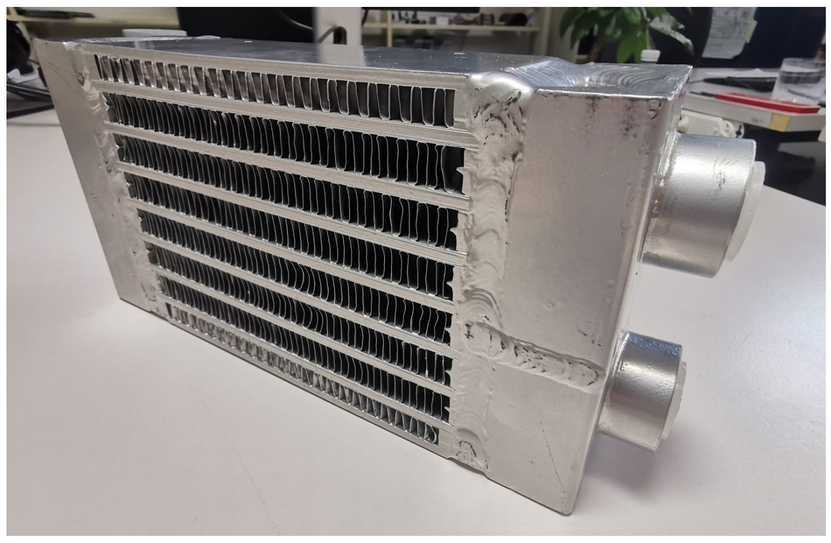
HSLU Hochschule Luzern

Technik & Architektur
Maschinenbau

Master-Thesis Studiengang

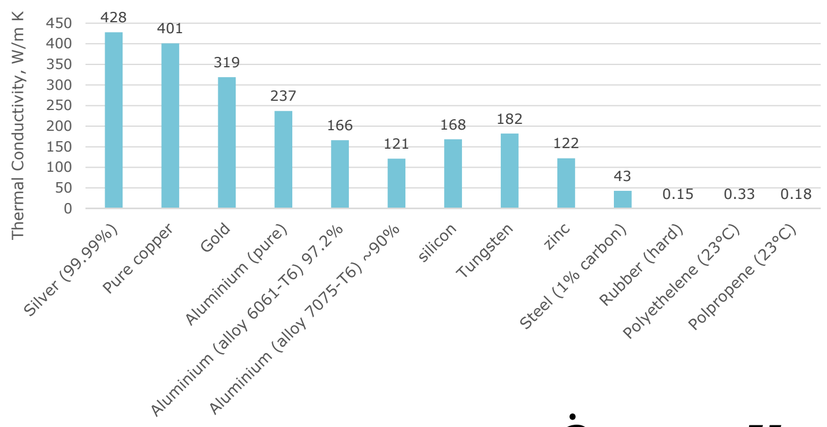
Design and analysis of 3D-printed Air-cooled heat exchangers

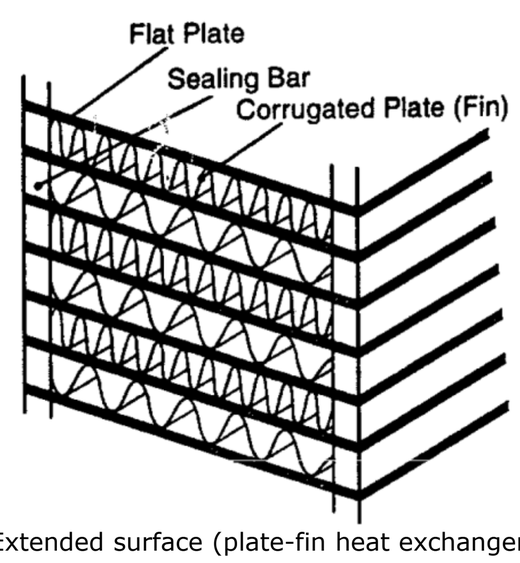
© Heat exchanger from Rigi Kühler



The Rigi Kühler AG heat exchanger (left) can be classified as a recuperator, with indirect contact between the two fluids that in our case are water and air, with extended surface (plate-fin heat exchanger), in cross flow disposition with forced convection of air.

Aluminium is chosen as the material due to its good thermal conductivity and relatively cheap price

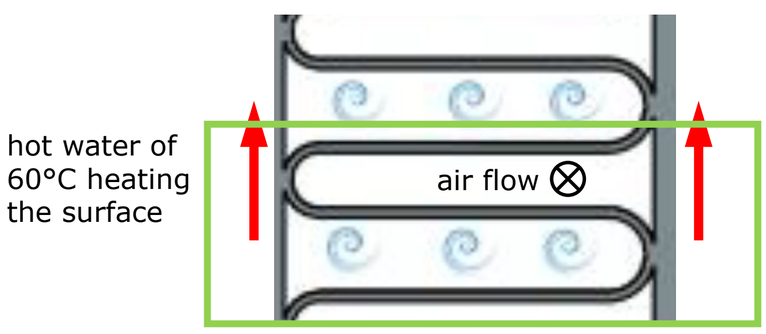




Extended surface (plate-fin heat exchanger)

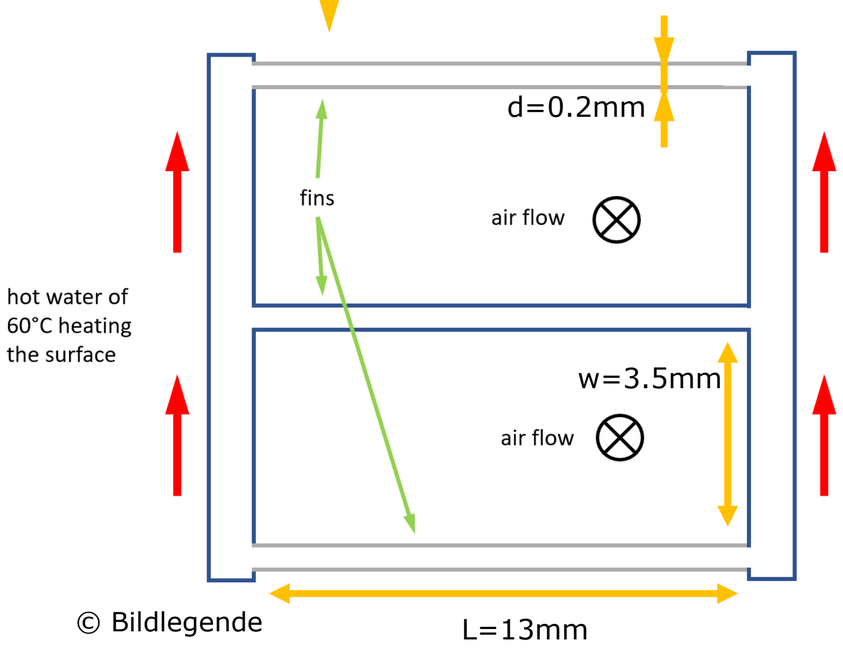
© **S. Kakaç, H. Liu, and A. Pramuanjaroenkij**, *Heat Exchangers*, 0 ed. CRC Press, 2002. doi: 10.1201/9781420053746.

The idea is to improve the design from Rigi Kühler. Before any potential design, however, it is needed to study the phenomenon occurring in this type of heat exchanger and to analyse them to see how certain aspects influence the heat transfer. Below is the zoom on the fins of the heat exchanger:



simplification

For simplification, the standard rectangular design below was taken in consideration for the analyses



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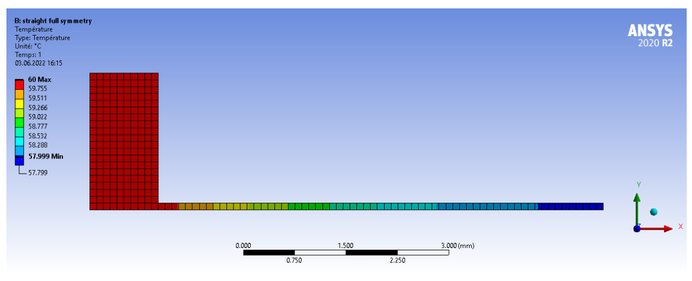
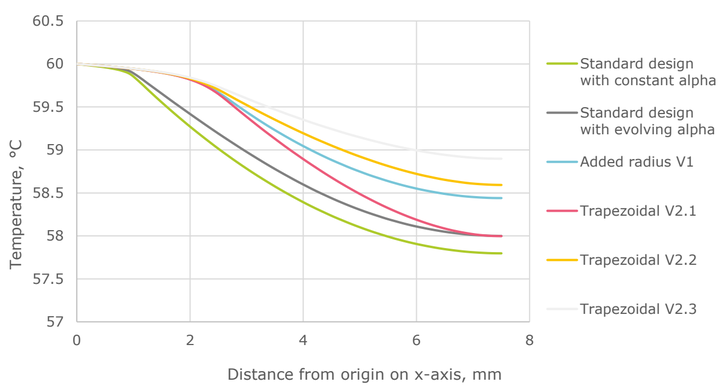
$$\dot{Q} = \alpha \cdot U \cdot \Delta T$$

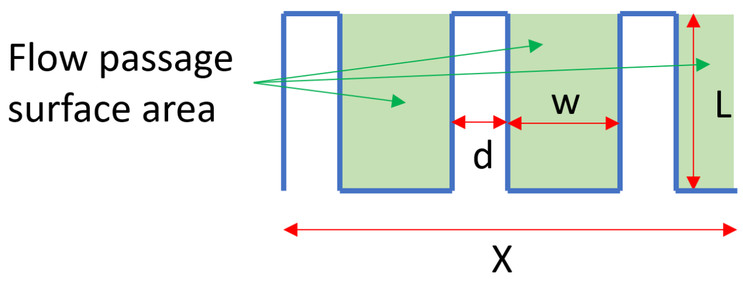
From this heat transfer equation, each of the three aspects were analysed



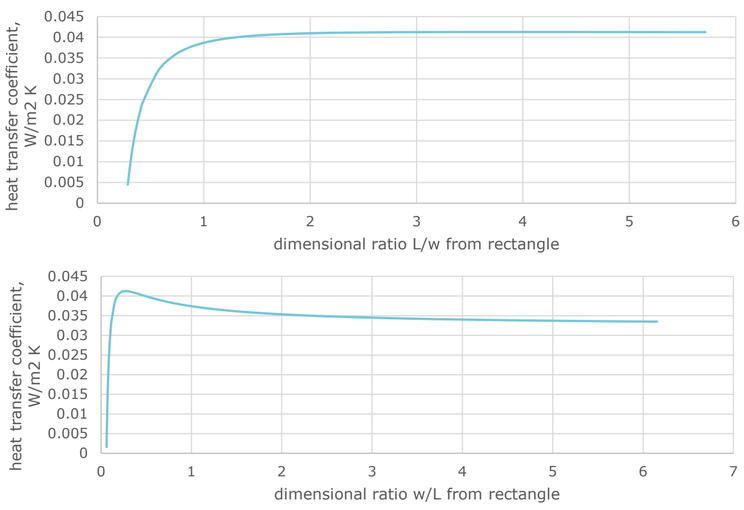
Taking care of the temperature difference ΔT
It was found that, for such small dimensions, a change in design would not increase the efficiency much since the standard design above matched efficiencies of 97%.



Taking care of the surface U
It was shown that a small reduction in space between fins would increase a lot the surface area of the fins but not reduce the flow passage surface area.



Taking care of the heat transfer coefficient α
It was analysed how changes in design would affect the heat transfer coefficient. A small change in either dimensions a or b would not have great consequences on the heat transfer coefficient for ratios over 1. These numbers, however, need to be considered with precaution since the value of heat transfer is extremely small. This might be due to the consideration of friction coefficient.



Problemstellung

In the context of use of the potential of Additive Manufacturing (AM) for design improvement of heat exchangers with better efficiency, this paper presents the base literature review concerning the liquid to gas heat exchangers linked to the context and use of the one studied. The goal is to identify the governing aspects that influence most of the heat transfer which is the first step towards optimisation and potential future new designs

Lösungskonzept

To achieve this, the heat transfer equation ($\dot{Q} = \alpha \cdot U \cdot \Delta T$) was taken into consideration and its components, the heat transfer coefficient α, the surface U and the temperature difference ΔT, were independently analysed in link with the context and quantified to have an idea of their influence. The results show that the fins already have a very good efficiency, but some improvements in the design, as the increase of surface area by decreasing the distance between fins, could significantly increase the heat flow.

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FH Zentralschweiz

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