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Development of Outside Heat Exchanger with Defrost Function using Heat Transport Structure

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To comply with increasing environmental regulations in recent years, the development and market introduction of electric vehicles is accelerating. Since the only energy source for electric vehicles is the electricity stored in the batteries, power is supplied from the same batteries for air conditioning as well as running, so energy-saving performance is required more than ever. As a countermeasure, vehicle manufacturers have adopted highly efficient heat pump air conditioners that can absorb heat from the outside air to improve heating efficiency in winter. However, one of the problems with heat pump air conditioners is the formation of frost on the outside heat exchanger. The frost formation is a phenomenon that occurs in a low air temperature environment. The frost formation increases with operating time, and eventually covers the outside heat exchanger, leading to the stoppage of the heat pump operation. Residential heat pump defost operation periodically by reversing the direction of refrigerant flow to warm the outside heat exchanger. but vehicles require constant heating capacity. Therefore,An electric heater is used to cover for the lack of heating when frost forms, but it consumes electrical energy, which reduces the cruising range. Due to solbe the issue, we developed a heat exchanger with a new structure that has the function of defrost and recovering the absorb performance.(Fig1) There are two points to solve the issue: (1) a defrosting function that utilizes the waste heat of electric devices in the circuit, and (2) a drainage function of the water generated by defrosting. Details are shown below.

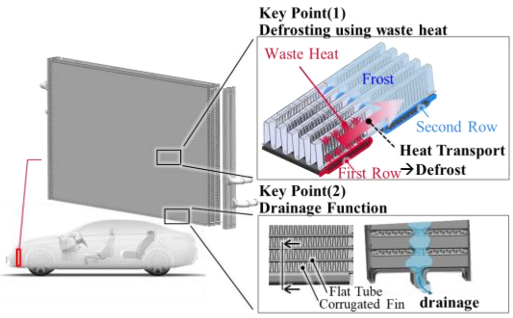

Fig1.Structure of Heat Exchanger and Installation Position

(1) Defrosting Function using Waste Heat

The unique structure of the developed product consists of two rows tubes through which cooling water flows, which are connected by fins. The water with waste heat stored in the first row of circuits and the second row of air conditioning circuits are connected by fins to defrost by heat conduction. Therefore, We designed a heat transfer part that exchanges heat with the air side and a heat conduction part that exchanges heat between two row tubes. The heat conduction is determined by the fin cross-sectional area (A) and tube distance (L). It is ideal to reduce L to increase heat conduction, but as a trade-off, heat conduction occurs in heat radiation scenes when heat conduction is unnecessary. We defined the limit value of (L) to maximized the amount of heat transfer to achieve efficient defrosting. (Fig.2)

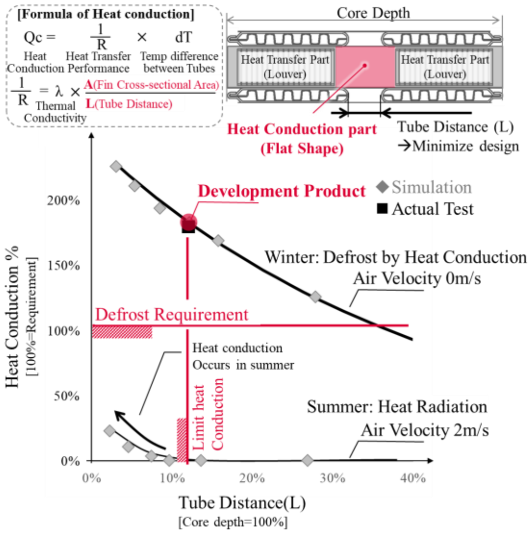

Fig2. Design of Thermal Conduction Fin

(2) Drainage Function

Compared to residential air conditioners, the space available for installation in a vehicle is limited, so we designed a combination of corrugated fins that enable the realization of a compact, thin heat exchanger, and flat tubes that secure a heat transfer area with the fins. However, since it is a flat tube, there is a problem of retaining water between the fins. Using the characteristic two row tubes, the gap between the two rows was used as a drainage path. We designed drainage slits to fins and plate that makes gravity greater than surface tension. (Fig.3)

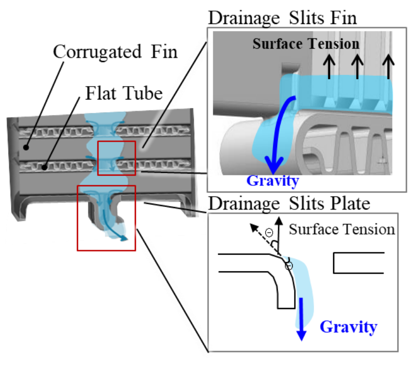

Fig3. Drainage Structure

As a result of (1) and (2), the heat absorption performance after defrosting can be recovered quickly, and the heat pump operating range can be drastically increased even in a frosty environment in winter. Mass production of this product will start in April 2022. We believe that this product will contribute to the spread of electric vehicles in the market.

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