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Experimental study on the frost characteristics on aluminum flat plate under various environmental parameter conditions

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Extended Abstract

Water vapor in the air meets a cold surface below the dew point to form frost. Frost interferes with the air flow in the air source heat pump and acts as thermal resistance. Frost formation leads to performance degradation and increases in system energy consumption and operating costs. In this study, the effect of various environmental parameters on the frost formation characteristics on an aluminium plate is investigated. Frost formation characteristics including frost thickness, frost growth velocity, and frost density are measured according to ambient temperature, humidity, and surface temperature. The experiments are conducted in a wind tunnel installed inside a psychrometric chamber to control the environmental parameters. Additionally, a test section is installed inside the wind tunnel.

Air velocity has little effect on frost formation characteristics. This is because the Reynolds number converted to the tested air velocity is over 10000. The effect of air velocity is ignored when the Reynolds number is over 10000 [1]. Relative humidity has an influence on frost characteristics. As the relative humidity increases, the absolute humidity of air increases, accordingly, the frost thickness becomes thick. Furthermore, ambient temperature affects the frost characteristics. The higher the ambient temperature under the same relative humidity, the higher the absolute humidity, resulting in a thicker the frost thickness. The frost thickness grows very slowly when the thickness reaches a certain value. This is because the frost growth period is shifted from the frost thickness growth period to the density growth period. In the density growth period, the upper part of the frost melts, and the melted water enters the frost layer to form frost, and the density increases owing to the high ambient temperature. The surface temperature has a great influence on the frost characteristics. The lower the surface temperature, the thicker the frost thickness and the faster the frost growth velocity. The low surface temperature lowers the ambient temperature, resulting in a very low saturation vapor pressure. Thus, the condensation process does not appear, and the desublimation process appears actively. Accordingly, the lower the surface temperature, the higher the frost thickness. On the other hand, the frost density decreases as the surface temperature is low. This is because the frost grows more porous at lower temperatures.

The effect of air velocity on the frost characteristics is insignificant. Additionally, the thickness of frost appears thicker as the relative humidity and the ambient temperature increase, and the surface temperature decreases. The frost density increases as the ambient temperature and the surface temperature increase. The surface temperature has the greatest effect on frost formation compared with the other parameters.

References

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