

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES DESIGN SIMULINK MODEL TO ESTIMATE THE DISPERSION PARAMETER WITH APPLICATION IN IRAQ

LumaNaji Mohammed Tawfiq^{*1} & MohammedA. Hasan²

^{*1&2}College of Education for Pure Science Ibn Al-Haitham, Baghdad University, Baghdad, Iraq

ABSTRACT

New approach to estimate dispersion parameter based on the Simulink environment is proposed. We design Simulink model to estimate the dispersion parameter which is important to determine the rate of heavy metals dispersion in soil. The dispersions for twelve groups of land taken from 20cm below the ground surface in the Baghdad city are obtained. On this basis, the problems within the calculation process when the Simulink method is applied into actual data

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I. INTRODUCTION

Mathematical models are simplified representations of some real world entity can be in equations or computer code are intended to mimic essential features while leaving out inessentials, that is, models describe our beliefs about how the world functions. Mathematical modeling aims to describe the different aspects of the real world, their interaction, and their dynamics through mathematics [1]. Simulink model is a block diagram environment for multi task simulation and model based design. It supports system design, simulation, code generation, and continuous testing [2].

Dispersion parameter is the foundation of researching the pollution regular pattern and predicting the water quality [3]. It is indispensable for the study of pesticides, heavy metals in farmland, chemical fertilizers, movement of water and groundwater [4-7].

The hydrodynamic dispersion parameter is named of convection dispersion. It is a comprehensive reflection parameter of soil, and it is depended on the effect of moisture content and the velocity of pore water [8]. There are many researches about hydrodynamic dispersion to determine the hydro dispersive. Several methods based on a series of laboratory dispersion tests from the tracer experiments such [9-11]. In this paper new approach used for calculation the dispersion parameter by design suitable Simulink model.

II. SIMULINK MODEL

Simulink is an input/output device GUI block diagram simulator. It contains a Library Editor of tools from which we can build input/output devices, continuous and discrete time model simulations. Library Browser is used to build simulation models which contains continuous and discontinuous model elements, list of math operation elements, signal routing elements, sink device elements, used for displaying simulation results say (sinks) and signal routing.

Model elements are added by selecting the appropriate elements from the Library Browser and dragging them into the model window. Alternately, they may be copied from the Library Browser and pasted into the model window [12].

III. BUILDING MODEL

Mathematical model that describe the dispersing of heavy metals in the loam land soil can be written depending on [13-14] as follow:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2} - V \frac{\partial C}{\partial x} \quad (1)$$

With initial-boundary conditions: $C(x, 0) = C_{x,0} = C_0 e^{-\frac{Vx}{D}}$

$$C(0, t) = C_0 \text{ and } \frac{\partial C}{\partial x}(\infty, t) = 0;$$

Where;

C_0 : Initial concentration ($\frac{\text{mg}}{\text{L}}$);

V: average pore-water velocity ($\frac{\text{cm}}{\text{hr}}$);

D: Dispersion parameter ($\frac{\text{cm}^2}{\text{hr}}$);

t: time (day⁻¹);

x: space (cm);

C: concentration of heavy metals ($\frac{\text{mg}}{\text{L}}$).

Equation (1) solved analytically by using Adomian decomposition method ADM, and given the following solution (for more details see [14]).

$$C = c_0 \exp\left(\frac{-Vx}{D} + \frac{2V^2}{D}t\right) = c_0 \exp\left\{\frac{V}{D}(-x + 2Vt)\right\} \quad (2)$$

Also, $V = 5.14 \times 10^{-6} \text{ ms}^{-1} = 44.4096 \times 10^{-2} \frac{\text{m}}{\text{d}}$, depending on results of [15, 16].

$$\text{Therefore, } C = c_0 \exp\left\{\frac{44.4096 \times 10^{-2}}{D}(-x + 2(44.4096 \times 10^{-2})t)\right\} \quad (3)$$

$$\text{So, } C = c_0 \exp\left\{\frac{44.4096 \times 10^{-2}}{D}(-x + 0.888192t)\right\}$$

$$\text{Then, } D = \frac{\ln \frac{C}{c_0}}{44.4096 \times 10^{-2}(-x + 0.888192t)} \quad (4)$$

To build Simulink model to estimate the dispersion parameter for the previous model, i.e., equation (4), we start by looking at the terms in the bracket. There are three input signal lines: t, y, and x, we also notice that both t and y are multiplied by constants, as in the case of the first- model; this can be done in Simulink by using a Gain block. The signals are then summed together as illustrated in Figure 1.

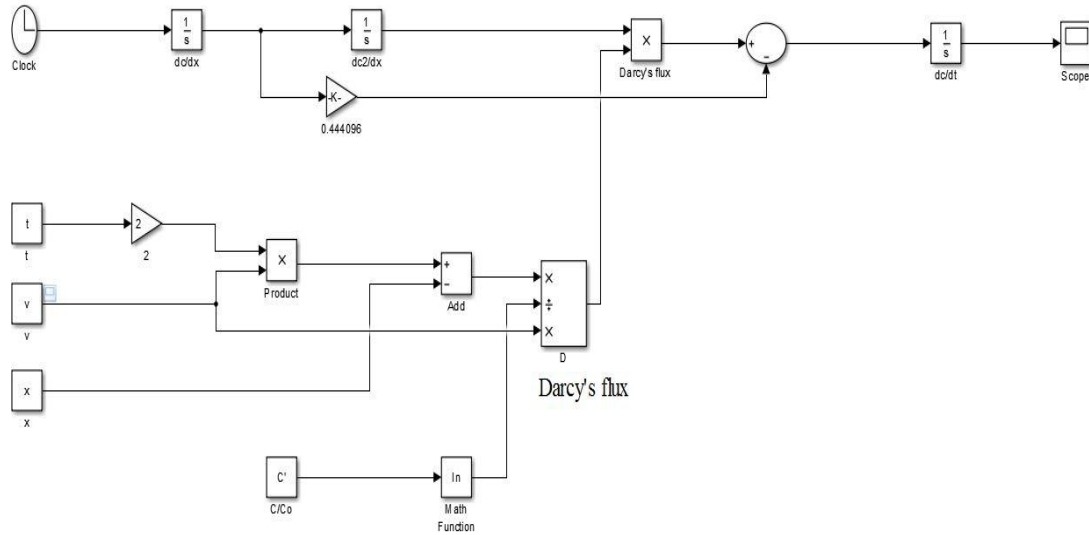


Figure 1: Simulink model to estimate the dispersion parameter

We can see from the suggested model that \dot{x} and x are both inputs and outputs of the model. Therefore, we need to use a feedback loop for each of these signals. Before running the model is sure to include a Scope block for viewing the results. Now that the model is complete, we are ready to run the simulation and look at the results.

IV. RUNNING SIMULATION AND ANALYZING DATA

Having completed the Simulink models, it is now run a simulation to get the results.

Double-click on the Integrator block and set the initial data measured in laboratory dispersion test for the twelve groups of samples for different zone in Baghdad city as given in Table 1, and illustrated in Figure 2. Then, double click on the **Gain** block and open the **Step** block. Now, run the simulation and open the **Scope** block. Hence we get the result that is the value of dispersion parameter (D_L) and close to 0.5.

Table1: Mean of data of laboratory test

| t(d) | C_0 |
|------|-------|
| 0.1 | 0.057 |
| 0.15 | 0.259 |
| 0.2 | 0.5 |
| 0.25 | 0.691 |
| 0.3 | 0.891 |
| 0.35 | 0.898 |
| 0.4 | 0.943 |
| 0.45 | 0.967 |
| 0.5 | 0.983 |
| 0.55 | 0.991 |
| 0.6 | 0.995 |
| 0.65 | 0.997 |



Figure 2: Locations of samples in different zone in Baghdad city

V. CONCLUSION

The main purpose of this paper was to verify the possibility of use Simulink environment to estimate the dispersion parameter. The result of design model was verified with the data from a real process. Currently, the approach described in this paper has been successfully used and tested for extended (full) mathematical model of the dispersion parameter; it can be observed that the suggested method is easy to calculate the dispersion parameter

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