THE EXPERIMENTAL DETERMINATION OF L/D RATIO USING WATER IN MINI CHANNELS TO ANALYSIS OF FLUID TEMPERATURE PERFORMANCE WITH NANO PARTICULATES

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Abstract: *Nano fluids is advantageous with high thermodynamic properties compared to pure fluids. In the last half century, rapid developments in production technology, which allows high-precision production of the micro heat exchangers and the use of the micro heat exchangers in different areas. These developments point researchers to enhance new methods in improving the heat transfer. One of these methods is; to improve fluid's heat transfer by adding different particulates to the fluid. The nano fluids are the new type of heat transfer fluids that are made by adding nano particulates which has high thermal conductivity to a conventional fluid. Since the solid metal has a higher thermal conductivity than the basis fluid, the addition of the metallic particulates to the fluid increases the heat transfer of the mixture. In this study, for analyzing the temperature performance of fluids with Nano particulates; an experimental study was performed using water to determine the optimum mini channel length and mini channel diameter. Performance parameters are; channel length, tube mini channel diameter, the flow and the inlet temperature. According to the experimental results, the maximum temperature performance of the mini channel was found to be at L/D=250/3 (at Selcuk University condition). Therefore, with these results, the optimum mini channel length and mini channel diameter are determined for the high efficiency that is to be achieved by using nano fluids.*

KEYWORDS: MİNİ CHANNEL, TEMPERATURE, PERFORMANCE, NANO FLUİD

1. Introductıon

Nano fluids are formed by mixing metallic or non-metallic particles smaller than 100 nm into conventional fluids such as water, biodiesel oil and ethylene glycol. Today, high performance heat transfer is required for industrial activities. However, due to their low heat transfer coefficient values, the amount of increase in heat transfer is limited to a certain point. Nano fluids have higher heat transfer coefficient values than conventional fluids. For this reason, it is very advantageous compared to conventional fluids.

Developments in nanotechnology, the nanofluidic word, was first described by Choi in 1995 as suspensions of solid nanoparticles suspended in liquid by nanometer size. Choi et al. [1] have shown that even at very small nanoparticle concentrations, the thermal conductivity coefficient of the nanofluid increases abnormally. Such experimental studies have shown that high thermal conductivity can be obtained with nano fluids [1-5]. The high coefficient of thermal conductivity in the nanoparticles offers the opportunity to increase the efficiency of heat transfer equipment. Accordingly, it is possible to reduce the size of the heat transfer equipment and reduce the operating expenses of the equipment. Hamilton and Crosser [6] have proposed a new model of heat transfer coefficient for nanofluids, taking into account the thermal conduction model and the effect of the Brownian motion. Corcione [7] made several experimental results for the nanoparticles in different sizes and at volume flow ratios in the literature to match the nanofluidic coefficient of thermal conductivity and viscosity.

In the existing literature, there are many the experimental, theoretical and analytical studies on nanofluid [8-15].

In this study, an experimental study was conducted using water to determine the effective mini channel length (L=250 and 350 mm) and diameter (D=2 and 3 mm) for the analysis of the temperature performance of nanoparticle fluids. Performance parameters are determined as mini channel length, mini-channel diameter, volume flow rate (VFR) and mini-channel inlet temperature. The best performance was obtained at T_{inlet} = 40 ° C (ΔT_{max} = 8.269 ^oC).

2.Temperature Performance Analysıs In Mını Channels

The experimental system used to determine the temperature performance of nanoparticulated fluids is presented in Fig. The test setup equipments are numbered in Fig. 1.

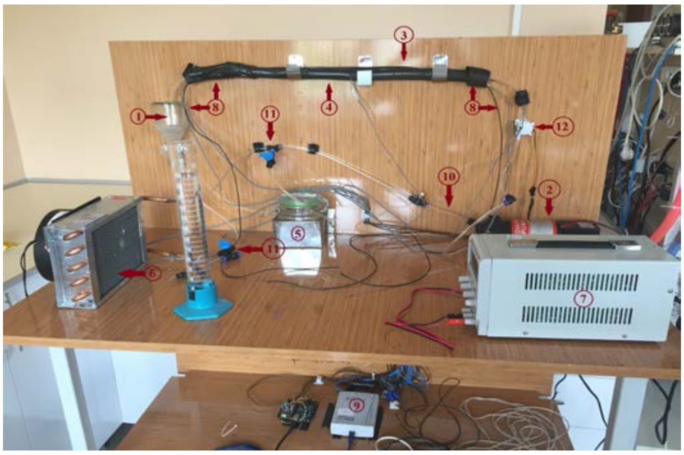


Fig. 1. Experimental system

The collection tank (1), diaphragm pump (2), mini-channel (3), silicon resistances (4), the reservoir (5), the fan (6), the DC power supply (7), thermal couples (8), data logger (9), plastic pipe (10), the valves (11), flow meter (12).

In this study, it is aimed to determine the effective L/D ratio using water to determine the temperature performance of the fluids in the mini-channels. Performance parameters are mini channel length, mini channel diameter, volume flow rate and mini channel input temperature. In this study, it is 0.2 lt/min (the low volume flow rate) and 0.7 lt/min (the high volume flow rate). Findings of this study are presented below.

In the mini channels, the temperature performances are presented in Fig. 2. for different L/D ratios.

Analysis of Figure 2a;

- ΔT_{max} is 0.99 ^oC for L/D = 250/2 and the low volume (LV) flow rate.
- ΔT_{max} is 2.815 ^oC for L/D = 250/3 and the low volume flow rate.
- ΔT_{max} is 0.787 ^oC for L/D = 250/2 and the high volume (HV) flow rate.
- ΔT_{max} is 1.848 ^oC for L/D = 250/3 and the high volume flow rate.
- The best performance occurred at L/D = 250/3 and the low volume flow rate for Figure 2a.

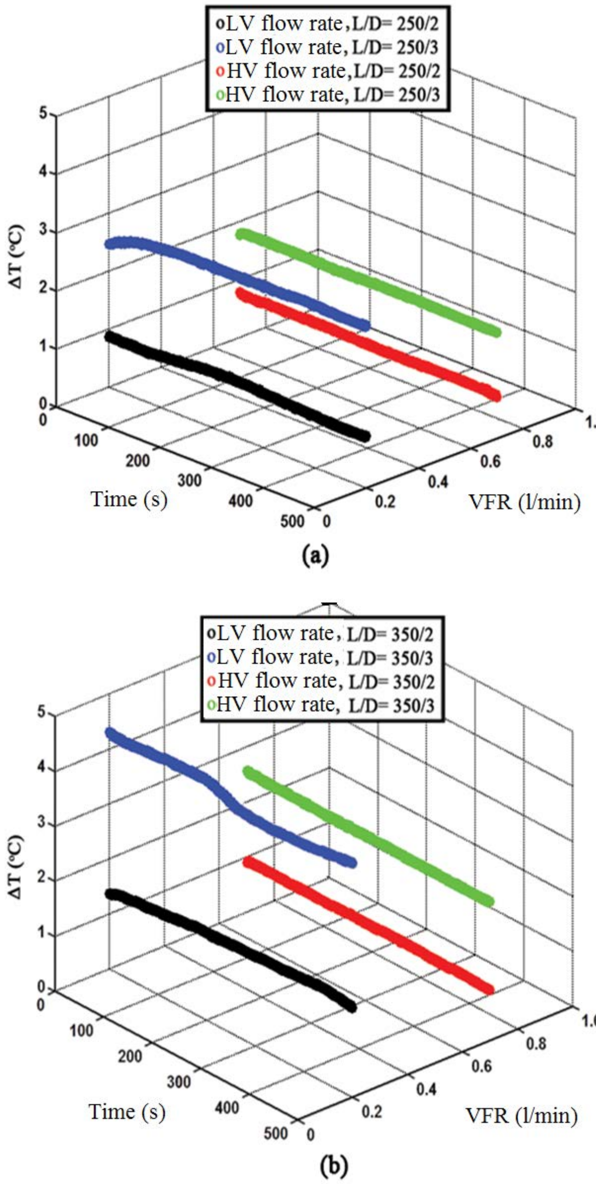


Fig. 2a) The temperature performances for L = 250 mm, D=2 mm
2b) The temperature performances for L = 350 mm, D=3 mm

Analysis of Figure 2b;

- ΔT_{max} is 1.72 ^oC for L/D = 350/2 and the low volume flow rate.
- ΔT_{max} is 4.379 ^oC for L/D = 350/3 and the low volume flow rate.
- ΔT_{max} is 0.962 ^oC for L/D = 350/2 and the high volume flow rate.
- ΔT_{max} is 2.571 ^oC for L/D = 350/3 and the high volume flow rate.

The best performance occurred at L/D = 350/3 and the low volume flow rate (Fig. 2b).

In the mini channels, the temperature performances are presented in Fig. 3. for at the various volume flow rates.

Analysis of Figure 3a;

- ΔT_{max} is 0.99 ^oC for L / D = 250/2.
- ΔT_{max} is 2.815 ^oC for L / D = 250/3.
- ΔT_{max} is 1.72 ^oC for L / D = 350/2.
- ΔT_{max} is 4.379 ^oC for L / D = 350/3.

The best performance was obtained at L/D = 350/3 (Fig. 3a).
The best performance was obtained at L/D = 350/3 for Fig. 3b.

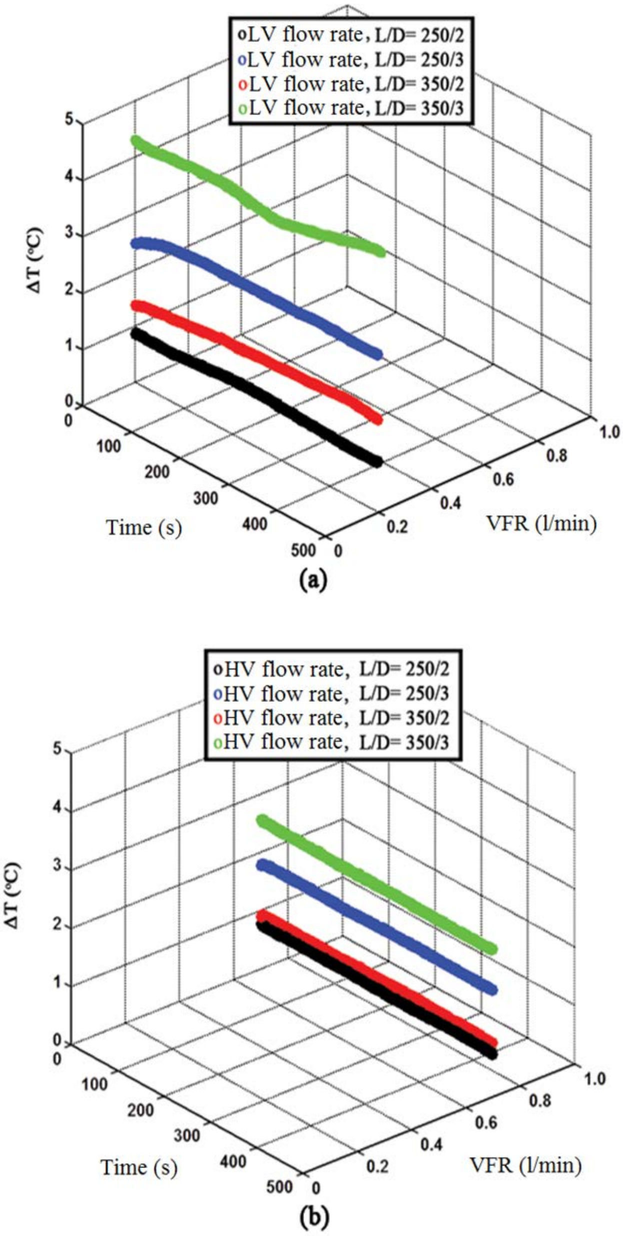


Fig. 3a) The temperature performances for the low volume flow rate (L = 250 and 350 mm, D=2 and 3 mm)
b) The temperature performances for the high volume flow rate (L = 250 and 350 mm, D=2 and 3 mm)

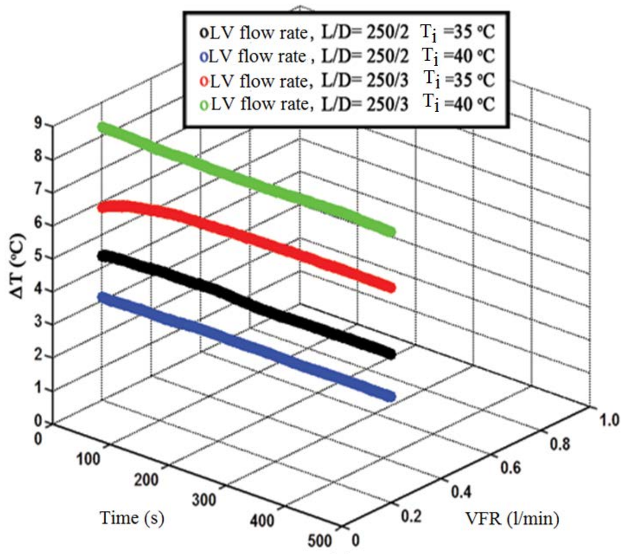
Analysis of Figure 3b;

- ΔT_{max} is 0.787 ^oC for L / D = 250/2.
- ΔT_{max} is 1.848 ^oC for L / D = 250/3.
- ΔT_{max} is 0.962 ^oC for L / D = 350/2.

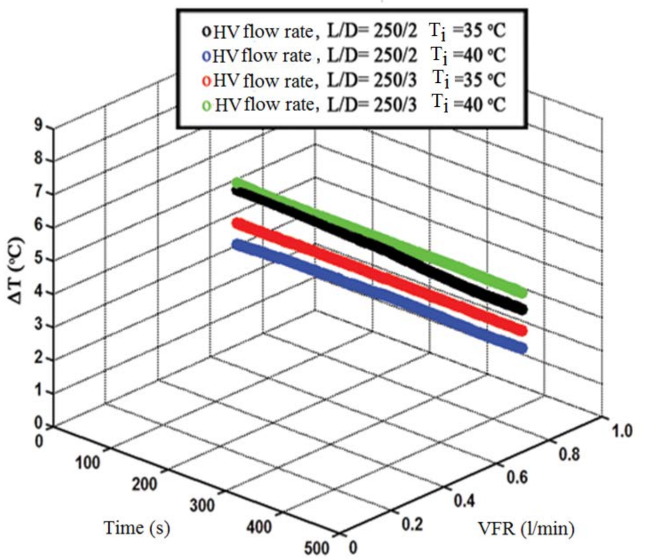
ΔT_{max} is 2.571 ^oC for L / D = 350/3.

Temperature performance studies were carried out for the mini channel inlet temperature (T_i) = 35 ^oC and 40 ^oC, D= 2 and 3 mm. It has been observed that performance increases for L=250 mm when mini channel inlet temperatures are increased. Therefore, studies were made of L = 250 mm.

In the mini channels, the temperature performances are presented in Fig. 4. for T_i= 35 ^oC and 40 ^oC.



(a)



(b)

Fig. 4 a) The temperature performances for the low volume flow rate (L = 250, D=2 and 3 mm, T_i=35 and 40 ^oC)
b) The temperature performances for the high volume flow rate (L = 250, D=2 and 3 mm, T_i=35 and 40 ^oC)

Analysis of Figure 4a;

- ΔT_{max} is 4.454 ^oC for T_i = 35 ^oC for L / D = 250/2.
- ΔT_{max} is 3.217 ^oC for T_i = 40 ^oC for L / D = 250/2.
- ΔT_{max} is 6.536 ^oC for T_i = 35 ^oC for L / D = 250/3.
- ΔT_{max} is 8.269 ^oC for T_i = 40 ^oC for L / D = 250/3.

The best performance was obtained at L/D = 250/3, at the channel inlet temperature = 40 ^oC for Fig. 4a.

Analysis of Figure 4b ;

- ΔT_{max} is 4.707 ^oC ^oC for T_i = 35 ^oC for L/D = 250/2.
- ΔT_{max} is 3.217 ^oC for T_i = 40 ^oC for L/D = 250/2.
- ΔT_{max} is 3.716 ^oC for T_i = 35 ^oC for L / D = 250/3.
- ΔT_{max} is 4.892 ^oC for T_i = 40 ^oC for L / D = 250/3.

The best performance was obtained at L/D = 250/3 at the channel inlet temperature = 40 ^oC for Fig. 4b.

3. Results

In this study, an experimental study was carried out using water to determine the effective L and D for the analysis of the temperature performance of nano fluids. Performance parameters are L, D, the volume flow rate and the inlet temperature of mini channel. The best performance was obtained at T_i = 40 ° C (ΔT_{max} = 8.269 ^oC) while L/D = 250/3 and the low volume flow rate.

4. Acknowledgments

This work was supported by Selcuk University under contract No. BAP_16201047.

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