# Experimental study of Condensation Heat Transfer Performance on an outer Super-hydrophobic tube with various materials

Min-Hyeong Lee[a], Hong-Ik Lee[a], Eon-Jong Jung[a], Kwon-Yeong Lee [a*]

[a]*Department of Mechanical and Control Engineering, Handong Global University, Pohang, Korea*

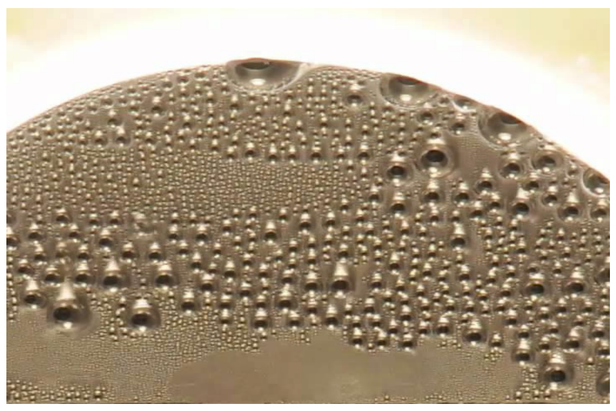
[*]*Corresponding author: kylee@handong.edu*

## 1. Background

### Condensation

Condensation is a natural phenomenon happening when steam hits on a cold plate. It is a widely applied phenomenon in order to cool down heated fluid in various fields of industry such as power plants or boilers. Improvement on condensing efficiency is a direct factor on energy efficiency.

### Type of condensation



**Dropwise condensation**

**Filmwise condensation**

- Water film works as heat resistance which reduces heat transfer efficiency. ***How to maintain dropwise condensation?***

## 2. Problem

### S.A.M (Self Assembled Monolayer)


**Bare Surface** **Super-hydrophobic surface**

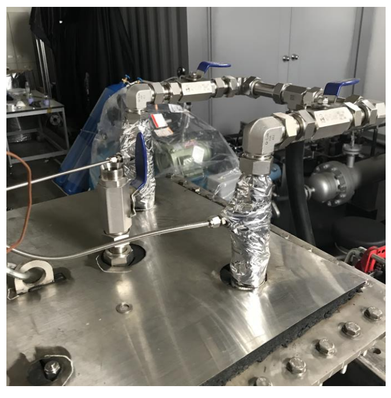
- Figures above show how Micro-Nano structure is formed on the Bare Aluminum plate → **S.A.M coating method**
- **S.A.M** coated surface makes a large contact angle in which makes the detachment of droplets to occur more readily.
- Super-hydrophobic surface techniques for various materials should be developed considering various industrial fields for application
- The condensation performance of such super-hydrophobic surface techniques should be evaluated thoroughly.

## 3. Experiment

### Experimental facility

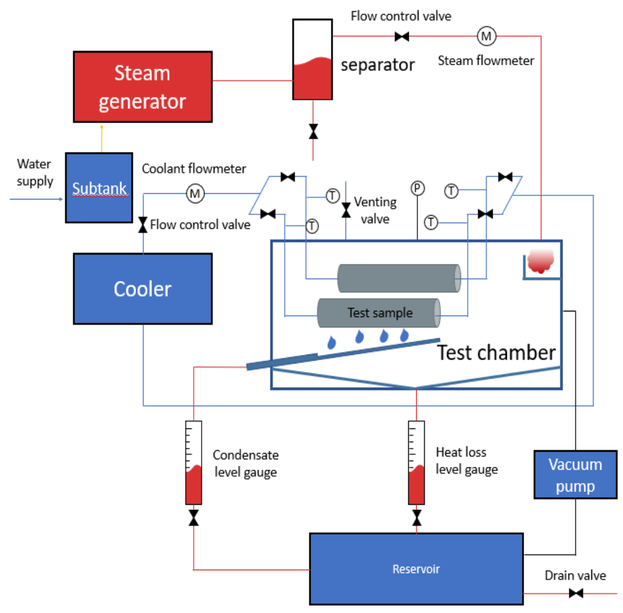
**Chamber**

**Visible acrylic plate**

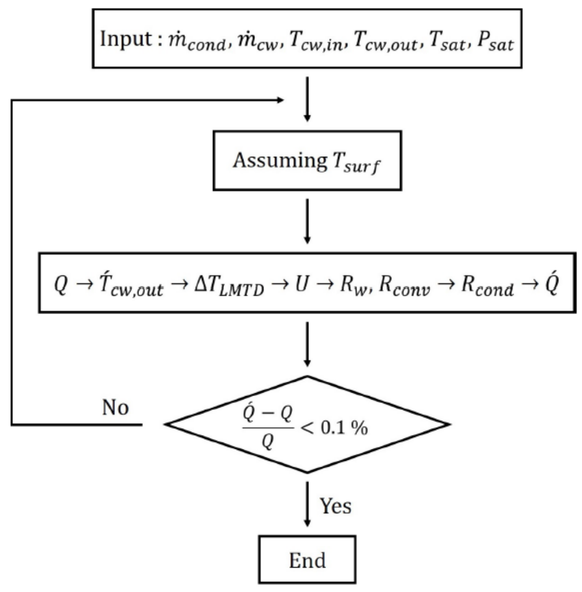


**Thermocouple**

### Strategy

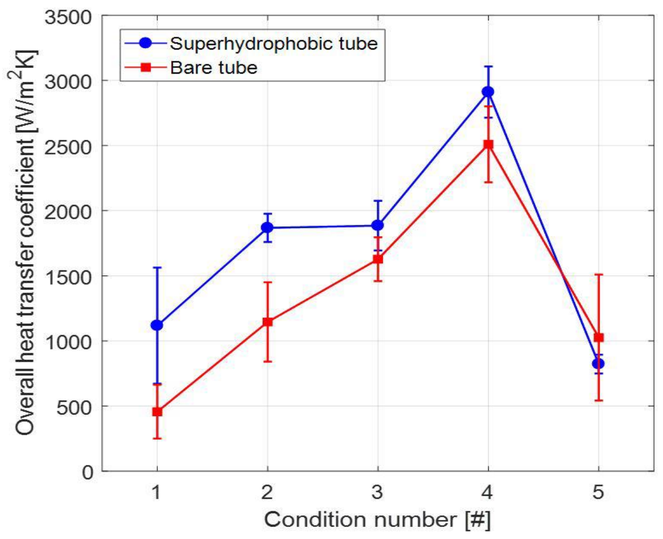



**Schematic diagram**




**Calculation Process**

## 4. Previous study




**Result of Previous study**

**Super-hydrophobic tube** showed better heat transfer performance than **Bare tube**.

Because **S.A.M coated Aluminum tube** maintained dropwise condensation longer.

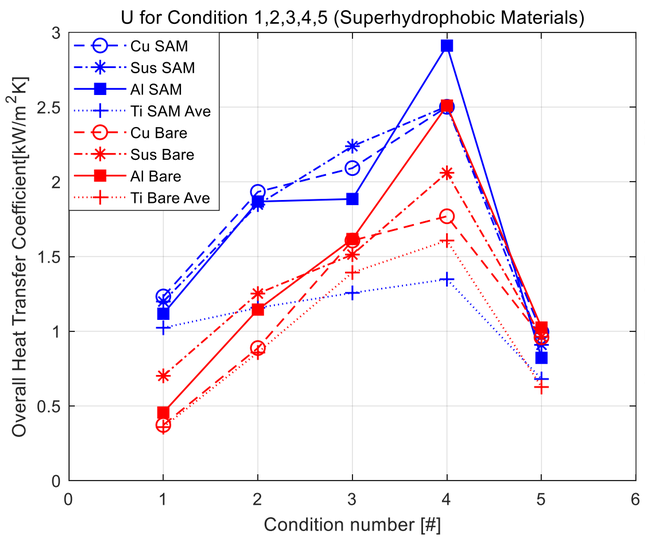
***What will be result for the other materials?***

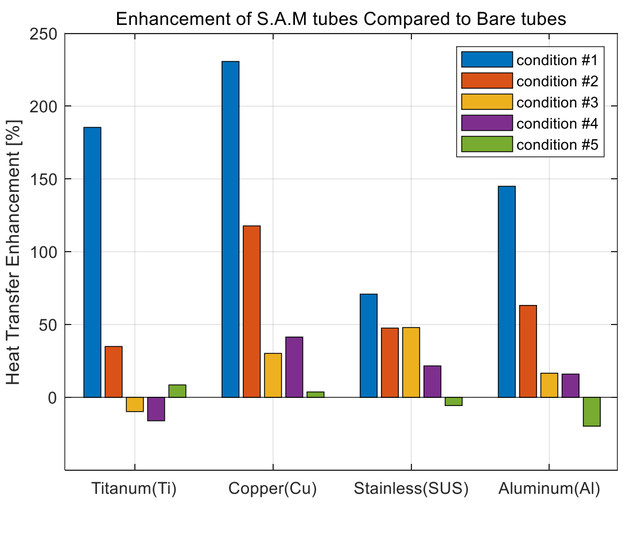
## 5. Result

### Test Matrix

| Saturation pressure \ Coolant flow rate | *Reynolds* number 10,000 | *Reynolds* number 20,000 |
|---|---|---|
| 0.2 bar | Condition #1 | - |
| 0.4 bar | Condition #2 | Condition #5 |
| 0.6 bar | Condition #3 | Condition #4 |

### Enhancement & Conclusion




- At Condition #1, the highest enhancement is shown for all materials. (71 ~ 230[%] )
- From Condition #2 to #4, the enhancement is getting reduced compared to that of Condition #1 for all materials. (37 ~ 117[%])
- At Condition #5, overall heat transfer coefficient decreased drastically due to the effect of attached condensation, resulting almost no enhancement for all materials of S.A.M coated tube.

→ S.A.M Coating can be said to be effective only in Condition #1, #2, and #3 which is considered to be actual condition for an industrial condenser in power plant.