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Review

Roles of drag reducing polymers in single- and multi-phase flows

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ABSTRACT

It has become a well-known fact that finding sustainable solutions to the unavoidable high pressure losses accompanying pipeline flows to increase the pumping capacity without necessarily adding more pump stations is inevitable. Polymers, as one of the drag reducing agents which have been found to offer such an economic relieve, is the most widely investigated and most often employed in industries because they can produce drag reduction up to 80% when they are added in minute concentrations. In addition, polymer additives modify the flow configurations of multiphase flows to such an extent that stratification of individual phases is enhanced thereby making the separation of the phases at the fluid destination much easier. The achievements so far made and the challenges facing the use of polymers as drag reducers in turbulent single and multiphase flows are comprehensively reviewed. This review discusses the experimental studies of the effects of polymer additives in turbulent flows, the analytical studies, and the proposed models as well as the suggested mechanisms that explain the drag reduction. Likewise, specific areas of interest in the review include phenomena of drag reduction by polymers, factors influencing the effectiveness of the drag reducing polymers, methods of injecting the polymers into the base fluids, degradation of the polymers and industrial applications of polymers as drag reducing agents. The current and future research interests are also addressed. Although finding reveals that there are quite a lot of research in this area, most of the experimental and theoretical works are devoted to single phase flows while the remaining ones are mostly directed towards gas–liquid flows except in very recent time when investigation into the use of polymers in liquid–liquid flows is being focused. Despite this voluminous works on drag reducing polymers, there are no universally accepted models and hence the mechanisms of drag reductions by polymers.

Keywords: Drag reducing polymer; Drag reduction; Single phase flow; Multiphase flow; Flow patterns

Contents

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1. Introduction

The concept of drag (or pressure drop) reduction in pipe flow using drag reducing agents (DRAs) has generated practical engineering interest because of these agents' abilities to reduce pumping power and increase piping system capacity. Recently, some drag reduction studies in multiphase flows revealed that apart from pressure drop, DRAs can also affect the spatial distribution of the fluids in the pipe and the boundaries between different flow patterns (Oliver and Young, 1968; Greskovich and Shrier, 1971; Virk, 1975; Al-Sarkhi and Hanratty, 2001a,b). Such areas of interest where these additives are particularly gaining tremendous attention are oil production and transportation pipelines, and district heating and cooling. The additives causing drag reduction can be divided into five categories: polymers, surfactants, fibres, micro-bubbles and compliant coating. This review presents only the use of polymers as drag reducers in turbulent single and multiphase flows as they have been most employed at industrial level due to their advantage of being applied in very small quantities when compared to surfactants and fibres.

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