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RESEARCH ARTICLE OPEN ACCESS

Improvement in Heat Transfer Characteristic of Nucleate-Pool Boiling of Water

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Abstract:-Now-a-days, to save energy and to save environment are the great issues of the world.The enhancementof boiling heat transfer is one of the most important andadvanced research fields to meet up the partial crisis of energy. But the way of research should beenvironmentally friendly. Various inferences have been drawn based on the existing parameters like operating pressure, temperature, and types ofworking fluids are Nano fluids by different researchers for enhancement of heat transferrate. Here is an experimental study which is conducted to investigate the pool boilingheat transfer of environmentally friendly water as base fluid and nichrome wire as aheating surfaces. The goal of the Experiment was to understand the characteristics anddesign of a pool boiling heat transfer, as well as evaluate the effect of addition of wateras a base fluid, in nucleate pool boiling heat transfer coefficient. The experiments werecarried out a nichrome wire as a heating surface.The results showed that, the heat transfer coefficient increases with increasing thickness of the nichrome wire.

Keywords:- Power dissipated, Heat Flux, Heat Transfer Coefficient, Nichrome wire.

1. Introduction

Pool boiling is the process in which the heating surface is submerged in a large body with a stagnant liquid. In a pool boiling, when a pool of liquid is heated with a heating coil (Nichrome wire) through a horizontal surface, the liquid motion of the surface is primarily due to naturalconvection and to mixing induced by bubble growth and detachment. Nucleate boiling region isa one of the most efficient heat transfer modes, which had been applied in various engineeringfields such as nuclear energy, electric power generation, electronic chips coolingand airconditioning plant. Now we conducted experiment improvement in heat transfer characteristic of nucleate pool boiling by water as a base fluid by using nichrome wire enhancing heat transfer coefficient due toincreasing the thermal conductivity wire. And further experiment as to be conducted by Nano fluid coating on the nichrome wire surface with diameter 100nm to 200nm thickness, in a base fluid such as water,oils. These Nano fluids coating way of enhancing heat transfer due toincreasing the thermal conductivity of base fluid properties.Choy [1], and Eastman etal.[2] Early studied of Nano fluids had mainly focused on thermalconductivity enhancement and the

behavior. The Influence of adding Al_2O_3Nano particlesdiluted binary watermixtures with different volumetric concentrations to enhance thenucleate pool boiling. The results indicated that the pool boiling heat transfer coefficientincreases by 25%.Soltani etal. [3] where, they studied increasing nucleate pool boiling heat transfercoefficients of Al_2O_3-water and TiO_2water Nano fluids at different volumetric concentrations.Their results showed that, for stainless steel and brass heating surface tubes, the presence of Nanoparticles significantly enhanced the pool boiling heat transfer coefficients, on the other hand,heat transfer coefficients deteriorated around the copper heating surface tube due to its higherthermal conductivity in comparison with the other tubes.

Principle of Operation:- It state that Electricallyheated nichrome wire is used as the source of heat. The heat source isimmersed in a pool of water heated to the desired temperature. The current through the resistancewire is continuously increased thus increasing the heat transferred to the water, and further study of convective, nucleate and film boilingregimes, as well as Micro bubble Emission Boiling. The current input and the voltage arerecorded by the VA meter for calculation of boiling parameters.

2. Objectives

The main objective of the current study are analyzed to complete the project are:

1. To study the pool boiling characteristics of water.

2. To enhance the pool boiling using nichrome wire as a heating element.

3. To study the bubble growth of pool boiling.

3. Materails and Methodology

3.1. Materails:-

Power Source, Water heater, Wire mounting arrangement, Water container, Steel shell, Heat exchanger, Submerged water pump, Temperature Controller, Data Recorder.

3.2. Methodology

Literature Survey

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Collection of Materials

⇩

Assembling of Parts

⇩

Conduction of Experiment with Nichrome Wire as a Heating Element

⇩

Optimization

⇩

Cost Analysis

4. Experimental details

1. Heating element Specifications:- The equipment is standardized for the use of Nichrome (80 Nickel 20 Chromium) wire, 0.54 mmdiameter and 95-135 mm long. Thinner wires and wires of other materials may also be used.

2. A suitable length of the resistance wire is taken and it is fixed on ends of the electrode rode, The effective length of the wire between the lugs ismeasured accurately.

3. The connecting flat surfaces from both the leads and the copper shoes are polished to ensure proper electrical contact.then fixed securely to the leads by screws.

4. Nearly 4 liters of distilled water is taken in the beaker. The copper leads, the RTD and theimmersion coils are assembled.

5. The micro SD card is inserted into the VA meter in the slot provided in the front of themeter.

6. The temperature controller is set to the desired level. Voltage is increased continuouslyand slowly. The rate of increase of the voltage depends on the experimental conditions.

7. The SD card from the VA meter is removed and the data transferred to the laptop/PCthrough an SD card reader.

5. Results and Discussions

1) The boiling heat transfer characteristics were enhanced by using of nichrome wire as a heating filament, calculated by using formulas.
2) we ploted some graphs comparison between the platinum wire and nichrome wire results obtained nichrome wire as more resistance then the other wire and constant increased heat transfer coefficient.
3) The enhancement increases with the nichrome wire thickness as to increases, the heat transfer coefficient of water had significant increased.
4) The experimental heat transfer coefficient of water is vary the nichrome wire thickness at different applied heat flux.

5.1 Specimen Calculation:-

- Resistivity of the wire material, ρ = 1.206 E-06 ohm-m,
- Temperature at which resistivity was measured, $T_{Ref:}$ 26 ^{0}C,
- Wire length (L): 0.132 m,
- Wire diameter (D): 0.54E-03 m,
- Water temperature: 60^{0}C.

Tabular Column:-

Sl No.	Current(A)	Voitage(V)
1	0.36	0.29
2	4.30	3.50
3	6.50	5.31
4	7.44	6.08

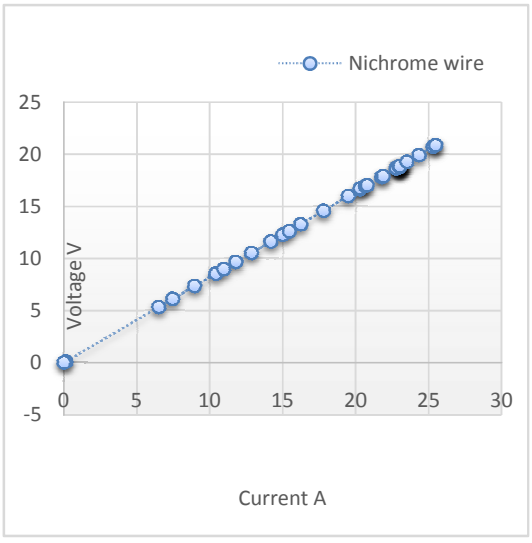
- Power dissipated $P = I^2 * R_{wire}$
  $= (2.0126)^2 * (0.7002)$
  $= 2.8336$ w

- Heat flux rate $q = P/A_s$
  $= (2.8336)/(2.2381E-04)$
  $= 12674$ w/m^2

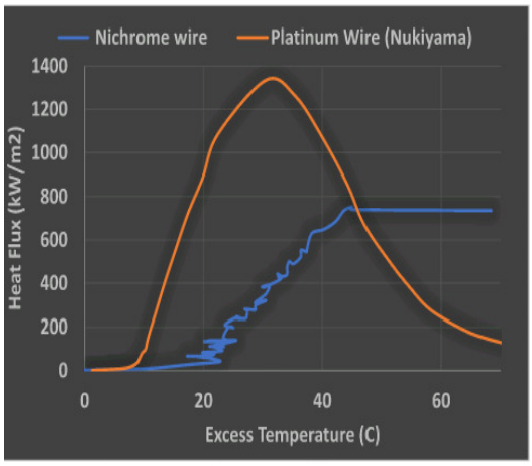
- Heat transfer coefficient
  □ $= q\ (T_{wire} - T_{water})$
  $=12674(76^0-60^0)$
  $= 789$ w/m^{2}K.

5.2 Graphs

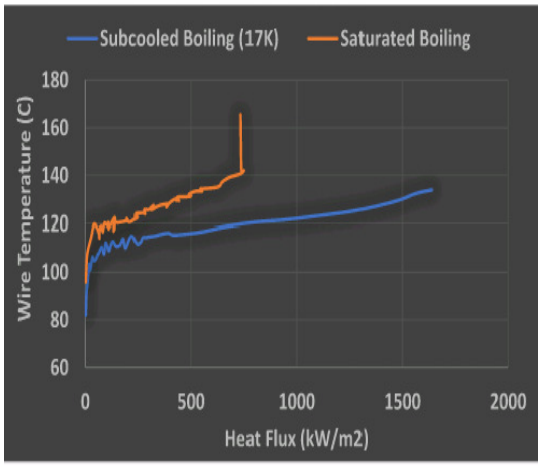
1) Current v/s Voltage Graph



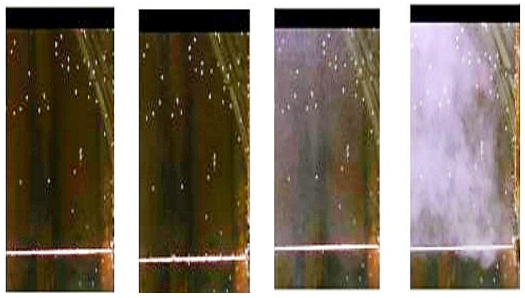
2) saturated pool boiling using nichrome wire compared with that using platinumwire



3) saturated pool boiling using nichrome wire compared with that using platinum wire



- **Bubble growth and detachment of heat transfer in pool boiling**



Natural Nucleate Transition Film

Conclusions

We carried out the literature survey and materials required for the experimental set up. We conducted experiment heat transfer coefficient of pool boiling by using water as a base fluid.

Results obtained improvement in the pool boiling using nichrome wire on the heating element and heat transfer take place to the bubble growth and detachment on the filament on pool boiling.

In this study following conclusion can be drawn:-

i. Heat transfer coefficient should be increased depends on the heating material used and thickness of the wire.

ii. The trend of higher heat transfer coefficients and heat flux is observed in the nichrome wire as heating source.

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