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Increasing the heat transfer in intercooler of a two stage compressor

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Abstract

The intercooler transfer the heat generated in the air compressor to the outside surroundings. The heat generated during the compression of the air in the first stage of the compression is reduced before it enters the second stage of the compressor. General parameters such as fin material, fine geometry, fin shape, fin thickness and so on were considered for the experimentations done. The final conclusion of this study shows that the main parameters that affect the heat transfer are the fin geometry and the material of the fin.

Introduction

Fin is one of the most important pieces of equipment to increase the rate of heat transfer in the intercooler. Over the recent years, various configurations of intercooler have been developed with a view of maximizing the heat transfer rates and reducing the effective space occupied by it. Various types of fins such as longitudinal, spines and radial fins are designed and used for different purposes. They are widely applied in many industries for cooling compressors. However, when fins are added into a system, this will lead to an increase in the volume of that system. The techniques of enhancement are passive if they do not require power, or active if they need additional power [1].

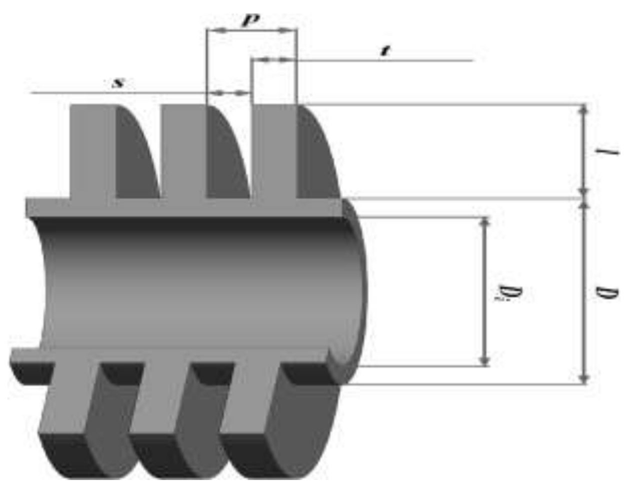

Fig. 1. Finned cylinder.

Several enhancement methods are described in [2,3] with fourteen different techniques and several convective heat transfer techniques.One of the possible techniques is the impinging jet which has a high efficiency because of the flow concentration and the limited expenses required to move the relatively small amount of fluid. Impinging jets of air have been proposed as cooling method [4]. In this application external air, entering throughout the fan of the vehicle, is used to cool the hot air, coming from the compressor, is flowing to the intercooler. A nozzle after the fan is suggested to converge the jet flow onto the hot-air tube. The jet flow increases the cooling performance but can be not enough because of the high temperature of air on the outlet of the compressor. Then, it is proposed to use an externally finned tube instead of a smooth one.

2. Literature Review

Some of the main factors that affect the heat transfer in the fins are:

Material of the fin:

The material of the fins may change amount of the heat transfer and the rate of the heat flowing from the engine combustion chamber through the fins

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to the outside of the engine by the combustion of the fuel. Thermal analysis of cylindrical fins made of aluminium and copper was made with help of transient analysis method. Copper has high thermal conductivity anaad it can be used for transferring more heat to the surrounding by the intercooler fins.

Properties	Cooper	Aluminium	Unit
Density	8933	2700	Kg/m²
Coefficient of thermal expansion	10	10	W/m²/k
Thermal conductivity	398	236	W/m/k
Specific heat	385	900	J/kg/k

Table 1-Properties of different materials

Geometry of the fin:

The geometry of the fin differs the heat transfer capacity of the engine fins. The change in the geometry of the engine fins results in the change of the heat transferring capacity of the fins and transfers more heat from the engine. The fin geometry helps in transferring the heat to the surrounding and helps to reduce the engine temperature. The fins geometry is a major factor for determine the heat transfer capacity In [6], the authors assumed that the spatially dependent thermal conductivity was given by the power law; in [7], the thermal conductivity was given as an exponential function of the space variable; and in [8], the authors assumed a number of functions for the thermal conductivity which include linear, quadratic and exponential functions. In these studies the heat transfer coefficient is taken to be a constant.

Experimental cylinders, fins and air velocities investigated by researchers [3]

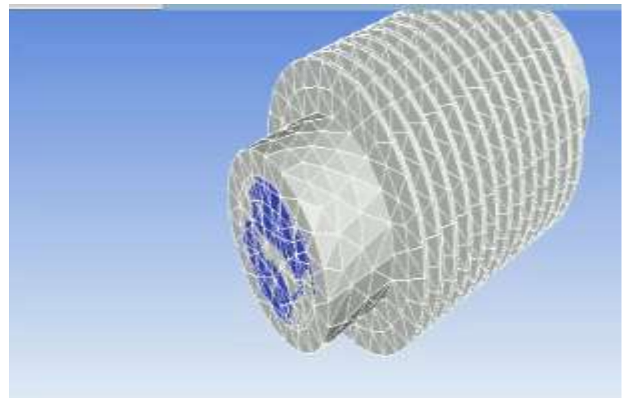
	Gibson A.H	Biermann A.E. et al.	Thornhill D. et al		MasaoY oshida M. et al
Cylinder diameter	32-95	118.36	86	100	78
Fin pitch	4-19	1.448-15.24	7-14	8-14	7-20
Fin length	16-41	9.398-37.33	25-65	10-50	35
Material	Copper, Steel , Al	Steel	Aluminium alloy		Al
Wind velocity	32-97	46.8-241.2	43.2-172.8		0-60

Table 2-Experimental cylinders, fins and air velocicies

Thus the considered models are linearover a 10 mm length of each channel using a 1 µm of the fin.

Thickness of the fin:

The heat transfer in fins is found to be highly efficient when the space between the fins is not too narrow and the space is large for the air to flow through the space between the adjacent fins to transfer more amount heat.



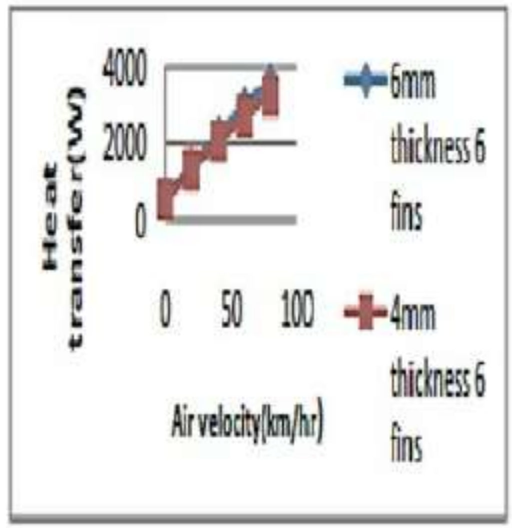


Fig 2- Heat transfer vs air velocity for 6mm and 4mm fin with one fin

Fig 3- Heat transfer vs iar velocity for 6mm and 4mm fin with 6 fins

The optimized fin pitches with the greatest cooling area at 20mm for non-moving and 8mm for moving[9]. The high velocity of the air can cool the fins with high thickness. For high speed vehicles thicker fins provide better efficiency. When the thickness was increased the small gap between the fins help in better transfer of heat due to the swirl production between the fins. Large number of fins with small thickness can be used instead of small number of fins with larger thickness as it induces greater turbulence[10].

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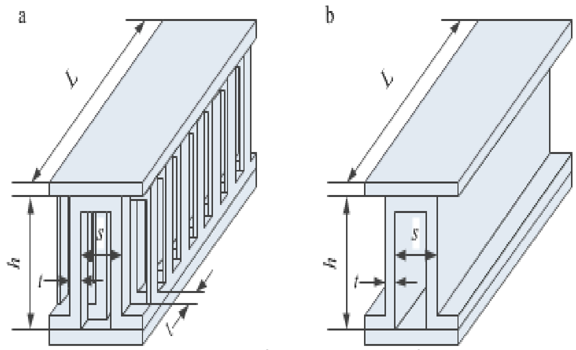

Fig. 4. (a) OSF fin; (b) plain plate-fin.

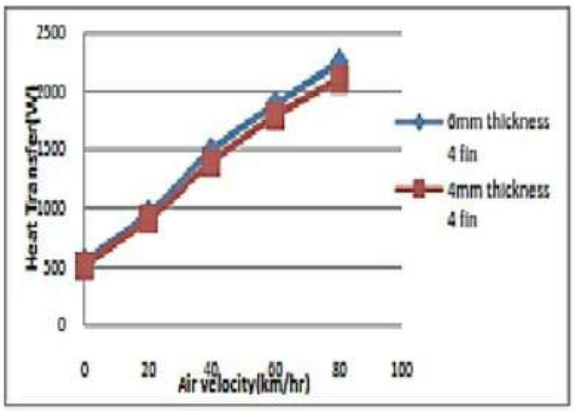

Fig 5-Heat transfer vs air velocity for 6mm amd 4mm fin for 4 fins

Air Flow Rate

The air flow rate an important parameter which determines the heat flow rate in the fins[11]. The rate at which the air flows through the fins also determines the rate of the heat transfer through the fins from the engine during the combustion in the engine in the combustion chamber during the burning of the fuel[12].

3. Conclusion

It can be concluded that the main parameters that determine the heat transferring capacity of the fins are the geometry of the fins and the materials of the fins[13]. The air flow rate also plays a major role in the transfer of the heat form the engine[14]. The copper is good conductor of heat and ot can carry away the heat produced in the engine but aluminium has high anti corrosion properties and so the fins are made generally using the aluminium in major automobile industries[15]. The thickness of the fins also play a major role in the heat transfer through the fins . So, fins of low thickness and large number of fins are generally used for transferring the heat more efficiently and at a faster rate effectively.

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