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Effect Of Flow Charestric On The Heat Transfer Performance Across Low-Finned Fin Banks

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Abstract- Air is a cheap and safe fluid, widely used in electronic, aerospace and air conditioning applications. Because of its poor heat transfer properties, it always flows through extended surfaces, such as finned surfaces, to enhance the convective heat transfer. In this paper, experimental results are reviewed and numerical studies during air forced convection through extended surfaces are presented. The thermal and hydraulic behaviors of a reference trapezoidal finned surface, experimentally evaluated by present authors in an open-circuit wind tunnel, has been compared with numerical simulations

Keywords - Heat Exchanger, Fins, Radiation , Free and Forced convection.

I INTRODUCTION

Heat exchangers are commonly used in many fields of industry, which are composed of finned surfaces for dissipation of heat by convection and radiation. The calculation of heat transfer of a cooling fin in heat exchanger system is the good practical application of heat transfer. Such fins are used to increase the cooling area of system available for heat transfer between metal walls and conducting fluid such as gases and liquids. In a chemical process, the reactor at hot temperature is cooled using cooling fins. The coolant is the surrounding air. Heat transfer in heat exchanger is dominated by convection from the surfaces, although the conduction within the fin may also influence on the performance. A convenient method to treat convection cooling is to use heat transfer coefficients, **h**. The present work is aimed to identify by an experimental study of the effect of inlet flow angle, and free-stream turbulence level on heat transfer rate to a row of fins arranged horizontally

Q. Zhang1, L. et al. [1] indicated that the inlet boundary layer thickness has little impact on the heat transfer over the tip surface as well as the pressure side near-tip surface. However, noticeable changes in heat transfer are observed for the suction side near-tip surface. Similar to the inlet turbulence effect, such changes can be attributed to the interaction between the passage vortex and the OTL flow.

H. P. Hodson [2] concluded that the aerodynamic efficiency of an axial-flow turbine is significantly less than that predicted by measurements made on equivalent cascades which operate with steady inflow. The turbine rotor midspan profile loss was approximately 50 percent higher than that of the rectilinear cascade. The 50 percent increase in loss is due to the time-dependent transitional nature of the boundary layers.

G. J. Walker [3] decided that the computed performance values show an almost unique relation between the blade losses and the suction surface diffusion ratio. However the correlation of losses with the equivalent diffusion ratio is found to break down at high values of the latter parameter.

Sunita Kruger and Leon Pretorius [4] indicated that the presence of baffles influenced the heat transfer from the hot wall considerably, and it was concluded that a partitioned enclosure containing conducting partitions can be used to represent an enclosed greenhouse containing raised benches with single/multiple racks.

Syeda Humaira Tmasni et al. [5] demonstrated that the attached horizontal obstruction adds some thermal insulation effect. This finding is important in double wall space filled with fiberglass insulation in contemporary buildings, where the side wall is reinforced on the inside with structural members.

Gongnan Xie et al. [7] decided that a double-layer micro channel cannot only reduce the pressure drop effectively but also exhibits better thermal characteristics. Due to the negative heat flux effect, the parallel-flow layout is found to be better for heat dissipation when the flow rate is limited to a low value while the counter-flow layout is better when a high flow rate can be provided.

A J Neely1 et al. [8] investigated that the correct selection of fin geometry can result in a significant increase in overall convective cooling performance.

Parinya Pongsoi et al. [9] showed that the convective heat transfer coefficient (h_o) for a fin pitch of 2.4 mm is relatively low compared with that of other fin pitches with the same air frontal velocity. Using larger fin pitches (i.e., 4.2, 6.2, and 6.5 mm) resulted in negligible differences in the pressure drop.

Parinya Pongsoi et al. [10] decided that no significant effect for either number of tube rows or fin materials on the heat transfer performance is found at high Reynolds number.

V. Dharma Rao et al. [11] demonstrated that the highest heat transfer rates are obtained from a fin array when the base is vertical and the fins attached to it are vertical width-wise.

II Experimental Apparatus and Procedure

A system is catalytic reactor with heat exchanging fins (Fig.1), which has a square base (30 Cm×30 Cm). This base contains fourteen square fins. Each fin (30 ×2.2×0.6) Cm^3 (length ×height ×width) respectively. The space between each two fins is 1.0 Cm. A natural air of a different velocities (0, 0.35, 0.7, 1.2, 2.0, and 3.0 m/s) passes across and a longitudinal the fins. Also, the air passes at an angles 0˚, 45˚, and 90˚. The temperature of inlet end rises rapidly, and then gradually decreases. During operation, the temperature inside the fin is maintained. The heat is conducted within the fins and then transferred to the surrounding air. There is a thermal load system as a galvanized tank with a dimensions of (0.3 ×0.3×0.2) m^3 (length ×width ×height) respectively as shown in Fig.2. There is a thermal resistance located inside the tank. The thermal resistance has an electric power 400 watt. The tank is filled with water before experiments through a hole located at a distance 0.15 m from the beginning near the upper tank surface. The water temperature was maintained at temperature 40˚C. As the air is heated, buoyancy effects cause heat to transport upward by heated air which rises (free convection) or heat sweep to right by forced stream of air (forced convection).

III Measuring Technique

There are a five thermocouple joints a longitudinal the fin at a distance (5, 10, 15, 20, 25 Cm) from the fin end. These joints supplied with a thermocouple of type **k**. The thermocouple terminals connected with a data logger which calculate the five local temperature values immediately, Fig.2. The total measured points each experiment are seventy local points. In this paper we study the centerline measured temperature value (at 15 cm).

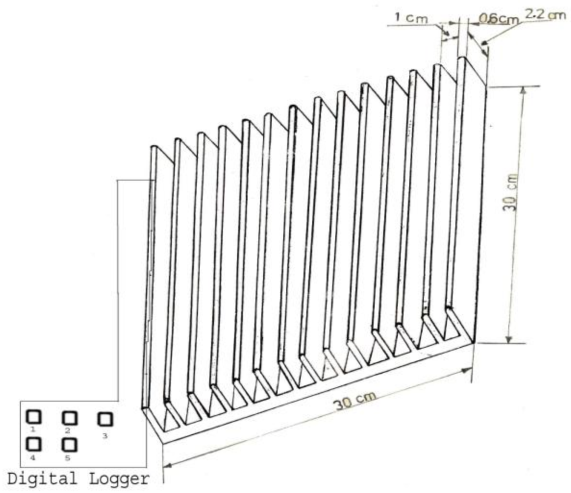
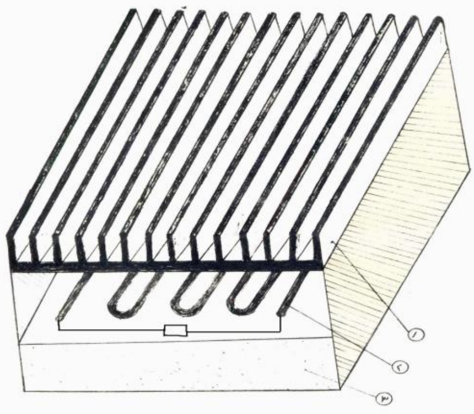


Fig. 1 Types of Used Fins



1. Fin. 2. Electic resistance (400 w)

3. Heating load.
Fin arrays
Fig. 2

IV Results and Discussion

IV. 1 Effect of Fin **angle on Heat Transfer Rate:**
Fig. (3) shows the relation between the temperature C˚ and the time at variable air velocities (at the range of (0 to 3m/s) at the flow air angle = 45˚. It is obvious from Figures (3), (4) and (5) that the flow angle affect on the fan heat transfer. It is noted from Fig. 3 that for flow angle = 45˚, the temperature range from (68 C˚ to 95 C˚) nearly. It is decided also that as the air velocity increased, as the fins temperature decreased. This as a result of, as the air velocity increased, the heat transfer rate increased, so, the fin temperature decreased.

Also, it is noted from Fig. 4 that for flow angle =90˚, the fins temperature at the range of (75 C˚ to 93 C˚) is slightly high as compared with flow angle = 45˚. It is noted also from Fig. 5, that for flow angle =0˚, the fins temperature at the range of (52 C˚ to 90 C˚) is slightly low as compared with flow angle = 45˚. This decided that as the flow angle increased, as the fin temperatures range decreased.

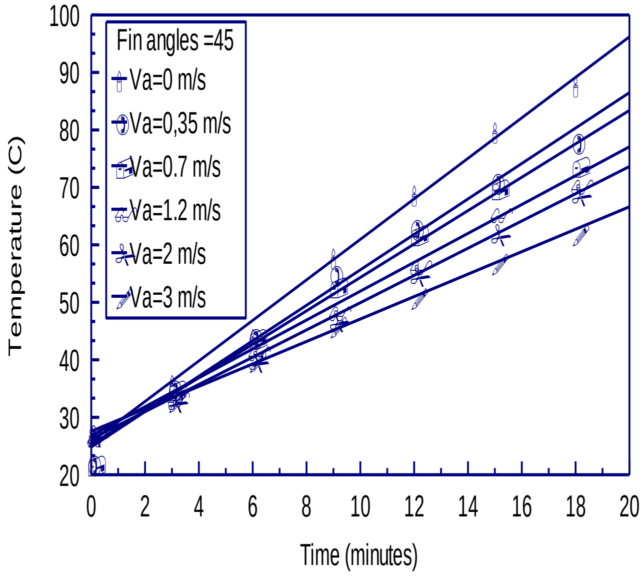


Fig. (3)

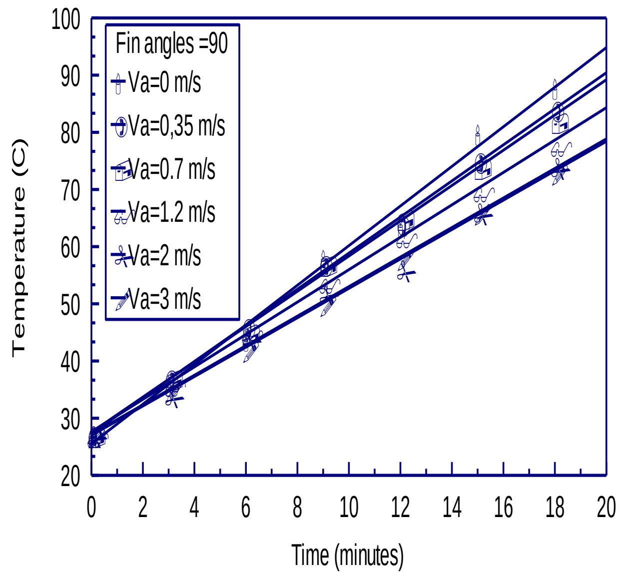


Fig. (4)

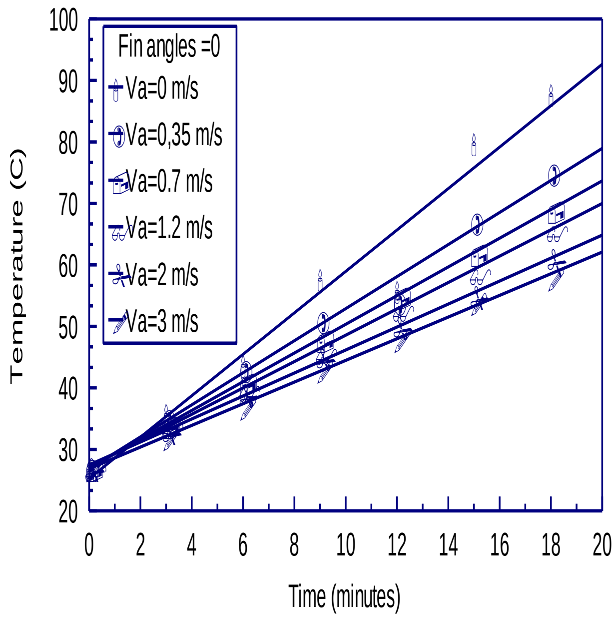


Fig. (5)

Also, notified from Figures (3), (4) and (5) that as flow velocity increased, as fin temperature decreased. This is as a result of increasing heat transfer rate.

IV. 2 Effect of Air Velocities on Heat Transfer Rate:

From Figures (6) to (11). It is noted from Fig. 6 that the temperature range from (90 ˚C to 95 ˚C), but from Fig. (7), the temperature range from (75 ˚C to 90 ˚C). Also, it is evident from Fig. 8 that the temperature range from (70 ˚C to 92 ˚C). This decided that as the air velocity increased, as the fins temperature decreased. This is because the heat transfer rate increased. Also, noted that as the flow angle increased, as the fin temperature decreased.

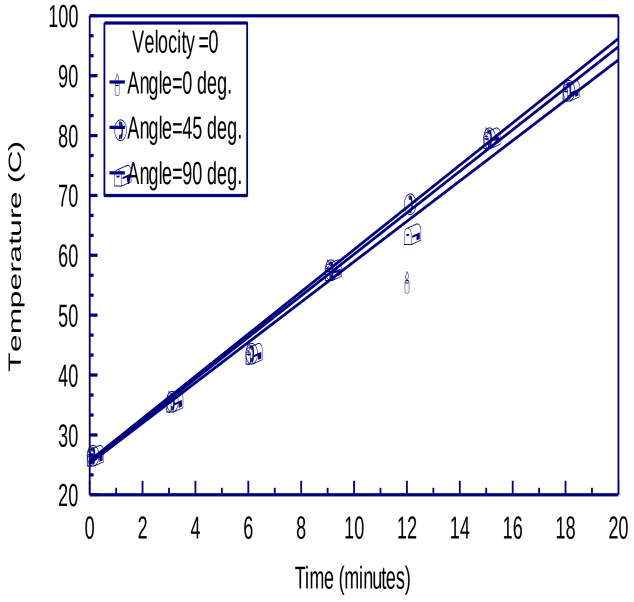


Fig. (6)

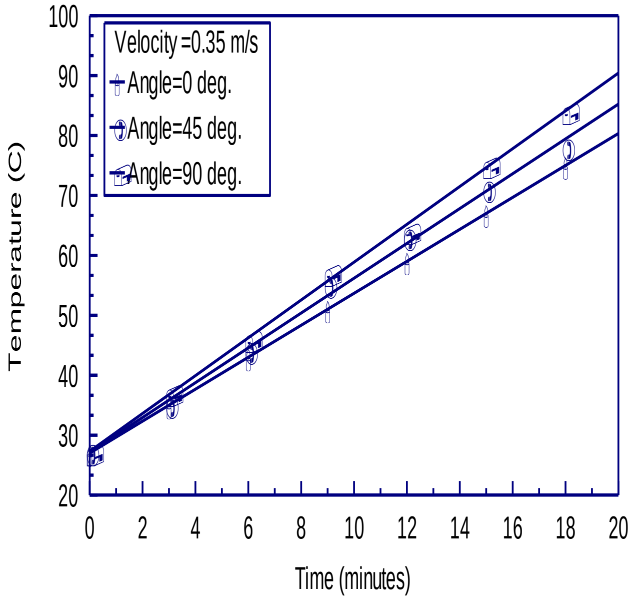


Fig. (7)

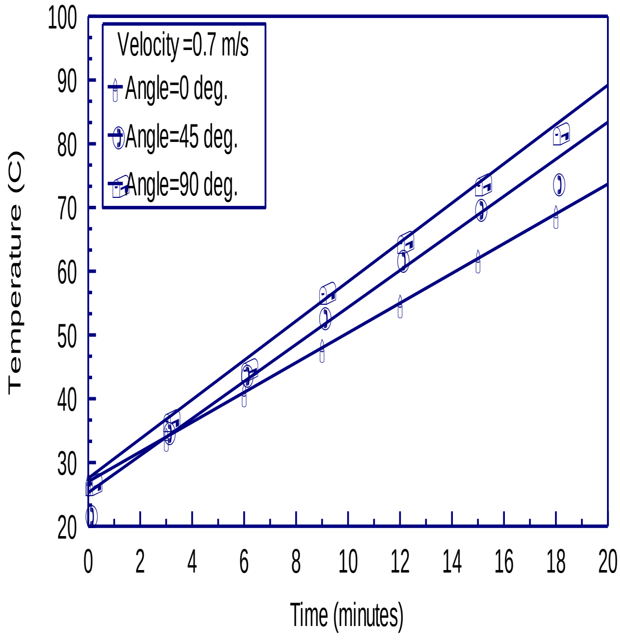


Fig. (8)

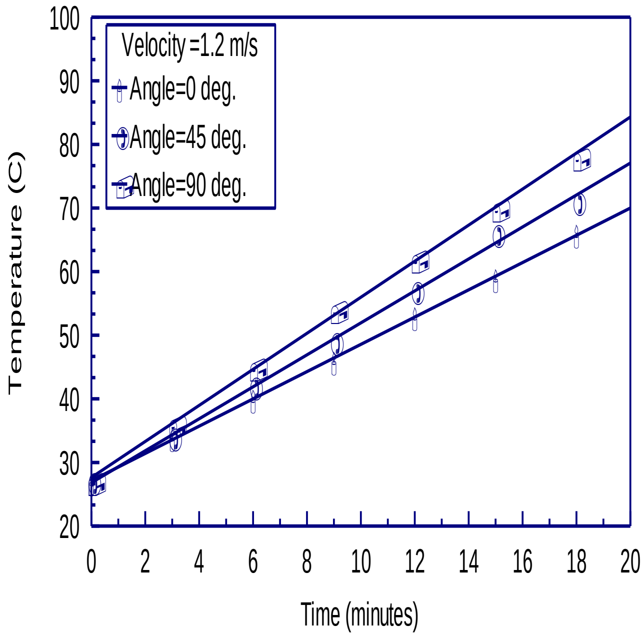


Fig. (9)

It is evident from Fig. (9) that the temperature range nearly (67˚C to 85 ˚C), but from Fig. (10), the temperature range from (63 ˚C to 75 ˚C). Also, it is evident from Fig. (11) that the temperature range from (57 ˚C to 78 ˚C). This decided that as the air velocity increased, as the fins temperature decreased. This is because the heat transfer rate increased. Also, noted that as the flow angle increased, as the fin temperature decreased.

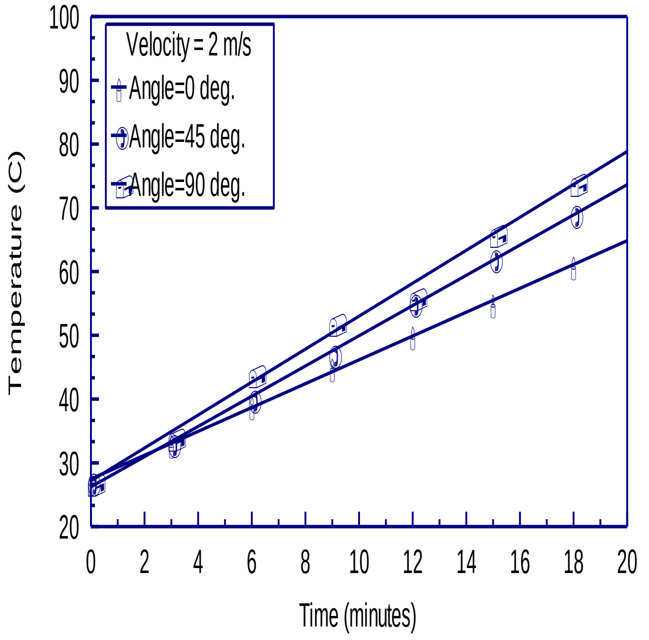


Fig. (10)

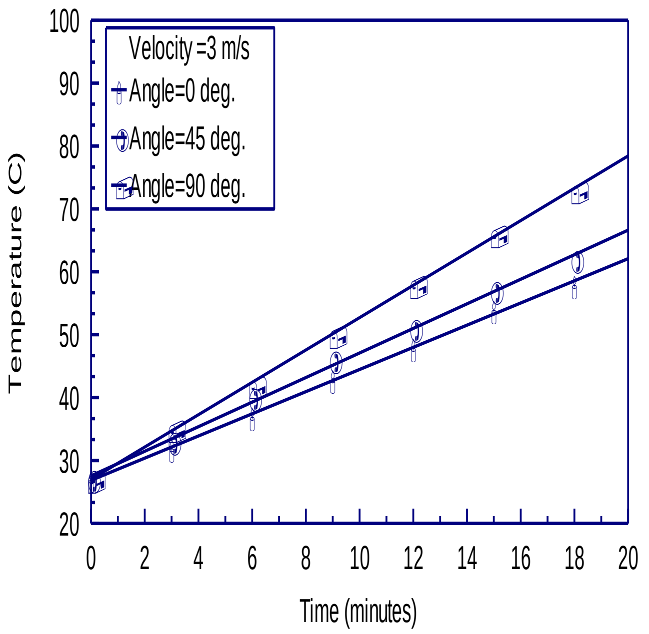


Fig. (11)

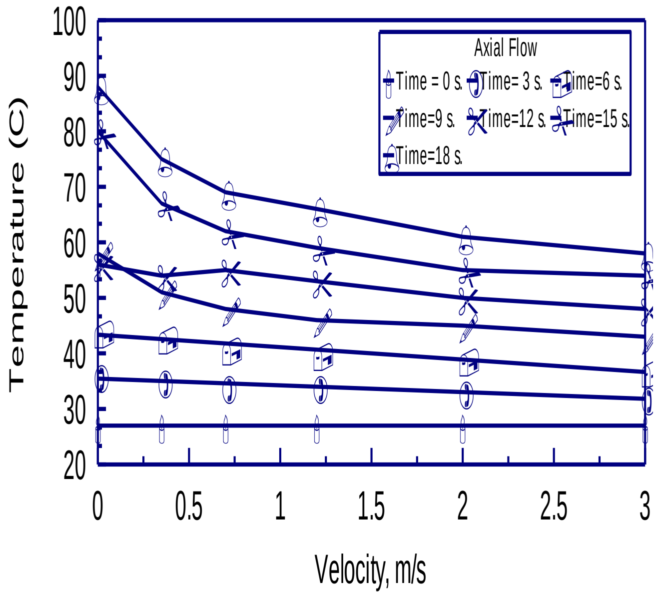


Fig. (12)

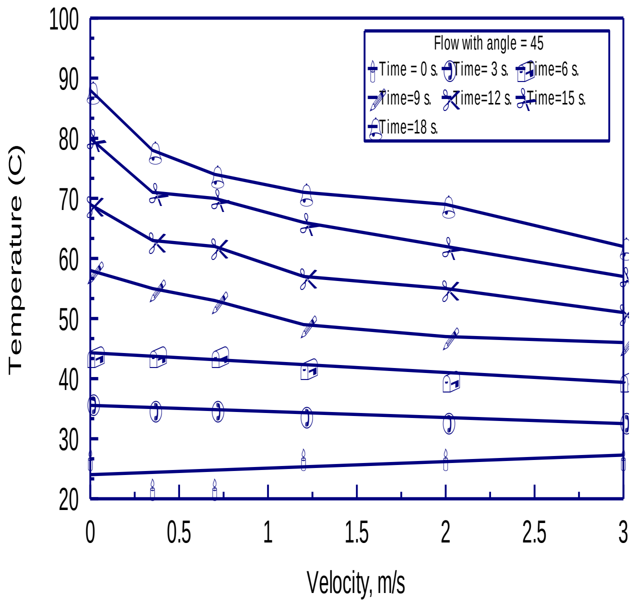


Fig. (13)

IV.3 **Effect of Air Velocities on Heat Transfer Rate:**

It is decided from Figures (12) to (14) that both the flow angle and flow speed affect strongly on fins heat transfer rate. Also, noted that both the flow angle = 45˚ , and flow velocity = 3 m/s are the best. Because they reduced the fin temperature approximately 30%.

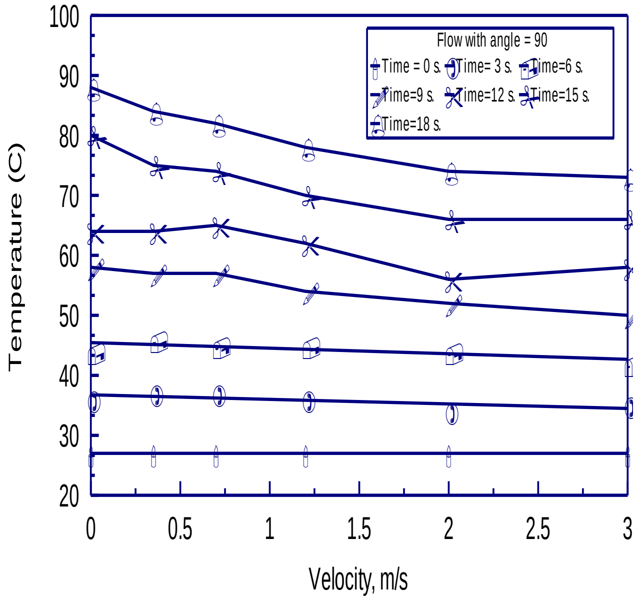


Fig. (14)

IIV. CONCLUSION

1-The radiation heat transfer in forced convection cooled finned surfaces is usually disregarded for two reasons. First, forced convection heat transfer is usually much larger than that due to radiation, and the consideration of radiation causes no significant change in the results. Second, the heat exchanger fin convection cooled systems are mounted so close to each other that a component is almost entirely surrounded by other components at about the same high temperature. As air velocity increased, as the fins temperature decreased. This is because the heat transfer rate increased. Also, noted that as the flow angle increased, as the fin temperature decreased.
2- The radiation effect is most significant when free convection cooled finned surfaces due to convection heat transfer coefficient is small (thus free convection cooling is limited). Also, as the flow angle increased, as the fin temperatures range increased also.
3. The flow angle and flow speed affect strongly on heat transfer fin rate.
4. Both the flow angle = 45˚ , and flow velocity = 3 m/s are the best. Because they reduced the fin temperature approximately 30%.

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