CuproBraze® Heat Exchanger Technology

EXECUTIVE REPORT

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*Cu*proBraze® radiators: Reduction of fan power in comparison to plate and bar type aluminum heat exchangers

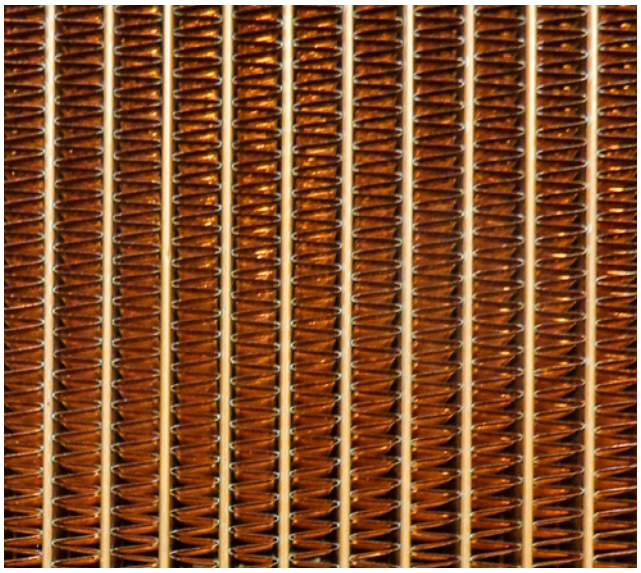

Plate and bar type aluminum heat exchangers are popular in many heavy-duty applications. The disadvantage of them is the high pressure drop of the core due to thick materials, requiring a lot of fan power to pull the air through. The fan power is directly related to the fuel consumption of the vehicle. Therefore, it is interesting to look at optional solutions to reduce the fuel consumption and operational costs. This case study shows that with a *Cu*proBraze® radiator with equal thermal performance, the fan power can be reduced by two-thirds. Isn't that interesting enough to look into more details?

*Image 1. Extremely high tensile strength of the Cu*proBraze® *base materials and brazed joints enables to utilize efficient tube-to-fin core configuration also for demanding industrial and off-highway applications.*

Constructional comparison of an aluminum radiator with a *Cu*proBraze® radiator

This case study describes the difference in performance of a plate and bar type aluminum radiator compared to a *Cu*proBraze® copper/brass radiator. The aluminum radiator is a representative commercial one from the market. It was tested in the calorimetric rig at the Aurubis Technical Center in Sweden for reference. The *Cu*proBraze® radiator was designed and built at the same center to match the thermal performance of the aluminum counterpart. The comparison of constructional data is shown in table 1.

Characteristics	Aluminum	*Cu*proBraze®
Construction materials	Aluminum	Copper and brass
Core length (mm)	450	499
Core width (mm)	470	500
Type of tubes	Plate and bar	Flat (brass)
Quantity of tube rows	1	5
Quantity of tubes per row	35	54
Tube width (mm)	63.5	16
Tube height (mm)	4.15	1.3
Type of fins	Bumper	Square wave (copper)
Fin width (mm)	63.1	97
Fin height (mm)	9	7.8
Fin thickness (mm)	0.2	0.05

Table 1. Constructional comparison of radiators.

The *Cu*proBraze® radiator was also tested in a calorimetric test rig to validate the thermal performance and air pressure drop. The comparison of the thermal characteristics of the two radiators is shown in figure 2.

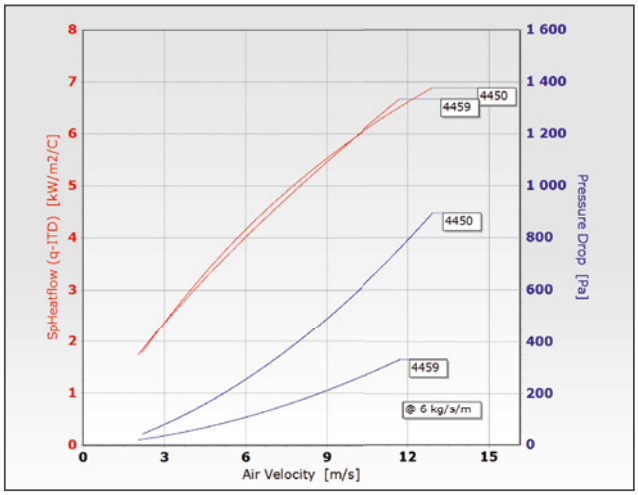

Figure 2. Wind tunnel curves.

Figure 2. Calorimetric test comparison. Test # 4450 refers to the aluminum radiator and test # 4459 to the *Cu*proBraze® radiator. The upper (red) curves show the specific heat flow (scale on the left axis), also called specific heat exchange.

The lower (blue) curves show the air pressure drop (scale on the right axis). It is apparent that the thermal performance of the two radiators is practically identical, which was the design basis. However, there are big differences in the pressure drops which tend to favor *Cu*proBraze®.

The thermal performance and pressure drop results are summarized in table 2 at an air velocity of 8 m/s and a water flow of 6 kg/s m.

The results in table 2 show that the the aluminum plate and bar type heat exchanger has more than double the air side pressure drop compared with *Cu*proBraze® of equal thermal performance. This conclusion gives the engineer designing the cooling system a huge amount of freedom.

Assuming a fan with 100 % efficiency, the *Cu*proBraze® radiator would save more than 50 % fan energy compared to the aluminum radiator.

Characteristics	Unit	Aluminum	*Cu*proBraze®
Specific heat flow (q-ITD)	kW/m2 oC	5.12	5.01
Air pressure drop	Pa	404	173

Table 2. Summary of calorimetric test results at air velocity of 8 m/s and water flow of 6 kg/s m.

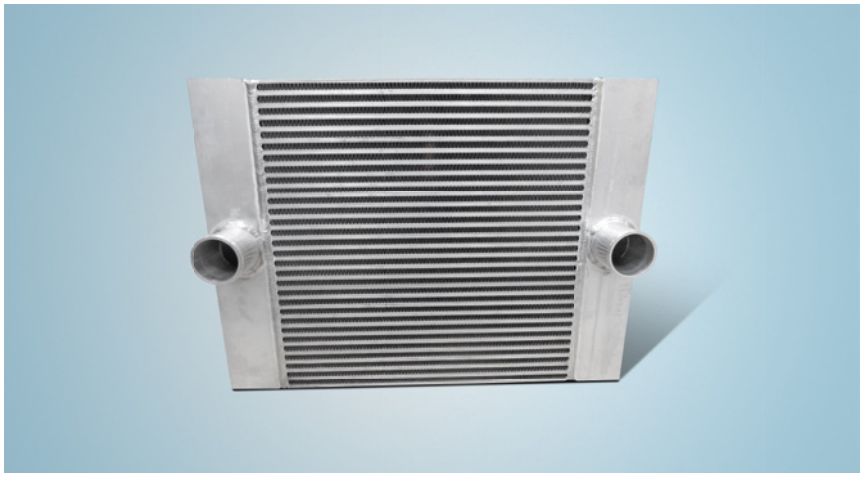

Image 2. Plate and bar aluminum core design is suitable for hard working conditions and offers resistance to mechanical and thermal loads with very wide dimensional range. Negative feature is requirement for thicker base materials influencing pressure drop and thermal performance.

TEST WITH FAN

To approach the difference in real applications, the radiators were mounted in a test rig with an ordinary fan. The heat exchange was measured at different fan speeds (RPM, revolutions per minute). The results are shown in table 3.

Characteristics	Unit	Aluminum	*Cu*proBraze®	*Cu*proBraze®
Water mass flow	kg/s	2.78	2.78	2.78
Specific heat flow	kW/m2 oC	0.76	0.76	1.02
Fan speed	RPM	1400	930	1400
Fan power	W	859	265	757

Table 3. Test results in test rig with fan.

As can be seen from the results, the *Cu*proBraze® radiator consumes only one-third of the fan power of the aluminum radiator to dissipate an equal amount of heat. When the same fan speed was applied for both types of radiators, *Cu*proBraze® dissipated 30 % more heat, still using 12 % less fan power.

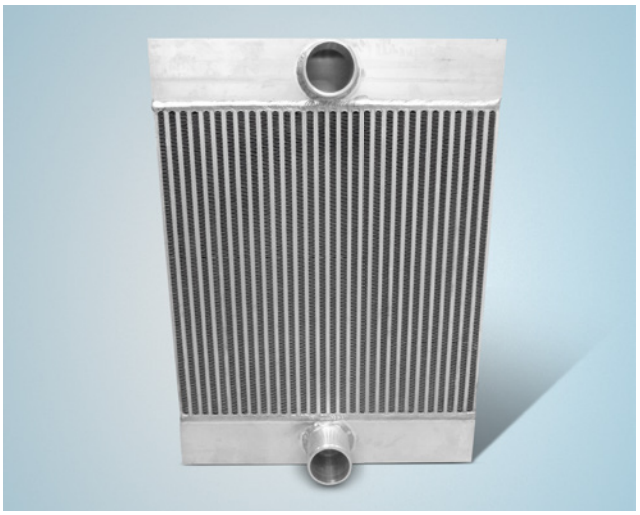

Image 3. Plate and bar cooler core consist of internal and external fin patterns which are laid between aluminum braze sheets and fitted with header and face bars. Core is then brazed either under vacuum or protective atmosphere.

Based on the tests at the Aurubis Technical Center, *Cu*proBraze® square wave fin radiators can save you a significant amount of fuel compared to plate and bar type aluminum radiators:

1. The calorimetric test showed that, assuming a fan with 100 % efficiency, the *Cu*proBraze® radiator would save more than 50 % fan energy compared to the aluminum radiator.
2. Additional tests with fans showed that the *Cu*proBraze® radiator consumes only one-third of the fan power of the aluminum radiator to dissipate an equal amount of heat.
3. When equal fan speed was applied for both types of radiators, *Cu*proBraze® dissipated 30 % more heat, still using 12 % less fan power.

Don't spend more than you have to – there are good reasons to try *Cu*proBraze® next time.

References

Aurubis, *Cu*proBraze® Alliance

Feedback on this article

*Cu*proBraze® Alliance,
Juho Partanen, MD

More information on copper and *Cu*proBraze®

www.cuprobraze.com, www.aurubis.com