AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

EXPERIMENTAL STUDY OF THREE LAYERED GAS-TO-GAS HEAT EXCHANGER USING POROUS MEDIA

By

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B.Sc. Mechanical Engineering, Power Section, 2005

A Thesis Submitted In Accordance With the Requirements for
The Degree of Master of Science

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Statement

This dissertation is submitted in partial fulfillment for the degree of Master of Science in Mechanical Power Engineering – Ain Shams University. The work included in this thesis is carried out by the author at the laboratories of the Mechanical Power Engineering Department – Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other University, or a place of learning.

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Abstract

An experimental work was carried out to investigate the influence of the insertion of porous segments with different thicknesses on heat transfer enhancement and the pressure drop in a three layered gas to gas heat exchanger. Also the effects of varying both of the volume flow rates of the hot and cold air streams which are varied together with the same values, and the hot air inlet temperature. The experiments were repeated with the same conditions but with the insertion of fins in the three chambers to study the effect of the fins with and without porous segments on the heat transfer enhancement and the pressure drop.

Five porous segments made of aluminum oxide with different thicknesses of 20, 30, 50, 60, and 70 mm were used at different hot and cold air volume flow rates of 0.2, 0.3, 0.35, 0.4, and 0.5 m^3/min., and different hot air inlet temperatures of 100, 200, 300, 400, 500, and 600℃. The experiments were carried in two groups. In the first the effect of varying the air volume flow rates, and the hot air inlet temperatures on the total heat recovery ratio, heat recovery rate, heat rejected by the hot air, heat losses, and the pressure drop across the heat exchanger were studied with the absence of both of the porous segments and fins, and the absence of the porous segments and the presence of fins. In the second group the effects were studied in the presence of porous segments of different thicknesses with and without fins.

It was found that as the porous media thickness increases, the total heat recovery ratio, and the pressure drop across the heat exchanger increase. Also the results showed that a porous media of 50 mm thickness is enough to obtain sufficient total heat recovery ratio under the present experimental conditions for both the un-finned and finned walls cases, as the total heat recovery ratio reaches an asymptotic value beyond this thickness, while the pressure drop keeps increasing. It was also found that by increasing the air volume flow rates the heat recovery ratio and the pressure drop increase using the same porous material thickness. Studying the effect of increasing the hot air inlet temperature, it was observed it has increased the total heat recovery ratio due to the role of the radiant heat transfer from the porous material segments to the enclosure walls.

On the other side, it was observed that using finned walls are quite effective to promote heat recovery from the high temperature gas. The total heat recovery rate has increased due to the insertion of both of the porous material and the fins by 273 percent to 300 percent using porous media of 70 mm thickness, and finned walls.

Nomenclature

	Air mass flow rate……....	kg/sec.
	Cold air specific heat capacity at constant pressure...	J/kg.K
	Hot air specific heat capacity at constant pressure…	J/kg.K
	Cold air inlet temperature……..	℃
	Cold air outlet temperature……	℃
	Average cold air temperature……	℃
	Hot air inlet temperature……	℃
	Hot air outlet temperature……..	℃
	Average hot air temperature…..……	℃
	Total heat recovery ratio……	--
	Rejected heat rate by the hot air…….	Watt
	Heat recovery rate……..	Watt
	Percentage of heat loss……...	%
	Optical thickness of porous material plate…….	--
HR	Heat recovery chamber	
HT	High temperature chamber	
LT	Low temperature chamber	

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