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Rotating Disk Apparatus: Types, Developments and Future Applications

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Abstract

Power consumption reduction investigations attracted the attention of enormous numbers of researchers in the past few decades due to its high academic and economic impacts. The pumping power losses during the transportation of crude oils are considered as one of the main power consuming applications due to the turbulent mode of transportation. Investigating the possible solutions for this problem is expensive and time consuming due to the large apparatuses needed to simulate the flow in real pipelines. Rotating disk apparatus (RDA) is an instrument mainly comprising a rotating disk and an electrical motor to rotate the disk, which was implemented as an efficient and economical path to simulate what can be done in pipelines through generating a controlled degree of turbulence. This technique was also used in many other scientific applications due to its dynamic mode of operation. For example, a rotating disk electrode was used in electrodeposition processes and to characterize deposition film thickness and uniformity. The rotating disk reactor was employed to investigate the reaction rate between fluids and solid surfaces. The present work evaluates the RDA from different prospective and applications in order to introduce it as an efficient research tools for future dynamic investigations.

Keywords: rotating disk apparatus, drag reduction, rotating disk electrode, rotating disk reactor

1. Introduction

In industry and research many types of rotating disk apparatus have been used, which can be classified and named depending on their use and application. For example, the rotating disk electrode apparatus can be used in electrodeposition processes and characterizes film uniform and thickness. The rotating disk instrument is increasingly being applied in the laboratory to study the reaction between fluids and solid surfaces. It is widely used in the petroleum industry for kinetic studies of the reaction of acidic fluids and chelating agents with reactive rock (Boomer, Mccune & Fogler, 1972; Fredd & Fogler, 1998; K. Lund, Fogler & Mccune, 1973; K. Lund & Foglers, 1975). In addition, it is employed to examine the effects of different additives on the drag reduction performance of liquids. The rotating disk apparatus (RDA) used in drag reduction applications is an equipment for simulating external flow, which includes the flow over flat plates, as well as the flow around submerged objects and is used for turbulent drag reduction characterization (Tong, Goldburg, Huang & Witten, 1990).

Although the drag reduction mechanism has been the focus of significant research, reportedly no comprehensive and sufficient explanation has been found (Armstrong & Jhon, 1984; Cadot, Bonn & Douady, 1998; Gyr & Bewersdorff, 1995; Jhon, Sekhon & Armstrong, 1987; Tabor & Gennes, 2007). Several attempts can be found in the literature to introduce different techniques to reduce the energy dissipation in pipelines. Generally, these techniques can be classified into two major categories, namely: passive and active (Abdulbari, Yunus, Abdurahman & Charles, 2013; Hwang, Kwon & Cho, 2008).