A NEW HEAT EXCHANGER GEOMETRY FOR NEXT CONDENSER GENERATION WITH ULTRA LOW REFRIOGERANT CHARGE

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ABSTRACT

This paper describes the evolution of heat exchanger geometry of condenser aiming to improve product efficiency and to lower internal volume.
Additional benefits of this configuration are high production flexibility combined with well known system for soldering condenser to piping on job site.

1. INTRODUCTION

In the last years in refrigeration and air conditioning sectors lot of discussions concerning environmental sustainability have been done. At first the attention was concentrated on ozone depleting refrigerants, secondly focus went to greenhouse effect reduction, following TEWI approach (i.e. combining direct and indirect emissions). Furthermore in some Countries taxes or limitation to refrigerant charges have been introduced.
Therefore an answer to those driven forces was necessary to be given and the development of Micro channel condenser can be considered a first trial.
LU-VE carried out in last years a wide research activity in different directions, trying to analyze all the possible alternatives and finally a completely new coil geometry, based on copper aluminum technology, have been developed.
Several are the advantages of such solution compared to Micro channel having as scenario production lot from 1 to 50 pieces. Other conclusions can be obtained in case of much larger production lots, but this is not the typical condition of refrigeration and air conditioning industry, taking into account ventilated condensers.

2. COIL ARRANGMENT

2.1 Micro channel with parallel flow configuration

Figure 1 shows a typical configuration of Mirco Channel in parallel flow arrangement.

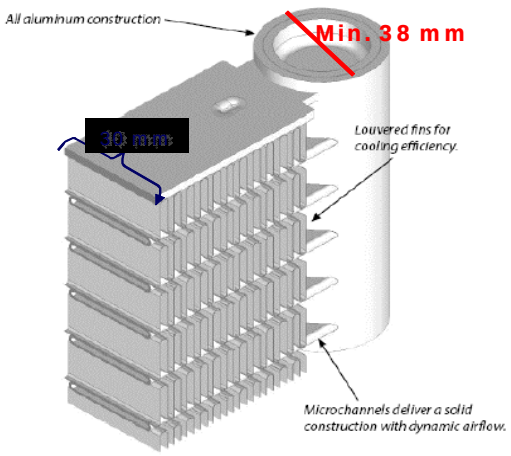

Figure 1 : drawing of Micro channel parallel flow

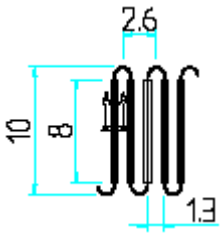

Figure 2: detail of fin spacing

Because of mechanical construction Mirco Channel in parallel flow arrangement needs to have rather big headers, at least big enough to let the aluminum profile enter into the header. From our research activity it appears aluminum profile of 30mm in depth are a good compromise in order to get from a condenser proper performance, therefore a minimum header diameter of 38mm is required. This is one of the main reason why Micro channel technology has still a bigger internal volume then necessary and the main refrigerant charge is located into headers.
Figure 2 shows the fin configuration of Micro channel, where the definition on fin spacing is rather different from the one normally used for finned coil; in fact the geometric definition bring to consider the fin spacing as the distance between two repetitive elements, in our example the 2 waves (i.e. fin spacing = 2,6mm), in reality the real distance between 2 fins is the half (1,3mm in picture), a much lower value compared to what at the present the market is used to for ventilated condenser (i.e. between 2,0 and 2,5mm).

2.2 New coil geometry

In order to satisfy the request of high heat exchange efficiency and low refrigerant charge a new coil geometry have been developed as shown in Figure 3. It is very compact and reach very high density capacity/fin surface.

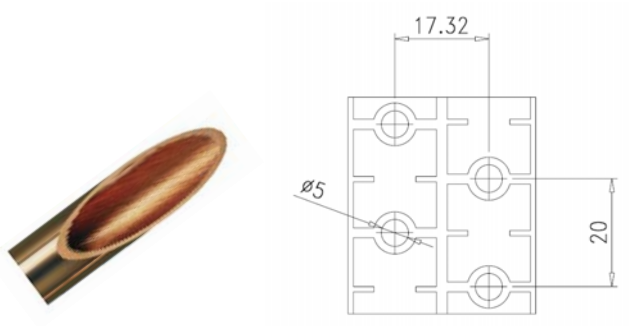

Figure 3 : new coil geometry with 5mm tube

Fins are having special corrugations that combined with internal grooved tubes with increasing on internal surface > 1,8 are giving very high performance.
The coil headers can be chosen according to the refrigerant flow, without any particular mechanical limitation and consequently it is possible to lower their volume.

3. COMPARISON BETWEEN NEW COIL GEOMETRY AND MICRO CHANNEL SOLUTION

3.1 Internal volume comparison

Table 1 shows a comparison between 3 possible air cooled condensers having similar capacity, same frontal areas, same fans (2 x Ø 350mm 4 poles).

Model	SHVN 19/0	Special 5mm tubes	Special multichannel
Capacity [kW]	19,6	20,2	19,5
Tube diameter [mm]	9,52	5,0	multichannel 30 x 2
Tubes volume [dm3]	5,15	2,04	1,90
Header volume [dm3]	0,36	0,36	0,91
Total coil internal volume [dm3]	5,51	2,41	2,81
Header diameter [mm]	22	22	38
Internal volume difference	100%	43,6%	50,9%
Internal volume difference		100%	116,7%

Table 1: air cooler condenser with different coil comparison

In the first column are the data of condenser type SHVN 19/0 of actual LU-VE production range, having coil geometry 25x21,65mm and 9,52mm tube diameter. In second column is solution with new geometry 20 x 17,32mm and 5mm tube, in the third column a solution with Micro channel configuration.

In order to illustrate more clearly the behavior of internal volume for the 3 different configurations, is indicated separately the internal volume for tubes (or extruded profiles for micro channel) and for headers. The result of comparison shows clearly that by using more modern technology it is possible to reduce very much refrigerant charge; furthermore it appears the advantage of new geometry with 5mm tubes in comparison to micro channel (16,7% further reduction), thanks to the smaller header diameter.

3.2 Other terms of comparison

In order to make a serious evaluation of the different technologies additional points have been compared as shown in Table 2.

	5mm geometry	Micro channel	Comment
Installation	+	-	Installer has to solder copper pipes as usual in both cases but MC has a joint Cu-AL rather fragile that can be damaged and repairing is difficult
Cost			Very much influenced by production lot, however till 50 pieces batch 5mm is surely competitive
Lifetime	+	??	No real experience on MC is available, tests on car can be used???
Flexibility	+	-	MC has very rigid production, difficult to provide special circuiting or enlarged coil. 5mm is very flexible as actual Cu/Al tecnology shows
Weight	~	~	Very similar values
Recicling	-	+	MC has advantage of mono-material construction
Dirt accumulation	+	-	MC has in reality 1,3mm fin spacing, dirt accumulation is much quicker
Cleaning	-	+	MC is stronger, cleaning is quicker and easier without damage risk

4. CONCLUSION

A recent development of new coil geometry based on copper aluminum technology have been presented and compared with aluminum micro channel solution. Several are the advantage of the new proposal, in particular it appears the best way to lower the internal volume and consequently the refrigerant charge, an issue that is more and more requested in order to ensure environmental sustainability of all the products.

REFERENCES