TRANSPORT CHARACTERISTICS OF A TRANSPORT DEVICE COMPOSED OF TWO MAGNETICALLY-DRIVEN SYSTEMS USING A TEMPERATURE-SENSITIVE MAGNETIC FLUID

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Abstract. The transport properties of fluid transport device composed of two magnetically-driven systems utilizing a temperature-sensitive magnetic fluid were investigated experimentally. Two driven systems were connected in tandem or in parallel. The flow rate of the two driving systems in parallel arrangement is larger than the flow rate of two driving systems in tandem arrangement.

1. Introduction

Magnetic fluids are colloidal suspensions composed of ferromagnetic particles covered with surfactant and mother liquid such as water and kerosene. Temperature-sensitive magnetic fluids are sensitive to temperature as well as applied magnetic field, i.e., magnetization of the temperature-sensitive magnetic fluids strongly depends on the temperature. The basic principle of the magnetically-driven system was proposed by Resler and Rosensweig [1]. The principle of energy conversion using this magnetically-driven system was proposed and many researchers have been studied [2-4]. When a non-uniform magnetic field is applied to the temperature-sensitive magnetic fluid by using a permanent magnet, the magnetic body force proportional to the gradient of the magnetic field acts on the fluid. When heat is applied to the fluid at the position displaced from the center of the arranged permanent magnet, a difference occurs in the balanced positive and negative magnetic body forces, which produces as a driving force and transport the fluid. The magnetically-driven system can be used for heat transport system, and this system is self-driven by applying magnetic field and heat, and its size can be reduced with a simple structure. In the previous research, it has been shown that using this system, the fluid is self-driven by applying magnetic field and heat, and heat transport of 6000 mm is possible [5]. In order to enhance the transport properties, it is conceivable to use multiple magnetically-driven systems connected in tandem or in parallel.

In this study, fluid transport characteristics of the transport device composed of two magnetically-driven systems using temperature-sensitive magnetic fluid is investigated experimentally. The flow rate of the transport device is measured when the magnetically-driven systems are arranged in tandem or in parallel.

2. Experiments

The experimental apparatus for investigating transport properties of transport device using the magnetically-driven system mainly consisted of a fluid driving part, a fluid cooling part, and a flow rate measuring part. Figure 1 shows the arrangements of the drive systems as the fluid driving part. In our experiments, the flow rate was measured and compared in the case of one drive system or the case when two drive systems were connected in tandem or in parallel. The test fluid was the temperature-sensitive kerosene base magnetic fluid (TS-50K, Ichinen Chemicals Co. LTD) whose magnetization strongly depends on the temperature in the normal temperature region. The diameter of the tube made of Teflon was 1.54 mm and the total length of the tube was 1730 mm. The maximum strength of applied magnetic field was 273 kA/m and the magnetic field was applied by using two permanent magnets whose width was 22 mm. The position of the magnets was changed and *d* is defined by the distance between the center of the magnets and the center of the heating area. When the number of drive system was 2, the distance *d* of one drive system was fixed to 25 mm. The heat flux was 5.0 kW/m^2.

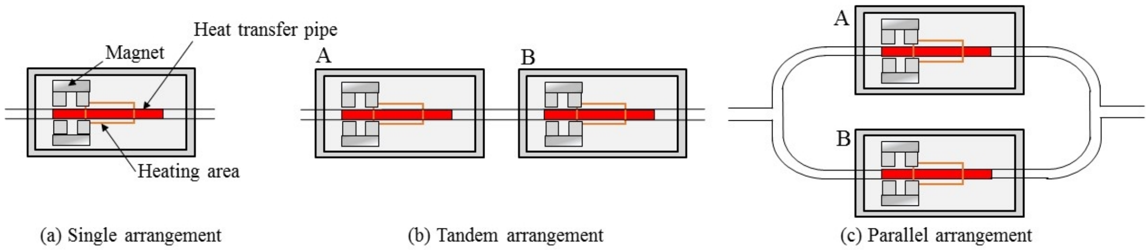

Fig. 1. Arrangements of the drive systems.

3. Results and discussions

Figure 2 shows the flow rates of the transport device when the distance *d* is changed. From Fig. 2, it can be seen that the flow rate is larger in the cases of using two magnetically-driven systems than in the case of using one magnetically-driven system. The flow rate is the largest when two magnetically-driven systems are connected in parallel. When two driving systems are connected in parallel, loss is generated at the junction part of the two flow paths, so it is considered that the flow rate is smaller than twice flow rate of the single system. In any case, when the magnet is arranged at 25 mm from the center of heating area, the flow rate becomes maximum. When two driving systems are connected in tandem, the flow rate is 1.55 times the flow rate of one drive system, while the flow rate of two driving systems in parallel is 1.75 times that of one driving system.

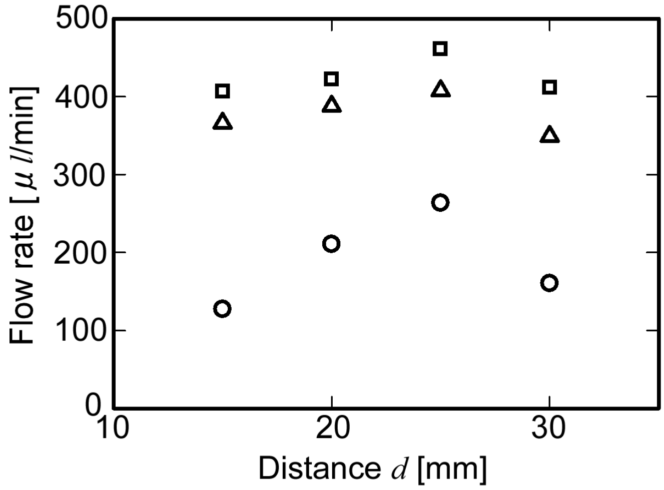

Fig.2. Flow rate of the transport device. The open circle: one drive system, the open triangle: two driving systems in tandem, and the open square: two driving systems in parallel. The distance *d* is defined by the distance between the center of magnet and the center of the heating area.

Conclusions

It has been found that the fluid transportation amount is increased when two driving systems are arranged than when only one driving system is provided. In the case of using two driving systems, the flow rate is larger in the case of connecting in parallel than in the case of connecting in tandem.

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