9th International Conference on Thermal Engineering: Theory and Applications
March 24-26 2016, Abu Dhabi, UAE

Liquid Flow Enhancement using Natural Polymeric Additives: Effect of Concentration

Hayder A. Abdul Bari [1,2], Fiona W.M. Ling [2]

[1] *Centre of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, Gambang 26300, Kuantan, Pahang, Malaysia*
[2] *Faculty of Chemical Engineering and Natural Resources, University Malaysia Pahang, Lebuhraya Tun Razak 26300 Kuantan, Pahang, Malaysia*

Abstract

Drag reduction technique is developed and applied widely in industries nowadays after the pioneer work from Toms in 1949 which are used to reduce the friction factor of the fluid flow. Active drag reduction by introducing polymers, as drag reducing additives, to the pipes or conduits are preferably to be used in industries for their economic value and effectiveness. In this work, natural polymers from okra (*Abelmoschus esculentus*) were extracted and was used as drag reducing agents to enhance the fluid flow in micro-channels. Investigation on the effect of variable concentration (100 to 500 ppm) of okra mucilage with 100 µm micro-channels on drag reduction is carried out. Maximum drag reduction up to 180% is achieved using 500 ppm of okra mucilage.

Keywords: Drag reduction, Micro-channels, Natural polymer.

1. Introduction

Great pressure drop in the pipeline system has been one of the major problem in oil and gas industries where the industries now are using pump to increase back the pressure of the fluids for the long transportation. Thus, there is a vast interest from researches to develop drag reduction (DR) after the pioneer work from Toms in 1949 [1].

DR is a technique to suppress the turbulence element, called eddies, hence increase the fluid flow in the conduits or channels after adding a minute amount, usually part per millions of drag reduction additives (DRA) [2]. Since then, Toms effect is not only commercially utilized in the 1300 km USA Alaskan pipeline [2-4] but also greatly applicable in other fields such as oil well operations, flood water disposal, firefighting, field irrigation, transportation of suspensions and slurries, water heating and cooling systems, airplane tank filling, marine systems, and medical application [5-9].

Active DR technique, by introducing polymers [10-14] and surfactants [15-21], is preferably to be used in industries for their economic value and effectiveness. Due to the degradation under high shear stress [22] and the properties of surfactants themselves, surfactants can only work in limited range of temperature and concentration [23].

In order to replace surfactants as DRA, many researchers have studied the feasibility of using polymers to enhance the flow in pipes. Therefore, in this study, natural polymeric DRA are introduced to enhance the flow of liquid. Microchannel was used in conducting this experiment to replace the conventional way as pipes can lead to several problems e.g., long preparation time and large amount of reagents used thus contribute to environmental problems [24]. In this research, effect of natural polymeric DRA was investigated.

2. Experimental Procedure

2.1. Material and Solution Preparation

In this work, fresh okra (*Abelmoschus esculentus*) were purchased from local market. The okra was chopped and soaked in 1L distilled water overnight to extract the mucilage out from the okra pod. The clean water would turn into a very thick solution indicating that the mucilage is ready to be used. Different concentration of okra mucilage solution ranging from 100 ppm to 500ppm were prepared by adding deionized (DI) water.

2.2. Experimental Set-Up

An experimental apparatus was erected as shown in Fig. 1**Error! Reference source not found.** for obtaining drag reduction data at wide range of okra mucilage concentrations.

The experimental setup comprised of pressure and vacuum controller (model: Elveflow OB1 MK3), an Elveflow flow sensor, costume-made thermoplastic polymer (Topas) straight micro-channel (size: 100 µm) provided by Chip-shop in Germany, tube connection and a beaker as storage tank. The structure started with the connection from the pressure and vacuum controller to a