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INTEGRATION OF TALUM'S ROLL-BOND HEAT EXCHANGER FOR DIFFERENT APPLICATIONS

INTEGRACIJA TALUMOVIH TOPLOTNIH PRENOSNIKOV, IZDELANIH PO POSTOPKU PLATINIRANEGA VALJANJA ZA RAZLIČNE APLIKACIJE

Janko Ferčec[1✉], Rajko Habjanič[1]

Keywords: Talum, Roll-bond, Heat exchanger, Evaporator, Absorber

Abstract

This article presents the integration of heat exchangers made using the roll-bond technology of Talum d.d., Kidričevo, Slovenia, to applications in refrigeration and heating technology. Talum has more than 30 years of tradition in the production of evaporators for cooling technology and heat exchangers for various purposes, such as absorbers and condensers. The heat exchangers produced in Talum are made of aluminium or aluminium alloys and are categorized as flat heat exchangers. Aluminium and aluminium alloys can be completely recycled after they reach the final phase of their life cycle, which is an essential feature in terms of sustainable construction. The roll-bond technology enables the manufacture of heat exchangers with a complex geometry of channels, which enables them to be used for various applications. Enabled through roll-bond technology, all of these features give the roll-bond heat exchanger a very useful and functional value. In this article, we focused only on some implemented and potential applications of heat exchangers made with using the roll-bond technology.

✉ Corresponding author: Janko Ferčec, Address, Tel.: +386 2 7995 589, E-mail address: janko.fercec@talum.si

[1] TALUM d.d. Kidričevo, Tovarniška cesta 10, 2325 Kidričevo

Povzetek

Članek predstavlja integracijo toplotnih prenosnikov izdelanih s tehnologijo platiniranega valjanja v podjetju Talum d.d. Kidričevo v nekatere aplikacije na področju hladilne in toplotne tehnike. Podjetje Talum ima več kot 30-letno tradicijo izdelave uparjalnikov za hladilno tehniko in toplotnih prenosnikov za različne namene kot so absorberji in kondenzatorji. Toplotni prenosniki, ki se proizvajajo v Talumu so izdelani iz aluminija oziroma aluminijeve zlitine in spadajo med ploščate toplotne prenosnike. Aluminij in aluminijeve zlitine je mogoče popolnoma reciklirati po izteku življenjskega cikla izdelka, kar je z vidika trajnostne gradnje pomembna lastnost. Tehnologija platiniranega valjanja omogoča izdelavo toplotnih prenosnikov s kompleksno geometrijo kanalov, kar omogoča izdelavo toplotnih prenosnikov za različne aplikacije. Vse te lastnosti, ki jih omogoča tehnologija platiniranega valjanja dajejo toplotnim prenosnikom veliko uporabno in funkcionalno vrednost. V članku smo se osredotočili le na nekatere implementirane in potencialne aplikacije toplotnih prenosnikov izdelanih s tehnologijo platiniranega valjanja.

1 INTRODUCTION

The company Talum, d.d. from Kidričevo, Slovenia was established in 1954 when the first aluminium was produced. Since then, Talum has been producing primary aluminium and different semi-products and final products from aluminium and aluminium alloys using different production technologies. Talum offers to its customers support in the development of processes, as well as support in the development of products for projects, *[1].*

In 1981, Talum started with the production of wide aluminium strips, which are a semi-finished product for manufacturing evaporators. Regular production of evaporators started in 1982. Since then, Talum has been producing evaporators for refrigerators and other heat exchangers for different applications of solar and heating techniques, *[1].*

The production of roll-bond plates for heat exchangers and evaporators is a continuous process consisting of several phases. The starting material for roll-bond heat exchangers is two sheets in coils, which are bonded together in a rolling mill under elevated temperature and high deformation. The next phase is recrystallization annealing in a furnace to reduce the strength of the material, which is necessary for the next phase. This phase is followed by the phase of the inflation of imprinted channels on a hydraulic press machine. The last phase of production of a roll-bond heat exchanger is cutting or stamping the plates in their final dimensions, *[2,3].*

Roll-bond technology or roll-bond plates are widely used as evaporators for refrigeration. For the past decade, it has also been popular in other applications, such as cooling plates for photovoltaic thermal (PVT) panels. In addition, it can be used in integrating roll-bond plates into other systems, such as battery cooling plates in battery modules, waste heat absorbers, and condensers, *[4].*

This paper focuses on Talum's research and development of roll-bond heat exchangers and introduces some examples of integration. The paper provides basic information on Talum's roll-bond technology and potential uses of roll-bond plates since the roll-bond technology shows potential in buildings for the heating and cooling industries.

2 TYPES OF ROLL-BOND PLATE HEAT EXCHANGER

Talum produces two different types of roll-bond heat exchanger according to the shape of channel. The first type is a double side (DS) inflated roll-bond plate (Figure 1) and the second is roll-bond plate inflated on one side (one side flat (OSF)) (Figure 2). The dimension of the cross section channel is standardized. Modification of the cross-section is limited by the formabilit properties of the material used for the heat exchanger.

LEGEND:

A = width of the channel or capillary

H = height of the channel or capillary

O^{+3} = width allowed on flat part of the channel

3$^{\pm 1}$ = width allowed on flat part of the channel

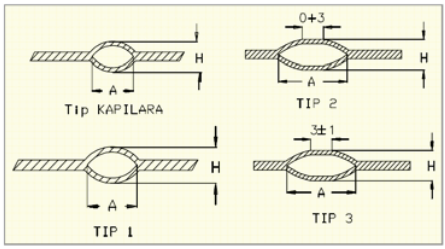

Figure 1: *Double side inflated roll-bond plate, [1]*

LEGEND:

D = thickness of the panel

H = height of channel, height of capillary

A = width of the channels, capillary

O^{+4} = width allowed on flat part of the channel

3$^{\pm 2}$ = width allowed on flat part of the channel

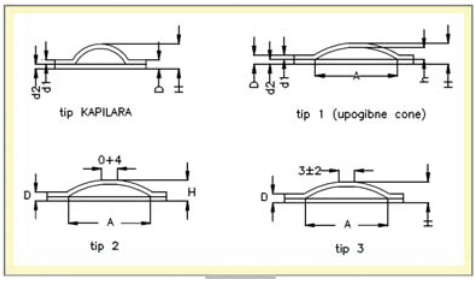

Figure 2: *One side inflated roll-bond plate, [1]*

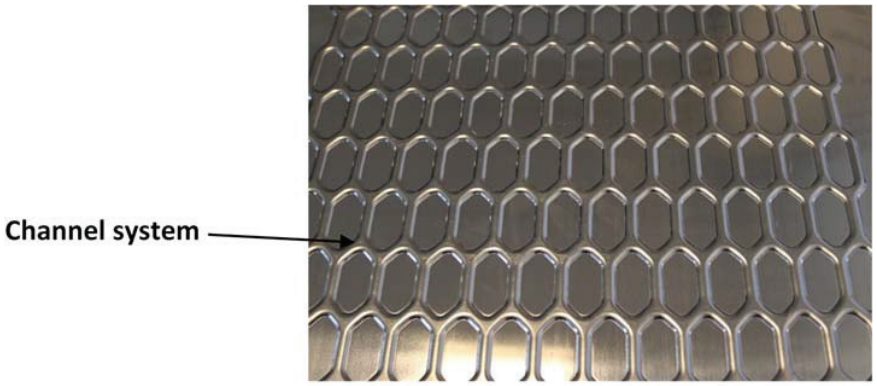

Figure 3: *Example of a channel system in a roll-bond heat exchanger plate*

Talum can produce a channel system for a heat exchanger in accordance with customer demand or can help customers design and produce different models of roll-bond heat exchanger. With the roll bond technology, it is feasible to produce a complex channel system like the one shown in Figure 3. The channel system has limited formability properties.

3 ROLL-BOND EVAPORATORS FOR REFRIGERATION

Roll-bond evaporators (Figure 4) were widely used in household appliances (e.g., coolers and refrigerators) until 2008, when, following the financial crisis, the existence of higher pressure on prices resulted in reduced demand for Roll bond evaporators due to the cheaper substitutes of tube on wire (TOW), tube on sheet (TOS), tube on foil (TOF) as well as dynamic cooling systems like ("no frost") fin on tube. All these substitutes are cheaper than roll-bond, but they cannot attain its heat transfer efficiency. The need for roll-bond has grown recently because energy efficiency demands (regulations) are increasing. The most efficient coolers are almost by default equipped with roll-bond evaporators.

The use of DS or OSF evaporators is defined by the purpose of use. DS evaporators are used when mounted inside the containment of the appliance. OSF is commonly glued behind the inner walls of the appliance and then foamed with thermal insulating foam. In specific cases in which a roll-bond evaporator is made as one side extra flat (OSEF); then the properly painted flat surface can also be used as a back wall inside the cooling cabinet.

The channel design enables equal (or desired) heat transfer flow; it must ensure that all refrigerant evaporates and also enables-low-pressure drop throughout the plate. The channels must be designed so that they are not deformed, while the evaporator plate is bent to a certain radius. The plate thickness and channel width are determined by the operating pressure.

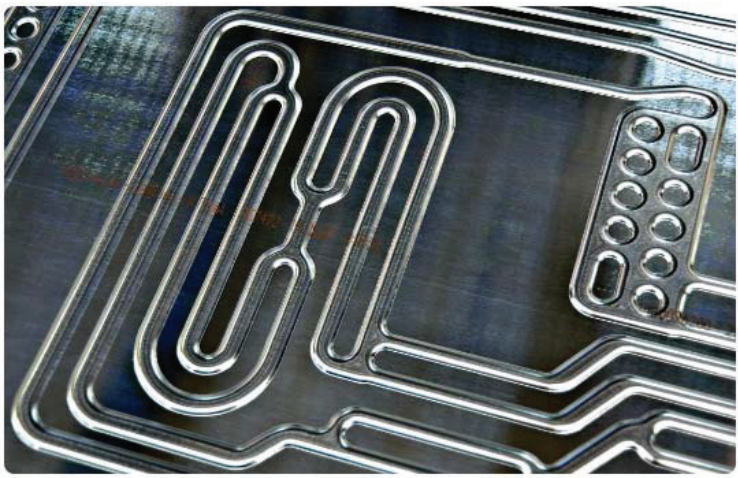

Figure 4: *Roll-bond plate for evaporator in refrigeration*

4 ROLL-BOND HEAT EXCHANGER FOR HEAT TECHNIQUE

In heat techniques, roll-bond plates are used as absorbers in different installations. Roll-bond plates are used as thermal absorbers and can be used as highly-efficient absorbers, when coated properly, in solar thermal collectors. Talum also develops and manufactures cooling plates for photovoltaic (PV) thermal (PVT) panels, as shown in Figure 5. Cooling of the PV panel can increase the efficiency of the PV panel. The thermal energy from the cooling of PV can be used for the heating of pool, domestic hot water, or support for building heating.

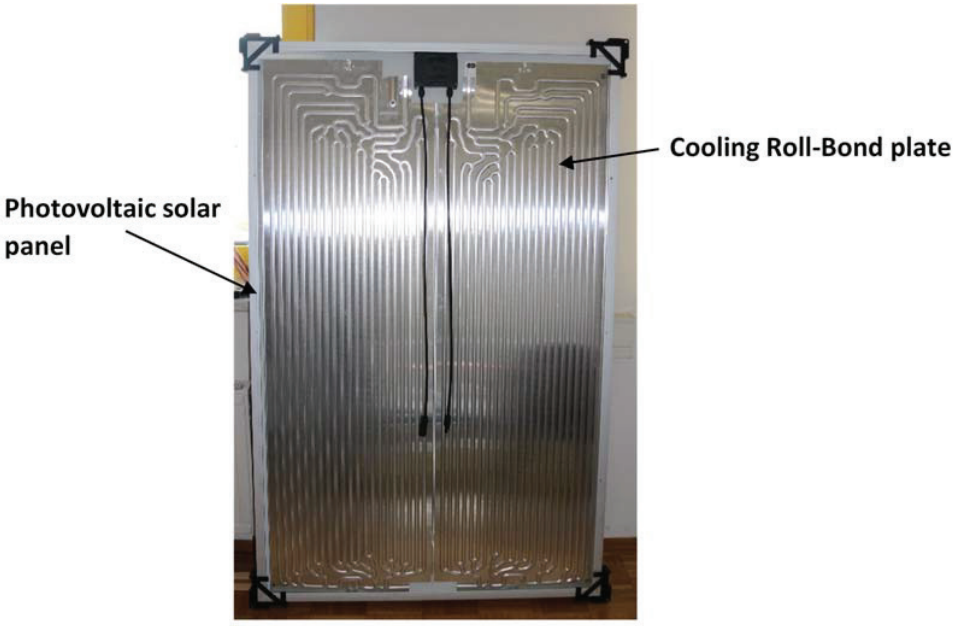

Figure 5: *Cooling roll-bond plate on the back side of Photovoltaic panel*

In Talum, the analysis and measurements of the manufactured roll-bond heat exchanger are performed. The purpose of measurements and analysis is to obtain feedback information to improve the efficiency of the product. For the analysis of the PVT with roll-bond cooling plate, a thermovision (IR) camera is used to see the temperature distribution and differences. In one analysis, thermovision analysis on the PV without the heat exchanger or cooling plate was performed. It was determined that on the back side of the panel on a normal sunny day, a PV panel reaches a temperature of 70°C, which has a negative impact on the effectiveness of the PV panel (Figure 6). The same thermovision analysis was performed on PV, but with an added roll-bond cooling plate. Figure 7 shows the thermovison analysis with a cooling plate, where a medium with the temperature around 20 to 25°C was used. With the integrated roll-bond plate, a reduction of the average temperature to approximately 30° on the PV panel was achieved. Such analysis and measurements facilitate the development and integration of our products into different applications. Based on these results, which are rapidly obtained, we decide whether to conduct more complex and precise research, such as measurements of the efficiency on the whole integrated system.

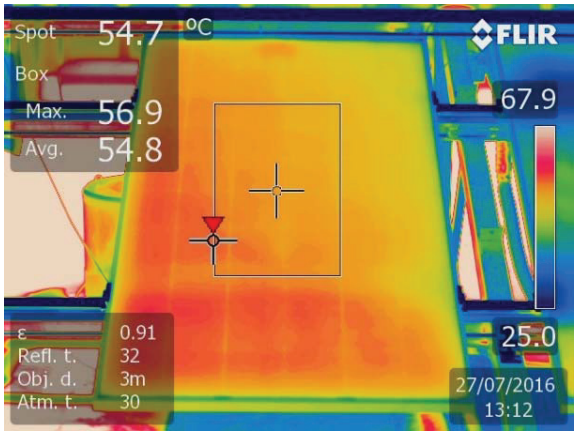

Figure 6: *Thermo-vision pictures of the front side of the photovoltaic panel*

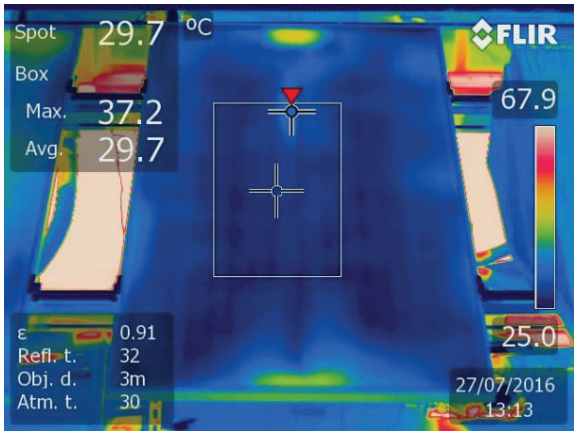

Figure 7: *Thermo-vision picture of the front side of the photovoltaic panel with the roll-bond cooling plate*

Roll-bond plates are also used as thermodynamic panels for heat pumps or as condensers in domestic hot water heat pumps (DHWHP). The heat transfer media in such roll plates is refrigeration gas for thermodynamic panels and DHWHP condensers, while for solar thermal absorbers, a mixture of water and glycol is used.

On various websites, it is possible to find some activities on implementation and integration of roll-bond plates to different systems in which a roll-bond heat exchanger is used as absorber, condenser and convector. Most systems include a heat pump, which increases the temperature since a low temperature is obtained from roll-bond absorbers, which is not directly applicable. From this reason, an additional system that increases the temperature of the medium to a useful level is needed.

5 COOPERATION ON INTERNATIONAL PROJECT

For the development of applications for roll-bond heat exchangers, Talum participates in the Interreg project SI-AT 125 "ABS-Network", *[5]*, which is a cross-border program between Slovenia and Austria. The program is financially supported by the European Regional Development Fund allocated by the European Union. The project aims at developing a prototype of a Solar Thermal-Activated Façade (STAF) panel. The lead partner of the project is Technical University (TU) in Graz (Austria). Talum is a project partner of the ABS-network project. The Faculty of Energy Technology at the University of Maribor (Slovenia) also participates in the project in the analysis on the usability of STAF panel.

The main idea of the ABS-network project is to meet the functional requirements of a façade. Buildings have a façade area (south side) on which the sun shines similarly as on the roof of the building. The idea of the project is to transfer the energy generated by the sun from the outer surface of the panel to the inner side, using a heat exchanger. Figure 8 shows the basic elements of STAF panel, *[6]*, including a two roll-bond heat exchanger (on the outside surface is a so-called absorber plate). Together with the partners on the project, we perform activities related to the analysis of the potential heat or cooling system using the energy from the panel.

The role of Talum in the project is the manufacture of the absorber and heat exchanger for the STAF panel. The absorber and the heat exchanger were designed and developed together with researchers from TU Graz. Many years of experience facilitate work in the development phase of the heat exchanger. One side-inflated channel system was used for the STAF panel. The channel system is integrated on the side with insulation. From the outside, only the aluminium plate can be seen. For that reason, the panel will look like a normal panel on a building, but it also has functional properties.

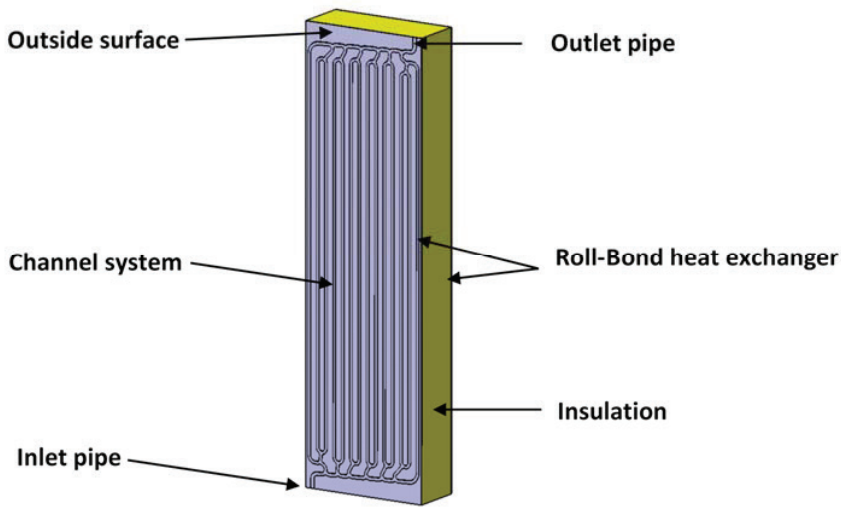

Figure 8: *Roll-bond plate for heat exchanger in solar thermal activated façade panel*

6 FUTURE OF ROLL-BOND PLATE FOR HEAT EXCHANGER

The future of the roll-bond production remains open. Increased demand for low-energy household appliances continues in developing and growing countries where there is still a lack of electric energy. The lowest energy consumption is achieved with roll-bond evaporators. Furthermore, electrical household appliances have a major impact on electrical grid load. As already mentioned in this article, roll-bond technology is finding its way in other industries. In parallel to it, other competitive technologies are developing heat exchangers and different solutions. Producers, led by consumers, are forced to reduce costs, which leads to the use of components that are just at the limit of acceptability.

Mainly due to regulations and overall understanding and awareness of the urgency to minimize energy consumption as well as the environment impact, producers will be forced to use not the cheapest but the best techniques. This should put the roll-bond products in a stable position in the future and give them a chance to develop and to overcome certain deficiencies.

References

[1] Talum d.d. Kidričevo, http://www.talum.si/

[2] **Hiwase R. E., Agrawa J. F:** Research methodology followed for optimization of production system for roll bond evaporator of domestic refrigerator, International journal of pure and applied research in engineering and technology, Vol. 4 No.3, p. 116-130, 2015

[3] **Ravi P.S., Krishnaiah A., Akella S., Azizuddin Md.:** Evaluation Of Inside Heat Transfer Coefficient of Roll Bond Evaporator for Room Air Conditioner, Evaluation Of Inside Heat Transfer Coefficient of Roll Bond Evaporator for Room Air Conditioner, Vol. 4, Issue 5, 2015

[4] **Wu J., Zhang X., Shen J, Wu Y., Connelly K., Yang T., Tang L., Xiao M., Wei Y., Jiang K., Chen C., Xu P., Wang H.,** A review of thermal absorbers and their integration methods for the combined solar photovoltaic/thermal (PV/T) modules, Renewable and Sustainable Energy Reviews. Vol.75, p. 839-854,2017

[5] Interreg Project SI-AT 125 ''ABS-Network'', http://abs-network.eu/en

[6] **D. Brandl, H. Schober, Ch. Hochenauer**: Analysis of Heating Effects and Deformations for a STAF Panel with a Coupled CFD and FEM Simulation Method, Journal of Façade Design and Engineering, Vol. 6, No. 3, p. 116−131, 2018