COMBINED HEAT EXCHANGE INTENSIFICATION TECHNIQUES AS A KEY TO DEVELOPMENT OF AUTOMOTIVE GTE'S COMPACT HEAT EXCHANGERS

Sudarev A.V.
«Scientific Center «Ceramic Engines» named after A.M. Boyko», Ltd («Boyko Center», Ltd),
195221, Russia, St. Petersburg, Polyustrovsky Av., 15, block 2,
E-mail: soudarev@boykocenter.spb.ru ; telefax. +7(812)2253453

Heat exchange intensification is a main technique of increasing the efficiency for heat engine heat exchangers and cooling systems efficiency. Combined techniques domain is a slowly developing heat exchange processes region, rather highly promising given a commercial application is arranged, since through interaction of various techniques a higher convective heat transfer coefficient could be achieved compared to application of each separate technique individually.

Typically, combined techniques signify a combination of a passive and active heat exchange intensification. Implementation of active techniques associated with mechanical, vibration, acoustic, electric and other external effects on the heat exchange process involves significant implications. Passive heat exchange intensification techniques are associated with a variation of the heat exchange surface, its macro- and microstructure configuration, as well as with a turbolization of the heat carrier flow boundary layer that moves nearby the heat exchange surface.

As studies indicate, the combined technique based on application of two and more passive heat exchange intensification techniques can, also, contribute to increasing the convective heat transfer given each of them, at interaction, does not suppress, through using other techniques, a turbolization effect imposed on the near-wall heat carrier layer, i.e. when techniques are compatible one with another. Findings of the studies are often contradictive, sometimes they look too much optimistic, while the methods offered are not always adaptable to realization, more often than not they worsen the heat exchanger operation reliability, its reparability, or lower its efficiency. A main requirement to heat exchangers and a plant as a whole at the stage of gas turbine engine developments is ensuring low weights and small sizes with the simultaneous provision of high parameters in terms of heat exchanger strength, power efficiency, applied heat exchange intensification techniques, easiness of manufacture, mounting and maintenance of a plant and its main components**.**

At designing and manufacture of a gas turbine engine incorporating two gas-gas recuperative heat exchangers, namely air heater (Table 1) and gas cooler (Table 2) and to put into effect all the complex of requirements to gas-gas heat exchangers, it would be a must to resolve the challenge of heat exchange intensification for either gas path of each heat exchanger. To increase its compactness and to lower its metal consumption rate, it would be required to take use of not simple but combined heat exchange intensification techniques.

Table 1
Main duties for GTE air heater

№	Name	Symbol	Value; media	
1	Heat carrier		gas	air
2	Mass flow	kg/s	0.122	0.125
3	Inlet temperature	°C	781	197
4	Outlet temperature	°C	235	734
5	Inlet pressure	MPa	0.0379	0.119
6	Outlet pressure	MPa	0.0371	0.113
7	Admissible total relative pressure loss	%	7.0	
8	Efficiency	%	92.0	
9	Heat output	kW	73.2	
10	Matrix volume	dm^3	60.4/144	
11	Mass	kg	75	
12	Compactness factor	1/m	425	

Table 2
Main parameters for GTE air cooler

№	Name	Symbol	Value; media	
1	Heat carrier		gas	air
2	Mass flow	kg/s	0.122	0.4
3	Inlet temperature	°C	235	15
4	Outlet temperature	°C	23	94
5	Excess pressure at inlet	MPa	0.0362	0.01
6	Excess pressure at outlet	MPa	0.0371	0.011
7	Admissible total relative pressure loss	%	6.0	
8	Efficiency	%	31.0	
9	Heat output	kW	31.8	
10	Matrix volume	dm^3	47	
11	Mass	кг	31	

In both heat exchangers, a combination of a number of effects promoting a near-wall layer turbolization and its thinning, transformed into a reduction of the thermal resistance and convective heat transfer increase was embodied. The heat exchange intensification in both heat exchangers (fig.1,2) allowed getting target characteristics at testing.

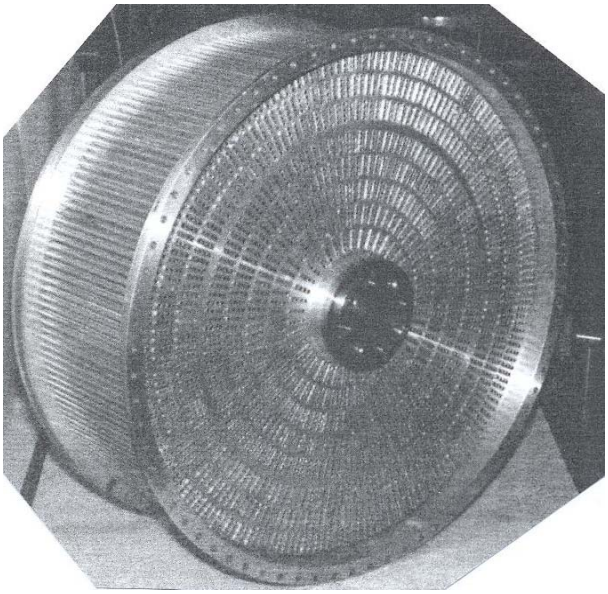

Figure 1. General view of GTE gas cooler

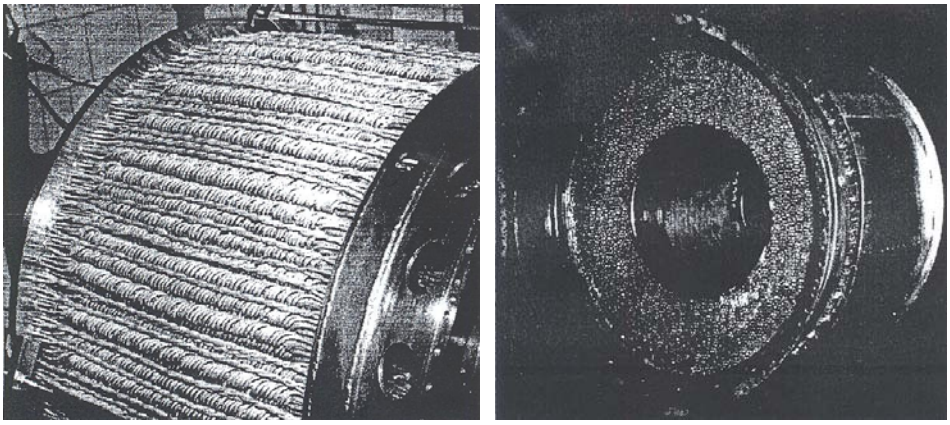

Figure 2. General view of GTE air heater