DEVELOPMENT AND PERFORMANCE TESTS OF A SEPARATOR FOR REMOVAL OF PHYSICALLY EMULSIFIED AND FREE OILS FROM WASTEWATERS

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ABSTRACT

A novel oil-water separator with multiple angles parallel coalescence frustums for removal of physically emulsified and free oils from wastewater was recently developed. Performance tests had been carried out to determine its removal efficiency. The primary component of the separator includes a series of inverted and upright frustums-shaped coalescence plates to form a multiple angle plate arrangement for enhance gravity separation and coalescence of oil droplets. The oil removal efficiency (E) of this separator was found to be inversely proportional to influent flowrate (Q) and directly proportional to retention time, t. The efficiency (E) of this separator can be expressed as a function of flowrate (Q), retention time (t), and influent oil concentration (C_{oil}) by a series of power equations; $E = 59.689Q^{-0.107}$ for C_{oil} = 100 mg/L, $E = 70.753Q^{-0.1269}$ for C_{oil} = 1000 mg/L, and $E = 40.16t^{0.127}$ for C_{oil} = 1000 mg/L. For C_{oil} = 100 mg/L, E could be best expressed by polynomial equation, i.e., $E = 0.0001t^2 + 0.0045t + 57.147$. The highest achievable oil-water separation efficiency of this separation system was approximately 82.4% at a flowrate (Q) of $\leq 5x10^{-6}$ $m^{3/s}$, and retention time of ≥ 4.80 hours. It was found that the presence of an outlet baffle component for the separator could improve oil removal efficiency by approximately 12.9% as compared to without an outlet baffle.

Keywords: *Coalescence Frustums, Emulsified and Free Oils, Oil-water Separation, Removal Efficiencies*

1. INTRODUCTION

At present, the simplest systems are often inadequate and more complicated systems are either too expensive or too maintenance-intensive [1]. Some of the common separators in use with various designs include 1) American Petroleum Institute (API) Separators, 2) Coalescing plate separators, 3) Coalescing tube separators, and 4) Packing type separators. Burns and Mohr [2] used a coalescing plate separator to treat coolant contaminated with tramp oil. Foley et al. [3] upgraded a refinery "once-through" cooling water systems from a gravity separator with 8 pits arranged in 2 trains with the additional of multiple-angle coalescing plate module. Saleh and Hamoda [4] upgraded of a conventional rectangular sedimentation tanks by applying inclined plate settlers in secondary sedimentation to improve its performance. Veenstra et al. [5] provided an overview of oil-water separation as used in the petroleum refining industries. The two API separators were converted into four cells by adding multiple angle coalescing media pack, divider walls and additional inlet/outlet piping. Schlegel and Stein [6] proposed to feed the sludge/water mixture directly into the sludge layer on the bottom of the secondary sedimentation tanks. Demír [7] carried out a study to determine the settling efficiency and optimum plate angle for a rectangular settling tank with inclined parallel plate.

1A. OBJECTIVES

The objectives of this research project includes (a) to develop an enhanced oil-water separation system with multiple angles of parallel coalescence frustums for removal of physically emulsified and free oils from water suitable for small to medium volume of municipal wastewater loaded with oil and grease, and (b) evaluate and determine the separation system oil removal efficiency, *E* in relation to the specific design and influent parameters such as oil concentrations, flowrates and retention time.

2. HYPOTHESIS

In the 1920's, Boycott noticed that blood cells settled faster in test tubes that were inclined than in tubes that were straight up or vertical. Acrivos and co-workers developed a theoretical basis, but the general concept is not difficult to grasp [8]. As illustrated in Figure 1, when the settler is inclined, the falling particles and the rising liquid get out of each other's way. In vertical tube, particles settling displace fluid that must rise. An element of this fluid passes past more particles and has to accelerate and decelerate depending on whether its path is wide or narrow. The vector arrows for the enlarged view are the same at the start, but eventually the inclined tube gets the particles near the wall where their direction changes. In this region, they are denser than in the vertical tube, and the liquid has a shorter

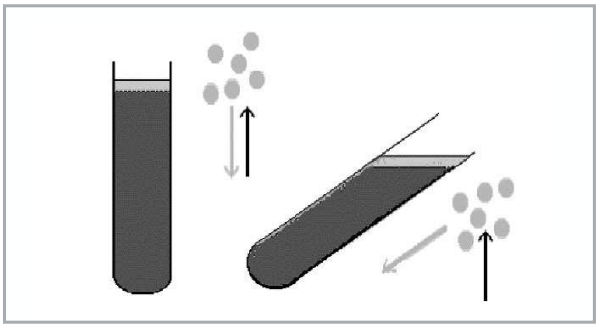

Figure 1: Comparison of particle settling in a vertical tube and an inclined tube