MATHEMATICAL MODELING OF OIL POLLUTION DISSEMINATION IN RIVER

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For dearest,

my husband, Abu Samah Bin Ibrahim

my parents, Mohd Noh Bin Abdul Karim & Jamaliah Binti Salleh,

my lovely daughter, Nur Imtiaz

my siblings,

Norita, Mohd Farid, Mohd Hafiz, Nuraini

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ABSTRACT

In this study, analytical solutions are shown for the spreading of hydrocarbon oil in 2-dimensional river which in *x* and *z* coordinates. Both the conservative and non-conservative forms of the advection diffusion equation are solved analytically using the method of Laplace transform. The results of concentration are presented graphically. Results show that the conservative model concentration of hydrocarbon oil that spreads into the river is higher compared to the non-conservative model. The oil concentration is decreasing as distance increasing.

ABSTRAK

Dalam kajian ini , penyelesaian analisis ditunjukkan untuk proses penyebaran minyak haidrokarbon di dalam sungai secara dua dimensi iaitu *x* dan *z* koordinat. Bentuk konservatif dan bentuk bukan konservatif persamaan resapan adveksi diselesaikan secara analisis menggunakan kaedah perubahan Laplace. Keputusan kepekatan ditunjukkan secara grafik. Keputusan menunjukan bahawa model konservatif mempunyai kepekatan minyak haidrokarbon yang lebih tinggi berbanding model bukan konservatif. Kepekatan minyak itu akan terus berkurang apabila jarak semakin bertambah.

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LIST OF ABBREVIATIONS

Abbreviations		**Significant**
1D	-	One Dimensional
2D	-	Two Dimensional
ADE	-	Advection diffusion equation
ADM	-	Advection diffusion model
PDE	-	Partial differential equation

LIST OF SYMBOLS

Notations		Signification
C	-	Hydrocarbon oil concentration
D, γ	-	Diffusion coefficient
erfc	-	Complement error function
H	-	Mixing height of oil in z coordinates
M	-	Mass of oil spilled
s	-	Laplace parameter
t	-	Time
u	-	Speed of water current along x coordinates
w	-	Speed of water current along z coordinates
w_0	-	Speed of oils sludge sedimentation
x	-	x coordinates axes
z	-	z coordinates axes
Δx	-	Change in x
δ	-	Dirac delta function
σ	-	Speed of admixture loss due to evaporation
γ_1	-	Diffusion coefficient along x coordinate
γ_3	-	Diffusion coefficient along z coordinate

Subscripts		**Significant**
c	-	Complimentary solution
p	-	Particular integral solution
t	-	First differentiate respect to t
x	-	First differentiate respect to x
xx	-	Second differentiate respect to x

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter contains six sections which will be introduction of oil pollution dissemination in river, background of this study, the statement of this study, the objectives of this study, the scope of this study and the significance of this study. The focal point of this study is to learn mathematical model of oil pollution dissemination in river.

1.1 Background of the Study

Oil spilling in river and sea has become common and this is because of the rapid development of oil industry, especially seagoing oil transportations. For example, in the region of Caspian Sea, the existing reservoir for oil and gas has been renewed; new Baku-Supsa and Baku-Tbilisi-Ceyhan oil pipelines and Baku-Tbilisi-Erzurum gas pipeline have been constructed and have been put into operation. The volume of oil products from Tengiz (Kazakhstan) and Khanchagal (Azerbaijan) fields, transported by railway from Baku to the Black Sea coast, has increased (Begalishvili *et al*, 2012).

The activities mentioned above may cause the risk of emergency and catastrophic oil spilling increase drastically. The existence of oil spills in the river creates an unpleasant sight and odour as well as actual harm to marine life. The need for an early warning system to detect the violator and to initiate clean up procedures is brought out by the cost of cleanup in some recent oil spill cases where millions of dollars has been expended by major oil companies to cleanup various coastlines (Marshall, 1978).Thus an accurate prediction of oil spill is very important to minimize river damage due to unexpected oil spilling accident (Cho *et al*, 2012).

Developing a model to enable us to understand how to predict and control oil pollution dissemination is a significant interest. A lot of researches are carried out in order to provide information of oil spilling, the quality of river water and possible ways to improve. The model of oil pollution dissemination is useful for the simulation of accidental hydrocarbon oil release in river water as well as for the simulation or ordinary discharges.

1.2 Statement of the study

The quality of river become worst caused by emergency or catastrophic oil spill. In order to study oil pollution dissemination in river, we need to study a suitable mathematical model that represents the physical phenomenon. In this study, we formulate two-dimensional mathematical model of oil pollution dissemination in river.

1.3 Objectives of the study

The research objectives are:

1) To study the model of oil pollution dissemination in river
2) To formulate two-dimensional mathematical model of oil pollution dissemination in river.
3) To find the analytical solution of two-dimensional conservative advection diffusion equation for oil pollution dissemination in river.
4) To find the analytical solution of two-dimensional non-conservative advection diffusion equation for oil pollution dissemination in river.

1.4 Scope of the study

The scope of the study is to present Advection Diffusion Model (ADM) for two-dimensional conservative and non-conservative of oil pollution dissemination in river. Results will be shown in graphs by using Matlab software.

1.5 Significance of the study

The study of mathematical model of oil pollution dissemination in river is important because we can accurately predict the oil pollution movement. By knowing the spreading of oil we can give an idea of the oil spilling impact and a proper design for cleanup recovery operations and protect the ecological sensitive zone. In addition to the significance of this study, the management team can make quick decision making on policy of oil pollution on river.

1.6 Outline of the study

This study contains six chapters including introduction and conclusion. First chapter describes the background of this study, problem statements, objectives, scope and significance of this study.

Literature review of this study will be discussed in Chapter 2. This chapter contains the conceptual studies of oil pollution dissemination in river model, advection diffusion equation, history of oil pollution model. Derivation of the governing equation of oil pollution dissemination in river model will be discussed in Chapter 3. Results and data analyses will be done in Chapter 4. Finally, the conclusion and recommendation of this study will be discussed in chapter 5 and 6.

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