Research on durable junction of multimaterials

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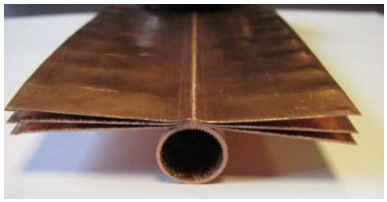
Introduction

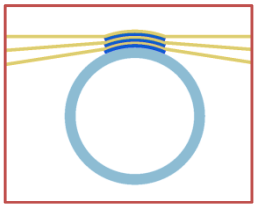
This collective project aimed to assess the potential of adhesive bonding in various applications in the field of building construction. This evaluation takes into account technical, economical and ecological aspects and provides a methodology that can be easily transferred to other applications.

Goal

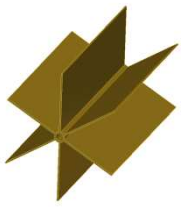
Investigate alternatives to welded solutions currently used in heat exchangers



Welded copper heat exchanger



Bonded copper blades and tube



Extruded Aluminium profiles

Influence of the geometry of an exchanger on its energetic performance

The energetic performances are compared through a finite elements analysis. The amount of heat exchanged by 250mm tube is calculated by taking as initial conditions an outside air temperature of 10 °C and a liquid refrigerant R123 entering the exchanger at a temperature of -10 °C, at a pressure of 2 bar at a flow rate of 1g/sec.

Solution	**Heat exchange/250mm(W)**	**Tube length required for equivalent heat exchange that a 250mm welded copper tube**
Welded copper blades and tube	5,3	250
Bonded copper blades and tube	5,2	254
Extruded Aluminium profile	10,4	127,4

Influence of the geometry of an exchanger on its ecological performance

Introduction of this geometrical data, used materials and methods of machining and assembly in Granta Eco-design software allows to reveal differences in performance and CO_2 emissions associated with changing materials and geometry of the heat exchanger.

	Welded copper blades		**Bonded copper blades**		**Extruded aluminium profile**	
	Energy(MJ)	CO2 (kg)	Energy MJ	CO2 (kg)	Energy MJ	CO2 (kg)
Material energy	12,4	0.768	12,6	0,783	38.5	2.36
Assembly energy	1,44	0.105	0.878	0,0685	2.53	0.192
Recycling energy	9,55	0.547	9.73	0.557	31.9	1.84
TOTAL	**4.29 MJ**	**0.326 kg**	**3,748 MJ**	**0,2945 kg**	**9,13 MJ**	**0,712 kg**

Influence of the geometry of an exchanger on its economical performance

A software is developed to evaluate and compare the production costs of these different configurations including the material and manufacturing costs. The economic aspect is particularly interesting for this application as the welded solution required rare soldering skills and is thus very expensive.
Bonded solution decreases significantly the assembly cost of the heat exchanger.
Extruded aluminum profile solution modifies strongly the structure of the costs because of the fundamental change in the manufacturing process and also because aluminum is cheaper and lighter than copper.

Conclusions

The application of this three steps procedure and the use of GRANTA ECO-design software promote the adoption of this evaluation process by the industrial sector.
The University of Liege students, in the Materials selection course, must achieve a research work that is to select materials (or justify their use) in specific applications. Their analysis is based on the ASHBY performance index or on the GRANTA ECO-design software database. The heat exchanger case study will illustrate the course to help students to adopt this holistic approach in their decision making.