Jr. of Industrial Pollution Control 29(1)(2013) pp 93-96

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STUDIES ON CONVECTIVE HEAT TRANSFER IN POROUS MEDIA

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Key words : Porous media, Experimental research, Convection heat transfer.

(Received 24 August, 2012; accepted 15 October, 2012)

ABSTRACT

A porous medium is a material containing pores (voids). The skeletal portion of the material is often called the "matrix" or "frame". The pores are typically filled with a fluid (liquid or gas). Natural porous materials such as rocks and soil , biological tissues bones, wood, and syanthice materials such as cements and ceramics can be considered as porous media. The concept of porous media is used in many areas of applied science and engineering: filtration, mechanics geomechanics, soil mechanics, rock mechanics, petroleum engineering, bio-remediation, construction engineering , material science. The convection heat transfer of air by heating plate was investigated experimentally. Porous media intensify fluid flow mixing and increase the surface area in contact with the coolant, so porous structures are an effective heat transfer to greater increase technique. Type of porous media natural and synathice and fluid properties on the convection heat transfer and heat transfer increase were investigated. The results showed that the convection heat transfer in the synathice porous media was more intense than in the natural porous media. For the tested conditions, the heat transfer in the syanthice porous media was more than the natural porous media for air.The pressures drop were decrease with respect to time in the natural porous media and the syanthice porous media for air. The temperatures were increased with respect to time in the natural porous media and the syanthice porous media for air.

INTRODUCTION

A porous medium (or a porous material) is a material containing pores (voids). The skeletal portion of the material is often called the "matrix" or "frame". The pores are typically filled with a fluid (liquid or gas). The skeletal material is usually a solid, but structures like foams are often also usefully analyzed using concept of porous media.A porous medium is most often characterised by its porosity. Other properties of the medium (e.g., permeability, tensile strength, electrical conductivity) can sometimes be derived from the respective properties of its constituents (solid matrix and fluid) and the media porosity and pores structure, but such a derivation is usually complex. Even the concept of porosity is only straightforward for a poroelastic medium.Often both the solid matrix and the pore network (also known as the pore space) are continuous, so as to form two interpenetrating continua such as in a sponge. However, there is also a concept of closed porosity and effective porosity, i.e., the pore space accessible to flow.Many natural substances such as

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rocks and soil (e.g., aquifers, petroleum reservoirs), zeolites, biological tissues (e.g. bones, wood, cork), and man made materials such as cements and ceramics can be considered as porous media. Many of their important properties can only be rationalized by considering them to be porous media.The concept of porous media is used in many areas of applied science and engineering: filtration, mechanics (acoustics, geomechanics, soil mechanics, rock mechanics), engineering (petroleum engineering, bio-remediation, construction engineering), geosciences (hydrogeology, petroleum geology, geophysics), biology and biophysics, material science, etc. Fluid flow through porous media is a subject of most common interest and has emerged a separate field of study. The study of more general behaviour of porous media involving deformation of the solid frame is called poromechanics.

MATERIALS AND METHODS

The three sampled of porous media the two sampled natural porous media such as soil and wood and the one sample is synathice porous media such as cement both porous media sampled size 4x3cm.The sample was tested the heat transfer by the convection in the synathice porous media and the natural porous media for air. The smaples heated by the heating plate the heating plate was 230 voltage and 2 ampier range the blower generated the air and heating plate heated air in wood box and hot air heated to the porous media.

Experimental setup

The wood box was long, width and hight 9x5x5 inch respectively the heating plate fixed into the wood box the heating plate connected to the electric wire and metallic net was 1 inch on the heating plate. The 2 thermocouples connected to the digital temperature indector.its show to the temperature (°C).The thermocouples fixed into the top and connected with porous media of wood box. The three porous media sample tested in experiment samples such as soil,wood and cement each sample sized 4x3 cm. In experiment the blower is connected to the pipe length was 0.5m and pipe diameter was 0.038m the menometer fixed into the pipe and the manometer filled up potassium chromate (k_2cro_4) and water the wood box connected to the diameter of pipe,wood box outer diameter was 0.0127m the heating plate was 230 voltages and 2 ampier range.The blower was generated to the air and air under goes to the wood box and heating plate heated to the air then hot air surrounded to the wood box .The soil sample on the matelic net and the soil sample is contact to hot air in the wood box after that temperature (°c) show the digital temperature indector and menometer show to the pressure drop,the stop watch show the time this process applied to steady state condition. Similarily the wood and cement sample tested in the wood box.

RESULT AND DISCUSSIONS

Soil

convection heat transfer in the natural porous media was less than the synathice porous media the natural porous media was soil, wood and the synathice porous media was cement. The heat flux(q)was 7.5 w/m²h at started 5 minutes after that q increase 15 w/m²h at 10 minutes the reason was temperature increase 2 °C and the q was decrease 7.5 w/m²h at 15 to 25 minutes the temperature were decrease.

Table 1. heat flux v/s time

Heat flux (w/m²h)	7.5	15	7.5	7.5	7.5
Time (minutes)	5	10	15	20	25

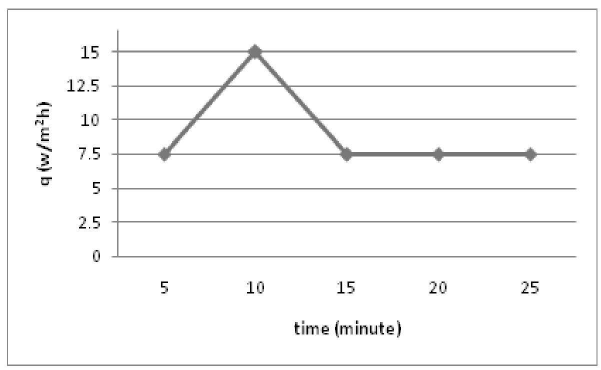

Fig.1 heat flux v/s time

Table 2. pressure drop v/s time

Pressure dropx10-4 (kg/m²)	5	4	3	2.5	2.5
Time (minutes)	5	10	15	20	25

Table 3. Temperature v/s time

Temperature (°C)	33	35	36	37	37
Time (minutes)	5	10	15	20	25

Table 4. Heat flux v/s time

Heat flux(w/m2h)	4.25	8.5	4.25	4.25	4.25
Time (minutes)	5	10	15	20	25

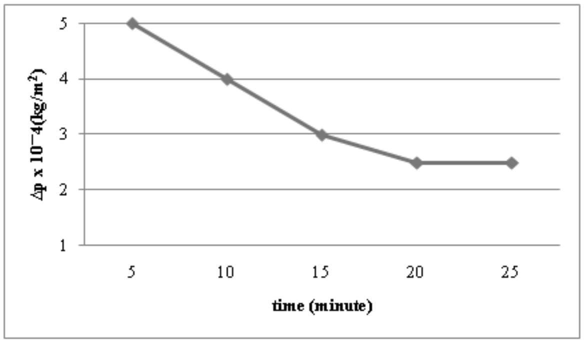

Fig. 2 Pressure drop v/s time

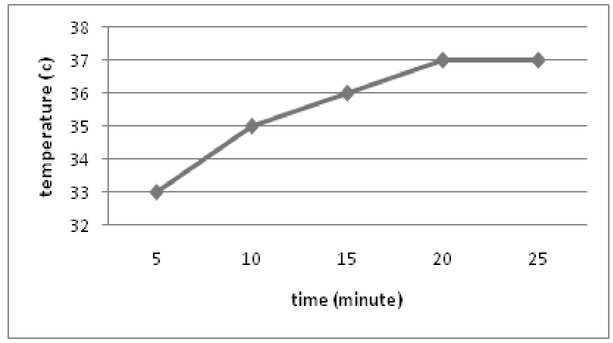

Fig. 3 Temperature v/s time

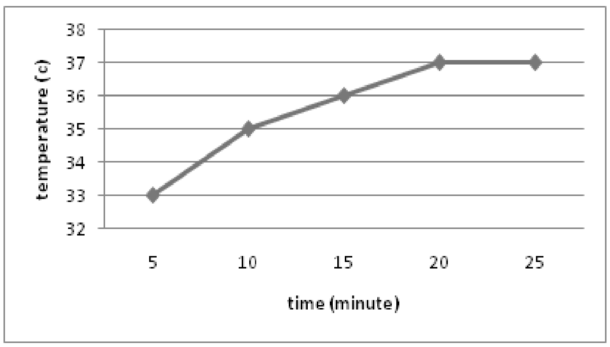

Fig. 4 heat flux v/s time

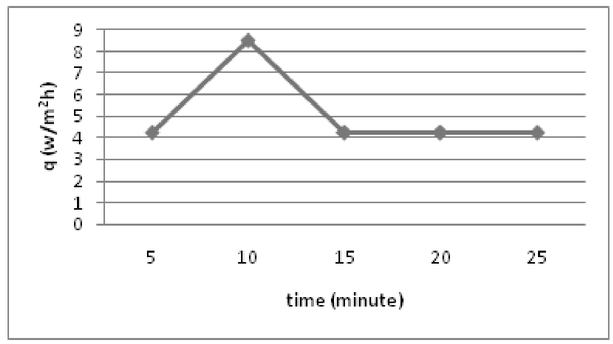

Fig. 5 Pressure drop v/s time

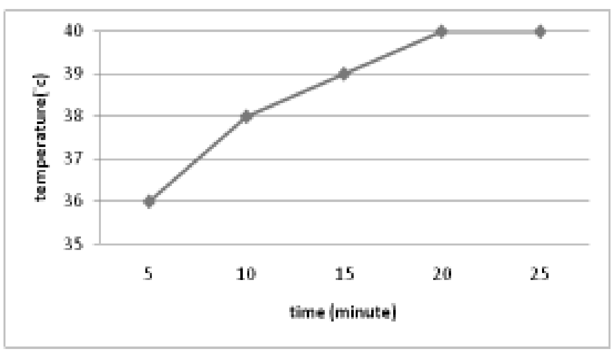

Fig. 6 Temperature v/s time

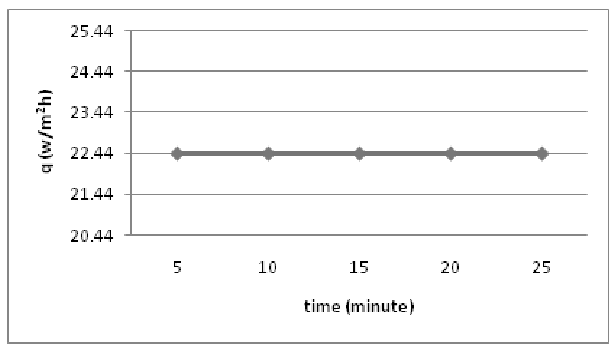

Fig. 7 Heat flux v/s time

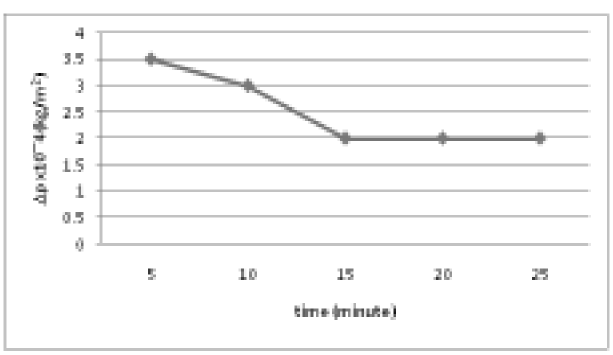

Fig. 8 Pressure drop v/s time

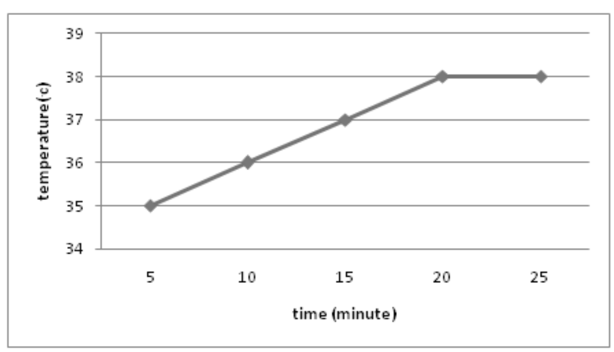

Fig. 9 Temperature v/s time

Wood

convection heat transfer in the natural porous media was less than the synathice porous media the natural porous media was soil and wood. The heat flux (q) was 4.25 w/m^{2}h at started 5 minutes after that q increase 8.5 w/m^{2}h at 10 minutes the reason was temperature increase 2.c and the q was decrease 4.25 w/m^{2}h at 15 to 25 minutes the temperature were decrease.

Table 5. pressure drop v/s time

Pressure dropx10-4(kg/m^2)	4	3.5	2.5	2	2
Time (minutes)	5	10	15	20	25

Table 6. Temperature v/s time

Temperature (^{o}C)	36	38	39	40	40
Time (minutes)	5	10	15	20	25

Cement

Convection heat transfer in the synathice porous media was more than the natural porous media. The synathice porous media was cement the heat flux(q) was 22.44 w/m^{2}h at started 5 to 25 minutes the heat transfer was constant the reason was temperature only increase 1 ^{o}C.

Table 7. Heat flux v/s time

Heat flux (w/m^{2}h)	22.44	22.44	22.44	22.44	22.44
Time (minutes)	5	10	15	20	25

Table 8. pressure drop v/s time

Pressure dropx10-4(kg/m^2)	3.5	3.0	2	2	2
Time (minutes)	5	10	15	20	25

Table 9. temperature v/s time

Temperature (^{o}C.)	35	36	37	38	38
Time (minutes)	5	10	15	20	25

CONCLUSION

The convection heat transfer of air by heating plate was investigated experimentally. Porous media intensify fluid flow mixing and increase the surface area in contact with the coolant, so porous structures are an effective heat transfer to greater increase technique. The convection heat transfer in the synathice porous media was more intense than in the natural porous media. For the tested conditions, the heat transfer in the syanthice porous media was more than the natural porous media for air.The pressures drop were decrease with respect to time in the natural porous media and the syanthice porous media for air. The temperatures were increased with respect to time in the natural porous media and the syanthice porous media for air.

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