EFFECT OF ASPECT RATIO ON THE SUSPENDED SOLIDS SEPARATION EFFICIENCY OF CONVENTIONAL OIL/WATER SEPARATORS

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ABSTRACT: This research work investigated the effect of Aspect ratio (length:width) on suspended solids separation and the suspended solids (SS) separation efficiency of conventional oil/water separators. It was found that suspended solids separation and the suspended solids (SS) separation efficiency increased with increase in the Aspect ratio of the oil/water separators. Thus, suspended solids separation and suspended solids separation efficiency vary in direct proportion with the Aspect ratio of conventional oil/water separators.

1.0 INTRODUCTION

Only a small fraction of water used by industry is incorporated into its products or lost by evaporation. Most of the water is eventually emptied into natural water courses as wastewater (Fair and others, 1981).

The most important physical characteristic of wastewater is its total solids content which is composed of floating matter, settleable matter, colloidal matter and matter in solution (Metcalf & Eddy Inc., 2003). According to Domkundwar, V. (2014), the solids in wastewater are classified as suspended solids ($< 1\mu m$), dissolved solids ($< 10^{-3}\mu m$), colloidal solids (1 to $10^{-3}\mu m$) and settleable solids ($> 10\mu m$).

The objectives of wastewater treatment may be summarized as reduction of suspended solids, reduction of biochemical oxygen demand, destruction of

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pathogens, removal of nutrients, removal of toxic compounds, removal of non-biodegradeable compounds and removal of dissolved solids (Agunwamba J.C., 2001)

According to US Environmental Protection Agency (2005), oil/water separators used to pre-treat wastewaters are usually of two types namely Standard Gravity Oil/water separators (Conventional oil/water separator) and Enhanced Gravity oil/water Separators (Coalescing Plate Oil/water Separators).

Suspended solids separation and suspended solids separation efficiency are of great significance in wastewater quality management. Suspended solids refer to small solid particles which remain in suspension in water as a colloid or due to the motion of the water. It is used as one indicator of water quality. Furthermore, total suspended solids (TSS) is a water quality parameter used to assess the quality of wastewater after treatment in a wastewater treatment plant. It is listed as a conventional pollutant in the U.S. Clean Water Act (Wikipedia, 2015).

There are petroleum industry applications in which oil/water separators are the only end-of-pipe treatment provided. These are usually cases in which the only effluent restrictions specified are for oil or suspended solids and the wastewater in question consistently contains sufficiently low amount of emulsified and dissolved oils (American Petroleum Institute, 1990).

Conventional oil/water separators separate oil and suspended solids from wastewater. The API oil/water separator is an example of a conventional oil/water separator. The API oil/water separator is designed to separate gross amounts of oil and suspended solids from the wastewater effluents of oil refineries, petrochemical plants, chemical plants, natural gas processing plants and other industrial sources (Wikipedia, 2011).

The Aspect ratio of an oil/water separator is the ratio of its length to its width (Length:Width). This research work emphasizes the benefits associated with increasing the length of oil/water separators. Increasing the length of the separator increases the distance traveled by the wastewater in the separator. It also increases the residence time of the wastewater in the separator. Furthermore, it increases the contact time between suspended solids and consequently the aggregation of suspended solids as the wastewater travels through the oil/water separator. These attributes form the pivot of this research.

Suspended solids separation efficiency is one of the performance measures for oil/water separators. According to Ultraspin Inc. (2015), the performance of oil/water separators can be measured in many ways and the typical examples of performance measures are oil separation efficiency, suspended solids separation efficiency, flow rate capacity, reliability, operator training/attention required and

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ability to operate without service or maintenance.

The suspended solids (SS) separation efficiency of oil/water separators can be calculated as suspended solids concentration in the influent minus suspended solids concentration in the effluent divided by the suspended solids concentration in the influent. According to Ultraspin Inc. (2015), the suspended solids separation efficiency can be expressed as

$$Separation\ Efficiency, E = \frac{C_i - C_o}{C_i}\ x\ 100$$

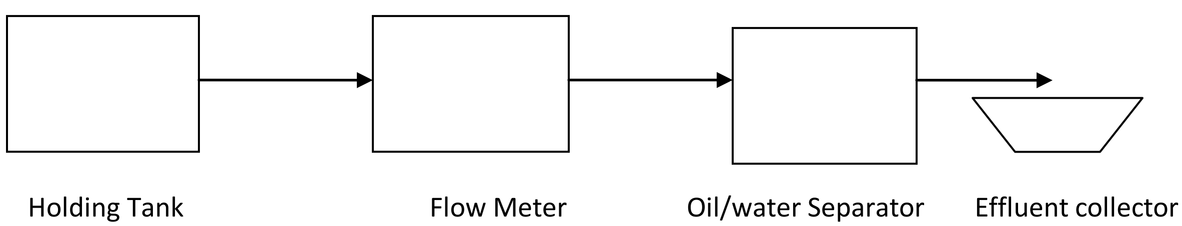
E = Suspended solids Separation efficiency

C_i = feed inlet concentration (mg/l)

C_o = discharge outlet concentration (mg/l)

2.0 METHODOLGY

Conventional oil/water separators of different Aspect ratios 1:1, 2:1, 3:1, 4:1 and 5:1 were constructed with steel plates. The oil/water separators were separately connected to a Holding tank and a Flow meter.



Wastewater samples of different suspended solids concentrations were flowed from the Holding tank through the Flow meter and the oil/water Separators at the same flow rate. The suspended solids concentrations in the influent and effluent were determined in the laboratory and recorded. The results are as evidenced by the graphs below. The suspended solids separation efficiency was calculated as follows.

$$Separation\ Efficiency, E = \frac{C_i - C_o}{C_i}\ x\ 100$$

E = Suspended solids separation efficiency

C_i = Total concentration of suspended solids in the influent (mg/l)

C_o = Total concentration of suspended solids in the effluent (mg/l)

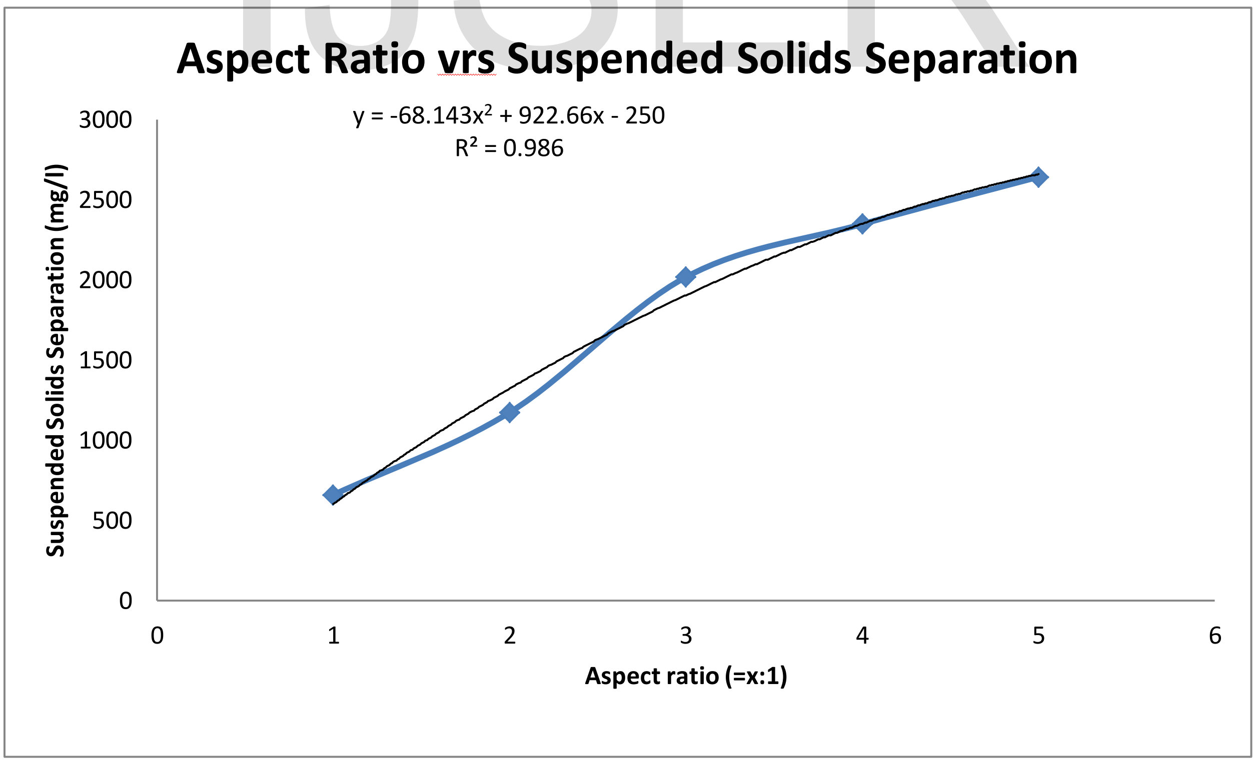


Fig. 1: Plot of Aspect ratio versus Suspended solids (SS) Separation

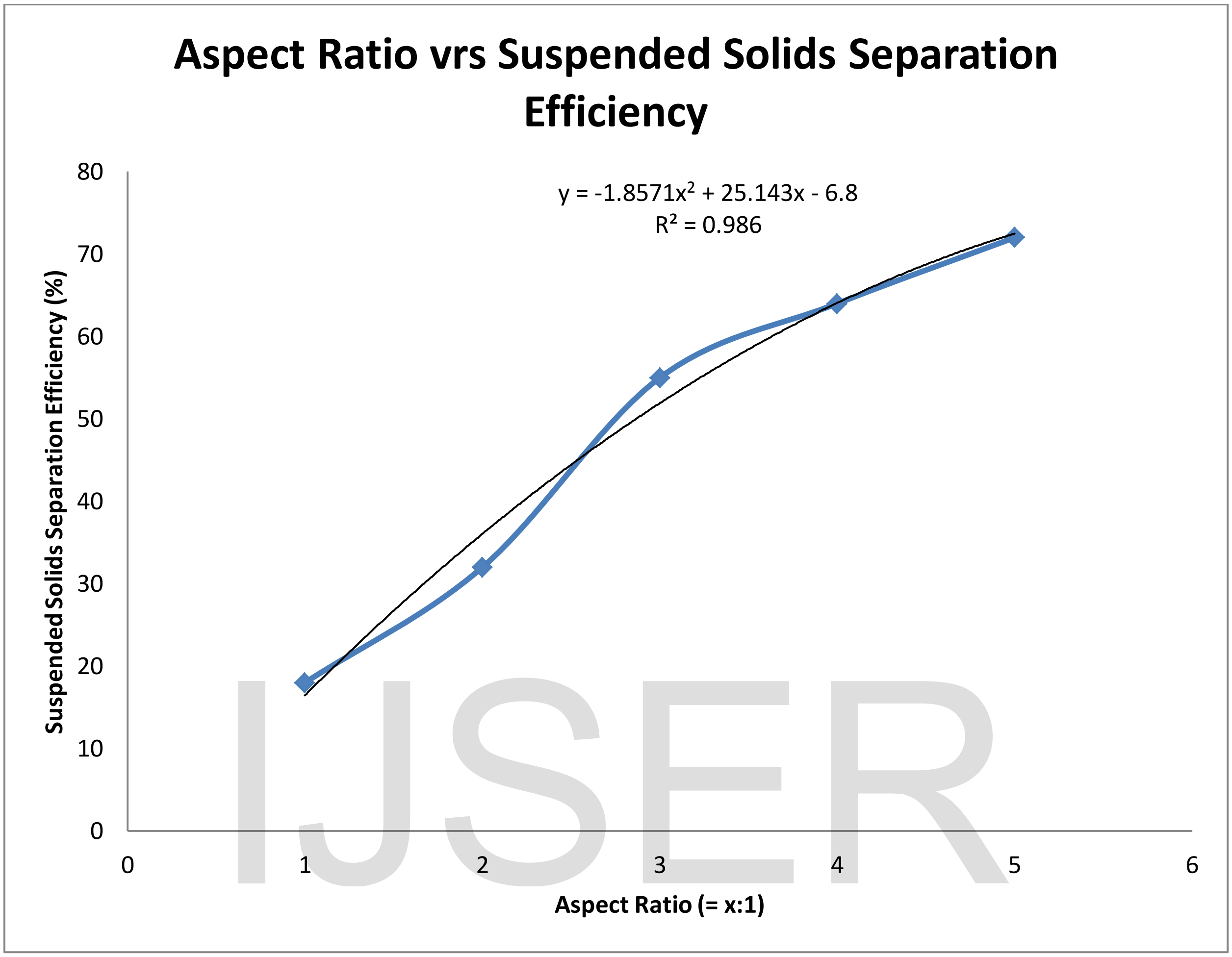


Fig. 2: Plot of Aspect Ratio versus Suspended solids (SS) Separation efficiency

3.0 RESULTS AND DISCUSSION

While keeping number of baffles and flow rate of wastewater constant, it was observed that suspended solids (SS) separation and suspended solids separation efficiency increased with increase in aspect ratio of the oil/water separators as evidenced by the graphs above. This is supported by the fact that residence time increased with increase in aspect ratio leading to increasing contact time and increasing aggregation of suspended solids with the resultant increase in separation and separation efficiency.

4.0 CONCLUSION

In conclusion, Aspect ratio affects suspended solids separation and suspended solids separation efficiency in conventional oil/water separators. The suspended solids separation and suspended solids separation efficiency increase with increase in Aspect ratio. Thus, suspended solids separation and suspended solids separation efficiency vary in direct proportion with the Aspect ratio of conventional oil/water separators.

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