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Effects of Co-current and Cross Flows on Circular Enhanced Gravity Plate Separator Efficiencies

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Abstract

This study compares the effects of flow on oil and suspended solids removal efficiencies in circular enhanced gravity plate separator equipped with coalescence medium. Coalescence medium acts to capture rising oil droplets and settling solid particles and assist in the coalescence of oil and coagulation of solid. The circular separator uses an upflow center-feed perforated-pipe distributor as the inlet. The co-current flow is achieved using 4 increasing sizes of frustum, whereas cross flow uses inclined coalescence plates running along the radius of the separator. The different arrangement gave the cross flow separator a higher coalescence plan area per operational volume, minimal and constant travelling distance for the oil droplets and particles, lower retention time, and higher operational flowrate. The cross flow separator exhibited 6.04% and 13.16% higher oil and total suspended solids removal efficiencies as compared to co-current flow.

Keywords: Circular enhanced gravity plate separator, Coalescence medium, Co-current flow, Cross flow, Oil droplets and solid particles removal

1. Introduction

Regulatory requirement for oil and suspended solids content allowable in sewage and industrial effluent discharge are ≤10 mg/L and ≤100 mg/L, respectively, for most countries, such as the United State, Canada, Colombia, Malaysia, and some European countries [1]. Effluent from oil and gas industry or shipping activities contains high amount of oil [2]. Wastewater high with suspended solids particles due to erosion are introduced into the environment from land clearing and earthworks activities [3].

Most separators used to treat oil or solids are rectangular separator [4]. Some of these separators currently in use include 1) the American Petroleum Institute separators, 2) coalescing plate separators, 3) coalescing tube separators, and 4) packing type separators [5]. Rectangular separator has a constant horizontal velocity, v_h throughout. In rectangular separator, co-current flow is favorable for solid particles removal whereas cross flow is preferable for oil separation [6].

A circular separator takes advantage of the continual decrease in horizontal velocity, v_h as surface area increases along the radius. The decrease in horizontal velocity, v_h enhances separation. The circular separator is more compact as compare to rectangular separator [7]. The aim of this study is to determine which flow pattern along coalescence medium is preferable for oil and solid separation in a circular separator.

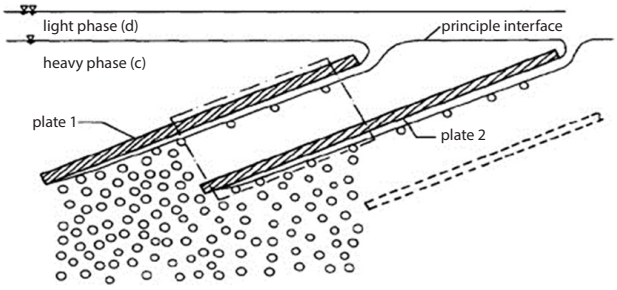

Fig. 1. Physics of processes in a plate settler [9].

Coalescence mediums in the form of parallel plates are applied in enhanced gravity separators to increase the separation efficiency by making the settling distance smaller and the interfacial area for the coalescence larger. In these separators, the oil droplets rise to the upper plate and form a trickling film which flows along the plate following the hydrostatic pressure gradient to the principal interface as shown in Fig. 1 [8-10]. Droplets of oil then coalesce on the trickling film [9].

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