ADVECTION-DIFFUSION MODELS

Numerical models are important engineering tools when considering the prediction of pollution transport in a body of water. Whatever the nature of a particular pollutant, the mixing process responsible for the distribution of quantities of heat, dissolved gas and solids, and suspended sediment, is shown to consist of a uni-directional movement by turbulent mean flows, called *advection*, and a three-dimensional spreading action produced by the turbulent flow components, called *diffusion*.

Numerical Advection-Diffusion models are intended to make predictions through solution of the so called advection-diffusion equation (Abbott & Basco, 1989):

$$\frac{\partial p}{\partial t} + u\frac{\partial p}{\partial x} - D\frac{\partial^2 p}{\partial x^2} = 0$$

where p is the probability, t is time, u is velocity, x is the spatial coordinate and D is the diffusion coefficient. In summary, the equation reflects two transport mechanisms:

- Advective (or convective) transport with the mean flow; and
- Diffusive transport due to concentrations gradients.

Typically, the main assumptions underlying the advection-diffusion equation are:

- The considered substance is completely mixed over the cross-section, implying that a source/sink term is considered to mix instantaneously over the cross-section;
- The substance is conservative or subject to a first order reaction (linear decay); and
- Fick's diffusion law applies, i.e. the diffusive transport is proportional to the concentration gradient.

Data Requirements

In addition to the data requirements outlined for the hydrodynamic modelling a large number of measurements are required to ensure the set-up, calibration and validation of a reasonable advection-diffusion model. A brief description of data requirements is given below:

- **Model Set-up**
  - Measurements of temperature, salinity, SSC (suspended sediment concentration) and contaminants.

- **Boundary conditions**
  - Contaminant discharge information.

- **Calibration and verification data**

- **Mass balance and displacement of substances**

For further information see: (Ippen, 1966; Dyer, 1973; 1996; Borthwick *et al*. 1998; CERC, 1993; Crank, 1975; Fischer *et al*. 1979; McDowell & O'Connor, 1977; Sloan & Pender, 1998; Niedoroda *et al*. 1995) and http://www.pol.ac.uk/coin/nrshrmod.html.

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