



Faculty of Engineering

**EFFECTS OF VIBRATION ON
REMOVAL OF SOLID PARTICLES FROM
WASTE WATER**

Jong Shin Poh

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**EFFECT OF VIBRATION ON REMOVAL OF
SOLID PARTICLES FROM
WASTE WATER**

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**JONG SHIN POH
(HURUF BESAR)**

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Author : Jong Shin Poh
Matric number : 16395

Has been read and certified by:

Prof Ir. Dr Law Puong Ling
(Supervisor)

Date

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JONG SHIN POH

This project is submitted in partial fulfillment of
the requirements for the Degree of Bachelor of Engineering with
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To my beloved parents, siblings, and friends

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ABSTRAK

Selari dengan langkah pembangunan yang pesat di Negara ini, isu-isu pencemaran juga menjadi semakin serius. Selain daripada penguatkuasaan undang-undang dan juga pertubuhan-pertubuhan dan persatuan-persatuan yang ditubuhkan untuk membanteras kegaitan-kegaitan manusia yang tidak mesra terhadap alam sekitar, terdapat juga penciptaan pelbagai kaedah dan teknologi bagi mengurangkan kesan-kesan pencemaran terhadap alam sekitar. Satu pemisah yang berfasa bulatan dilengkapi dengan tautan bahantara dalam aliran arus dimajukan baru-baru ini untuk merawat air kotor yang bermuatan titisan-titisan minyak dan pepejal bergantung.

Tetapan ini terdiri daripada empat rangkaian frustums cenderung dengan masing-masing terdiri daripada beberapa lapisan frustums secara berturutan. Rangkaian frustums ditempatkan supaya yang pertamanya condong ke atas dan terbalik kedudukan untuk yang kemudian sehingga membentuk susunan pelbagai sudut.

Tetapan ini membantu dalam mempromosikan pertimbulan titisan minyak ke permukaan air dengan kadar yang lebih cepat melalui proses peleburan, dan juga penetapan zarah pepejal yang lebih cepat. Bukaan masuk untuk pemisah telah

dilengkapi dengan satu paip pengedar tertebuk yang berada di pusat pemisah itu. Air akan diedarkan ke atas paip pengedar tertebuk itu yang kemudian akan dilorongkan aliran arus ke arah tautan pinggan yang mempunyai siri-siri selari bercondong. Dalam penyelidikan ini, getaran akan diaplikasikan pada pemisah ini untuk mengetahui bagaimana pengaruh getaran terhadap penyingkiran TSS daripada air.

Kecekapan penyingkiran pemisah MFCoC untuk kajian sebelumnya ialah 49.54%. Walau bagaimanapun, untuk penelitian semasa, penambahan getaran hanya memberi kecekapan penyingkiran sebanyak 47.68%. Perbandingan juga dibuat di antara pemisah MFCoC dan pemisah DPCC. Untuk pemisah DPCC, kecekapan penyingkiran TSS ialah 30.12% dalam penyelidikan semasa dan 56.34% untuk kajian sebelumnya tanpa penambahan getaran. Daripada keputusan-keputusan di atas, ia menunjukkan bahawa terdapat pengurangan dalam kecekapan penyingkiran TSS selepas penambahan getaran kepada kedua-dua pemisah MFCoC dan pemisah DPCC. Kesimpulannya, getaran tidak diperlukan atau getaran dengan lebih rendah atau lebih tinggi amplitud diperlukan.

ABSTRACT

In conjunction with rapid development of the country, pollution issues are also getting serious. Besides the environmental legislative enforcement laws and establishment of organizations and societies fighting for application of environmental friendly steps in all sort of human activities, there are also invention of various methods and technologies to mitigate the effects of pollution. A circular phase separator embedded with coalescing medium in co-current flow was developed a few years ago for treating wastewaters loaded with oil droplets and suspended solids.

The arrangement consists of four series of inclined frustums with each of the series consist of several successive layers of frustums. The series of frustums are placed in an up-right and inverted positions that subsequently form a multiple-angle arrangement. This arrangement helps promote faster rising of oil droplets through coalescence process, and rapid settling of solid particles. The inlet of the separator is equipped with an up-flow center-feed perforated-pipe distributor to direct flow to the series of parallel inclined coalescing plates in a co-current flow. In this research, the

vibration will be applied to the separator to know how the vibration influences the removal of TSS from the water.

The removal efficiency of MFCoC separator was previously researched to attain 49.54%. In this research, vibration was applied in an attempt to enhance its performance; however, the removal efficiency recorded 47.68% (approximately 1.86% lower than “without vibration”). The comparison was also made between the MFCoC separator and DPCC separator. For DPCC separator, the efficiency of TSS removal was approximately 30.12% in current research (with vibration) and 56.34% for the previous research (without the application of vibration). From the above results, it was shown that there was the decrease in TSS removal efficiency after the application of vibration to both MFCoC and DPCC separators. Therefore, it can be concluded that vibration (at current amplitude produced by angle grinder) did not enhance the removal of solid particles from water.

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LIST OF ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
TSS	-	Total Suspended Solid
DOE	-	Department of Environment
WQI	-	Water Quality Index
EQA	-	Environmental Quality Act
EIA	-	Environmental Impact Assesment
IWRM	-	Integrated Water Resource Management
IRBM	-	Integrated River Basin Management
MFCoC	-	Multiple-Angle Coalescence Frustums Arrangement for Co-Current Flow
DPCC	-	Angle Coalescence Plates Arrangement for Counter-Current Flow
NTUs	-	Nephelometric Turbidity Units
JTUs	-	Jackson Turbidity Units
CSOs	-	Sewer overflows
API	-	American Petroleum Institute
DAF	-	Dissolved air flotation
PVC	-	Polyvinyl chloride
DNA	-	Deoxyribonucleic acid
RMS	-	Root Mean Square
SWR	-	Standing wave ratio
COD	-	Chemical Oxygen Demand
DO	-	Dissolved Oxygen

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Asian rivers are recognized to be the most polluted rivers in the world. Malaysia as a part of Asian and yet a developing country, also cannot escape from rivers pollution issues (International Year of Freshwater, 2003 Factsheet). Total Suspended Solids (TSS) is one of the major pollutants found in Malaysian Water Quality Monitoring Stations within several river basins beside the Biochemical Oxygen Demand (BOD), and Ammoniacal Nitrogen (NH₃-N) (Water Environment Partnership in Asia, 2007). River pollutants can be categorized into two types that are point sources and non-point sources of pollution. Total suspended solid is one of the non-point sources of pollution that comes from the surface water runoff such as agricultural runoff and construction site runoff. Both kind of runoff are the sources of sediments and silt from eroded land. Besides, illegal logging is another cause that contributed to environmental degradation, especially river pollution, erosion, landslides, mud deposits and floods (EnvDevMalaysia, 2009)

The number of rivers which were categorized as polluted by the Total Suspended Solids amounted to 53 river basins, 33 river basins as slightly polluted and 57 river basins as clean (Malaysia Environmental Quality Report, 2008). As compared to year

2006 with 42 river basins which have been polluted by TSS, there showed a great increase in figure. In order to evaluate the status of the river water quality, and Water Quality Index (WQI) is used by Department of Environment (DOE). The maximum allowable amount of TSS which can be contented in water is ≤ 100 mg/L, respectively for most countries.

1.2 Legislations

There have several legislations which now used in Malaysia to control the water pollution. The principal legal instrument used is Environmental Quality Act (EQA) 1974 and its subsidiary legislations. However, the EQA is only applicable to industrial discharges and sewage. There have other related laws such as the Land Conservation Act 1960, National Land Code 1965, Local Government Act 1976, Town & Country Planning Act 1976, and Forestry Act 1985 among others have provisions to deal with pollution from other land-based activities. For pollution from non-point sources, the Local Authorities through the Local Government Act and by-laws could take legal action. Apart from that, under the legislation, all prescribed activities are required to submit to DOE EIA report for approval prior to project implementation and normally some modeling works are incorporated.

The Association that was established to manage the water resources - Malaysian Water Partnership of Global Water Partnership that promotes and facilitates IWRM / IRBM. The concepts of Integrated Water Resource Management (IWRM) and Integrated River Basin Management (IRBM) aim to provide the best approach on how to treat the natural water resources economically. Malaysia has recently adopted

IWRM as an innovative approach to managing its water resources. Beside that, National Monitoring Network which established in 1978 also helps to establish the status of river water quality and detect the changes in water quality as a result of development activities (Department of Environment, 2006).

1.3 Existing TTS Removal Methods and Technologies

There have two kinds of separators which can be found in market that are solid-liquid separators and oil-liquid-solid separators. Both of them are invented based on different market requirements.

1.3.1 Solid-liquid separators

The main objectives of solid-liquid separation are to physically separate and remove the suspended solids and some of the dissolved solids from the liquid manure.

Several methods are available to separate solids from liquids:

- Sedimentation (solids settle by gravity).
- Mechanical separation. Gravity and mechanical separation are the two most common techniques used for this purpose.
- Coagulation Flocculation. A relatively new technique for solid-liquid separation uses chemicals to aggregate suspended solids (coagulation) to form settle-able particles and to convert particles into large, rapidly settling flocs (flocculation).
- Others:
 - I) Evaporation ponds.

These may be effective in arid regions where much more water is removed by evaporation than is added by precipitation. Compared to systems that use treatment and irrigation of effluent, the use of these ponds is limited by their larger size, design requirements and current and evolving environmental regulations.

II) Dehydration.

This method, which uses heat to remove moisture, is unpopular because of its high initial costs, maintenance and energy requirements.

1.3.2 Oil-liquid-solid separators

Oil-liquid-solid separator is other types of separators which can be used to separate not only solid but also oil from water. Following show the main types of oil-liquid-solid separator that can be found in market:

- Gravity separation. The weight of mass and gravity forces have been used to settle the solid and rising up the oil particles.
- Centrifugal Separation. Application of the spinning to fluid and used the difference in specific gravity of TSS and oil to make the separation.
- Coalescing separators. Coalescing plate help to combine small droplets of water to form large ones so they will drop out of the oil more easily.

1.4 Existing technologies used to test TSS concentration.

TSS concentration can be measured through two different ways; TSS measurement and Turbidity measurement.

- TSS measurement. TSS concentration can be measured through the process of evaporation. In these cases, water has been removed from the water sample, and the actual weight of TSS will be measured. TSS measurement is considered to be more useful because it provides an actual weight of the particulate material present in the sample.
- Turbidity measurement. Turbidity is a measure of how much of the light travelling through water is scattered by suspended particles. The scattering of light increases with increasing suspended solid and plankton content. Turbidity is closely related to total suspended solids (TSS).

1.5 MFCoC Separator

MFCoC separator is the unique equipment invented by previous researchers in order to solve the problems of pollution due to TSS and oil in small to medium scale. MFCoC separator applies the multi-angle coalescence frustums arrangement to the circular tank and adopts the co-current flow to the equipment. In this research, vibration will be applied to MFCoC separator to test the effect of vibration on TSS removal efficiency.

1.6 Problems Statement

From the survey of the adequacy of TSS removal systems that are available in the market, the simple systems are more properly less efficient than the complicated system. However, the complicated systems are normally more expensive or maintenance-intensive. Some of the solid-liquid separators which are commonly used