conditions were controlled by bubbling parallel blend of water with Propanol or Ethanol at atm. weight. [4]

Dr. V. Ravi has been led an analysis for study the attributes of Carbon Nanotube (CNT) and Ethylene Glycol based nanofluids blend in nucleate pool bubbling. They can gauge a warm conductivity of working liquids, for example, Triethylene glycol, water and CNT blend with transient hot-wire (THW) technique. He was concentrated the qualities like Critical Heat Flux, conduct of nanotube with various warmth inputs and envisions the bubbling marvel. [5]

S. J. Kim they can led a test on pool bubbling and basic warmth flux upgrade by utilizing parallel nanofluids with weaken scatterings of the Zirconia, silica and alumina nanoparticle in the water, by utilizing wire warmer this test are directed. Amid the nucleate pool bubbling investigation there are some nanoparticles are stored on the warmer surface shape the permeable layer. The can create a higher wettability by utilizing CHF upgrade. [6]

G. A. Matre1, R. L. Karwande they can direct an analysis and concentrate on the CHF improvement in the nucluate pool bubbling by utilizing Al2O3 and Water as base liquid. The Critical Heat Flux upgrade as expands convergence of nanoparticles from 3 to from 12 gram/liter to build the greatest Critical Heat Flux and by uing more than 12 gram/liter the estimation of Critical Heat Flux lessens more than the Distil Water. The surface harshness esteem expands 3 to from 12 gram/liter and more than 12 gram/liter nanofluids in pool bubbling then unpleasantness esteem are lessen in nanofluids. [9]

Dr. S. Kumarappa, Dr. R. K. Hegde has been directed an investigation of a Pool bubbling Critical Heat Flux trademark in the nanofluids are studies inside an alternate convergence of the Graphene Oxide and likewise the Alumina nanofluids run from the 0.01 gram/liter to 1 gram/liter and they can impact on the nanoparticles in pool bubbling CHF for every focus is increments as expanding the nanoparticles from 0.01 gram/liter to from 1 gram/liter and the impact on warmth exchange improvement. [11]

P. Atcha Rao, V.V.Ramakrishna, S. Rajasekhar in experimentation is direct on Pool Boiling heat exchange with Ammonium Dodecyl Sulfate. The outcome in the most extreme warmth flux is 3628 KW/m2, to the ADS in measure of 2.5-gram can builds the warmth flux around hundred times more. Consequently, increment the rate of warmth exchange by utilizing ADS in nucleate pool bubbling. By utilizing Ammonium Dodecyl Sulfate in power plants, we may get best rate of steam era. [12]

H. Kim, J. Kim and M.H. Kim they can direct trials by utilizing titania (TiO2) and alumina (Al2O3) nanofluids extend from 10 - 5 vol.% to 10 – 1 vol.% focus. They can found that the 100% Critical Heat Flux improvement in the pool bubbling by utilizing titania (TiO2) and alumina (AL2O3) nanofluids bu utilizing nichrome wire and the nanoparticle are affidavit on the warmer. They can examined additionally the pool bubbling of an immaculate water nanoparticle kept on the wires and they can found that the high CHF improvement of those nanofluids. [13]

I.C. Blast and S. Heung chang, they can direct a trial by utilizing 0.5 vol.% to 4 vol % alumina nanofluid, and they can discovered half and 13% Critical Heat Flux improve for 1 vol.% of alumina on the flat likewise the vertical plate individually. [14]

S.J. Kim, I.C. Blast, J. Buongiorno and L.W. Hu, focous on utilized alumina, zirconia (ZrO2), and silica (0.001vol% - 0.1vol%) nanofluids in pool bubbling of wire warmer and discovered CHF improvements of 52%, 75%, and 80%, individually. [15]

Wu W., Bostanci H., Chow L.C., Hong Y., Su M., Kizito J.P., has directed an examination that they can utilize the copper plate with 1μm thickness likewise the covering of SiO2 nanoparticles and TiO2 nanoparticles with size of 10 nm. In the water pool bubbling examinations they can found, by utilizing TiO2 covering surface expanding 50.4% Critical Heat Flux upgrade and by utilizing SiO2 covering surface expanding 10.7% Critical Heat Flux improvement. [16]

5. Methodology:

i. Theoretical work:

1. To review of previous work on various surfactants and binary nanofluids used in pool boiling.
2. To design pool boiling test rig for testing purpose.

ii. Experimental work:

1. Prepare some samples of binary nanofluids with different concentrations.
2. To develop the pool boiling test rig according to requirement.
3. To conduct trials on pool boiling test rig taking water as base fluid and binary nanofluids as a surfactants to measure parameters like temperatures, heat transfer coefficient, Critical heat flux, etc.
4. To study bubble geometry by using high speed camera.

6. Advantages

1. The heat transfer in between the particles & fluids is very high.
2. The dispersion stability of the particles is very high.
3. The heat transfer rate enhances as compare to the base fluid.
4. To adjust properties of nanoparticles as increases the concentration of the nanoparticles.

7. Limitations

1. The high cost of nanoparticles.
2. The some nanoparticles have low specific heat.
3. Production of Nanofluids is very difficult.

8. Application

1. It can be used Industry for cooling purpose.
2. It is use in defense applications and an aerospaceapplication.
3. It is use in microchip for cooling purpose.
4. It is use for cooling purpose of high power an electronic application.
5. It can be used for cooling purpose of nuclear reactor.

9. Conclusions

1) In this review paper we can findings various literature to enhancement the critical heattransfer rate by using various nanofluids with its base fluid andincreasing concentration of nanoparticles to increasing critical heattransfer factor and increasing also Reynolds number.
2) In this review paper various experimental techniques for enhancement of Critical Heat Flux factor in the Nucleate Pool Boiling Heat Transfer.
3) We have needed a various nanofluids, for their maintaining stability to enhancement of CHF and BHT.

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