# EXPERIMENTAL INVESTIGATION OF CONDENSATION CONTROL FOR WATER DROPLET ON METAL FLAT SURFACE

Prasarnphun Saisin*, Santi Wangnippanto, Satean Tunyasrirut

*Graduate of Electrical Engineering, Faculty of Science and Technology*
*Pathumwan Institute of Technology, Bangkok 10330, Thailand*

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## ABSTRACT

The water droplets on the surface of the metal machine in industry occur from the change of condensed water vapor lower than dew point. It is one of the major corrosion and rust causes which result in the short circuit of electronical tools and lead to the damage. This study is to conduct the condensation of water vapor in the air on the aluminium surface. To avoid occurring of the water droplets on the surface, the temperature on the surface is controlled by increasing of the heat to the surface. The dimension of surface consists of 7.62 cm width, 11.43 cm length, and 0.50 cm thick. The surface is cooled by feeding the DC voltage at 12volts through two thermoelectric coolers, totally 184 watts. The experimental results show that the dew point temperature in the air at 20 ºC and the temperature on surface at 19 ºC make the occurrence of water droplets within 7 minutes. In addition to more increasing the heat on the surface, the water droplets has finally evaporated away from the surface approximately 7 minutes.

KEYWORDS: *Condensation control; Water droplet; Dew point temperature; Thermoelectric*

* Corresponding authors; e-mail: saisin_p@hotmail.com ,Tel: +668-4028-6923, Fax: +66-4241-2458

## INTRODUCTION

Water droplets on the surface of the metal machine in industry. It arises from the change of condensed water vapor lower than the dew point. This is well-known as one of the most common causes of corrosion, rust, and electric shock. The water droplets formed by condensation of water vapor in the air drip onto the metal surface due to the temperature surrounding the metal surface lower than the dew point. However, because the different surfaces have the different temperature levels. Thus, the amount of dew covering the metal surface in the same area is various. Equivalently, the hot water vapor will absorb the water in the air more than the cool water vapor. When the air is cooled down, the water vapor is unable to absorb the water in the air anymore. Then, the water vapour turns to the droplets in the air, which is called a saturated phenomenon of the air. Such a phenomenon occurring in the surface under conditions of high humidity will cause the deterioration of the insulation and the absence of the water droplets can extend lifespan [1]. The experiment about the present of the water droplets from condensation by using the technique to measure the size of the diameter of the water droplets leads to calculate the angle of the water droplets of various dimensions and the relevant elements [2].

Appropriate modelling for the solution and solving the problem of moisture in the air is very important. The obtained results are presented and shows that applied choices are in how much the right direction is. Being met the properties of the surface by the modelling is very useful for the implementation of closed-loop control point selection of the best work on the environment treatment [3, 4]. Controlling the temperature in the room by proper heating and related operation techniques will be performed together in order to be more effective in control of the humidity [5–7]. Although several researches conducted on the condensation of water by creating the new models, it cannot solve such a type of solution of condensation formed on the unique surface [8].

This study is the experiment in order to test the condensation of water vapor in the air and to avoid the water droplets on the Aluminium surface. The temperature is controlled by increasing the heat to the surface until this can reduce the damage resulted from the condensation of water vapor in the air of the industrial mechanical equipment.

## MATERIALS AND METHODS

*Preparation Material*

The materials for this study consist of as follows:

1. Aluminium plate with size width 7.62 cm, length 11.43 cm, thick 0.50 cm and the constructed surface of the Aluminium as the lightweight substance that effectively conducts heat to the surface heat are shown in Fig.1

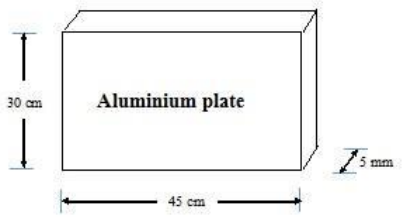


**Fig.1** Dimension of Plate.

2. Thermoelectric device has the size 92 watts 12 volts. The special properties of this material can transform the heat energy into electricity and then electricity transformed to the cool by the vibration principle of the internal structure of the solid material. Thermoelectric in terms of quantum physics called phonon, Electron and hole. When the thermoelectric material has high different temperatures, it is transferred to a lower temperature. That is movement of electrons and hole, it will generate the electric which leads to the electric power generator and refrigerator as shown in Fig. 2.

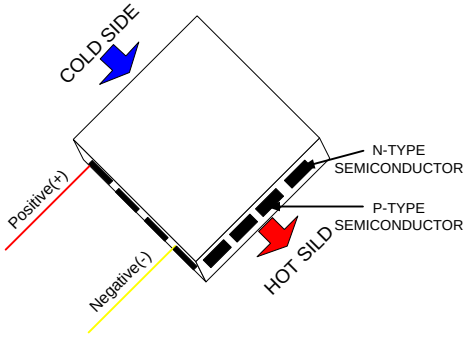


**Fig. 2** Component of Thermoelectric device.

3. Fin heat sink and the cooling fan with size 12 volts are the equipment of conductor and convector the heat, respectively, in order to lead the high heat source to the low heat source. The fin heat sink is made from copper, Aluminium, and mixture of copper and Aluminium. It is designed with fin depending on the usage and the efficient characteristics that specify the direction of cooling and the exposure area of cooling plate. Most structure of fin heat sink usually composes of fan as the blower to cool from the cooling plate.

4. Thermocouple is a device used to measure temperature by transformation the temperature or heat to the voltage. Thermocouple is made from two different types of metal conductors, which are different in the atomic structure. The main components in thermocouple are connected with each ends together. One end is called thermometer point and the other end is called reference point. If the thermometer point value and the reference point value are different a lot, the current is inducted at the both ends as shown in Fig. 3

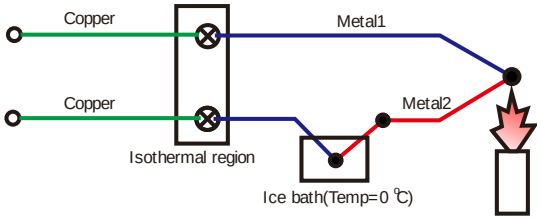


**Fig. 3** Thermocouple circuit.

5. Heater or resistance wire is a wire made from the alloy made the thin wire and it has a high resistance. For example, Nichrome wire, an alloy of Nickel and Chromium, is a resistance wire. The electric current flows through the wire causing more heat. This produces the more heat. Finally, the power supply of 12 volts supplies the current with maximum, 30 amps. This power supply is employed for feeding the thermoelectric plate.

*Preparation of the Laboratory*

For preparation of laboratory, all materials are composed and designed circuit are made for studying the behavior of the water droplets on the specimen and controlling the occurrence of water droplets on Aluminium surface as shown in Fig. 4.

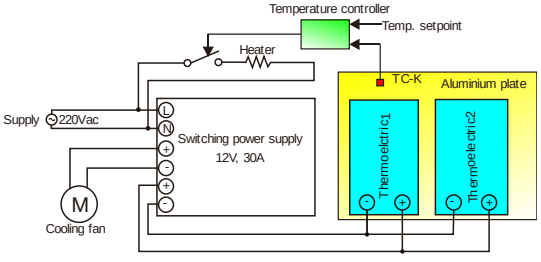


**Fig. 4** schematic diagram for experiment.

*Method of Experimental*

12 volts DC power was applied through the semiconductor type: n-type and p-type, the thermoelectric device. One of the thermoelectric device sides would be cool and another side of the plate would be hot. Cool thermoelectric device side would attach to aluminium surface. This made the aluminium surface cool and a cause of condensation to be the water droplets on the surface. However, the controller could get rid of the water droplets on the surface as shown in Fig. 5

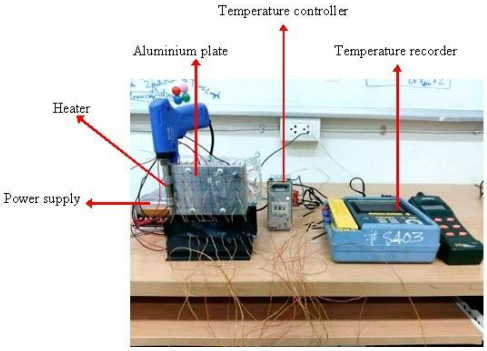


**Fig. 5** Experimental setup.

## RESULTS AND DISCUSSION

These experiments have tested and investigated of condensation control for water droplet on metal flat surface. The results of this research are as follows :

*Phenomena droplets on the metal surface*

This experiment is to test the condensation of water vapour in the air on the metal surface. The temperature was controlled by increasing the heat to the metal surface. The structure of metal surface is an aluminium with width, length, and thick: 7.62 cm, 11.43 cm, 0.50 cm, respectively. The metal surface was fed the DC power with 12 volts through 2 thermoelectric plates, totally 184 watts. The findings from the experiment indicate that the temperature at dew point in the air is 20 ºC and the temperature on the surface is 19 ºC. These temperatures make the water droplets spreading on the surface within 7 minutes as shown in Fig. 6 Then, more increasing the temperature to the surface and controlling the temperature over the temperature at the dew point was conducted. Finally, the water droplets were vanish from the surface starting at the sub-surface nearby equipment for controlling the heat within 7 minutes as shown in Fig.7–8.

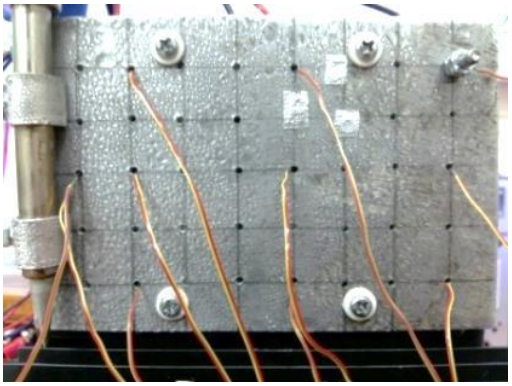

**Fig. 6** Drops occur across the surface.

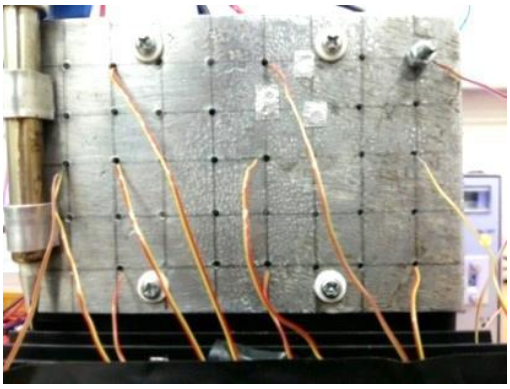

**Fig. 7** Droplets begin to disappear.

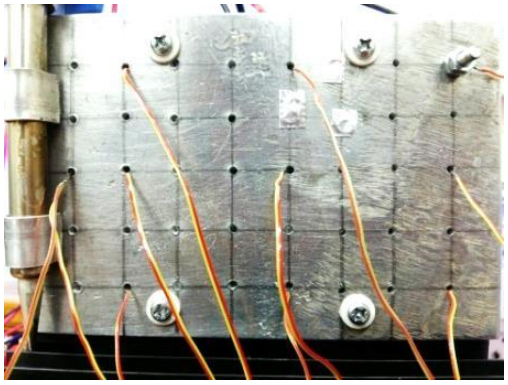

**Fig. 8** Droplets disappeared.

*Temperature control on the metal surface*

At the dew point temperature 20 °C, Fig. 9 shows the temperature control on the surface while setting the temperature setpoint at 19 °C and 21 °C in order to built and eliminate the droplets on the surface respectively.

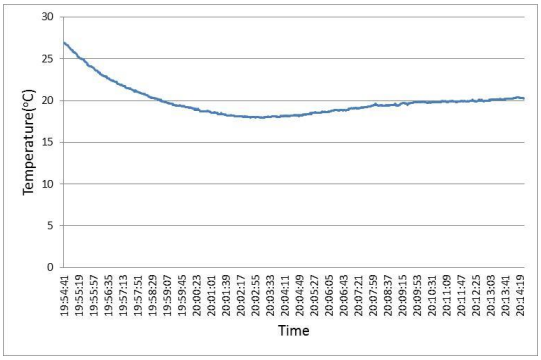


Fig. 9 The surface temperature control at temperature set point 19 ºC and 21 ºC.

## CONCLUSION

In this paper, it is to study the experiment of droplet condensation and prevent the droplet on the metal surface. The dew point temperature is investigated then the droplet on the metal surface can be controlled. If the temperature of metal surface is less than dew point temperature about 1 ºC then droplet is occurred. Otherwise, the surface temperature is higher than 1 ºC such that droplet is eliminated. This experiment can conduct droplet on the metal surface, effectively. In the future study, it will study the intelligence controller by dew point sensor. It can adjust the surface temperature robustness to occur or not following the desired condition.

## ACKNOWLEDGEMENTS

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