DETERMINATION OF SALINITY DISTRIBUTION COEFFICIENT IN TIDAL RIVERS

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In the tidal rivers, determination of salinity concentration is a complex problem. Tidal surges have high salinity concentration. In mouth of tidal rivers, salinity concentration is equal to salinity concentration in the sea. In the upstream of the tidal rivers, fresh water in tidal rivers decreases salinity concentration. Two factors determine salinity concentration in rivers:

1- Convection: its causes are inertia and velocity of current.

2- Diffusion: its causes are molecular and momentum distribution.

Distribution coefficient of ordinary rivers depends on velocity of current, hydraulic radius and Manning's coefficient. In addition to above factors, distribution coefficient of tidal rivers depends on domain of tidal surge, period of tidal surge and discharge of fresh water.

In the present research, a hydrodynamic model was established for determination of velocity of current and water surface elevation. This model makes use of the Priessman method. This method is based on a four point finite difference scheme. For determination of salinity concentration, a diffusion-advection model was established. This model also makes use of the Priessman method. Manning's coefficient in hydrodynamic model and distribution coefficient in diffusion-advection model were determined by calibration of models.

Karun River in Iran was selected for case study. This river is the most important tidal river in Iran. Selected reach of Karun River located between Ahwaz at the upstream and Khoramshar at the downstream was considered.

Salinity concentration of intermediate stations was estimated utilizing the model.

Ippen (1966), Officer (1973), Thoman (1987) and Huang & Spaulding (2000) developed empirical formulae. These formulae show the relation between salinity concentration and discharge of fresh water and show salinity concentration in different sections in tidal rivers. These formulae are mainly one-dimensional.

In this research based on the characteristics of tidal surges, salinity distribution coefficient is modified for the tidal rivers and a numerical model is developed for determination of salinity distribution coefficient.

Initially a hydrodynamic model is required for determination of salinity concentration in rivers. Yazdandoost, Shamloo & Adib (2004) developed a model for “Interaction between Tidal Surge and River Flow” (ITSRF Model) for hydraulic routing in tidal rivers. This model makes use of Preissman method for solving the Saint Venant equations. This method is a four point implicit finite differences method. ITSRF model considers the left bank, the right bank and the main channel as individual characteristics of longitudinal direction, where different Manning's coefficients can be incorporated for each one. Equivalent Manning's coefficient is determined by Horton-Einstein method.

The current velocity, the hydraulic radius, the area of cross section and the water surface elevation are determined by ITSRF model.

Advection-diffusion equation is simultaneously applied for determination of the salinity concentration. Perfect form of the advection-diffusion equation is shown as follows:.

$$\frac{\partial AC}{\partial t}+\frac{\partial UAC}{\partial x}+\frac{\partial VAC}{\partial y}+\frac{\partial WAC}{\partial z}=\frac{\partial}{\partial x}(D_{tx}A\frac{\partial C}{\partial x})+\frac{\partial}{\partial y}(D_{ty}A\frac{\partial C}{\partial y})+\frac{\partial}{\partial z}(D_{tz}A\frac{\partial C}{\partial z}) \quad (1)$$

Equation (1) is a 3-D equation. However, since in nearly all practical cases, the length of the rivers is very large compared to its width and depth, it would suffice to consider the system as 1-D. 1-D form of equation (1) is:

$$\frac{\partial AC}{\partial t}+\frac{\partial UAC}{\partial x}=\frac{\partial}{\partial x}(D_{tx}A\frac{\partial C}{\partial x}) \quad (2)$$

$$\frac{\partial C}{\partial t}+u\frac{\partial C}{\partial x}=D\frac{\partial^2 C}{\partial x^2} \quad (3)$$

The results of salinity part of ITSRF model are compared to the values estimated based on regression of data in Darkhovin and Salmanieh stations in the Karun River. The Darkhovin Station is at 140 Km from the hydrometric station of Ahwaz and Salmanieh Station is at 160 Km from the hydrometric station of Ahwaz.

The model is applied for two different states.

1- For a large tidal surge and a small fresh water discharge.

2- For a small tidal surge and a large fresh water discharge.

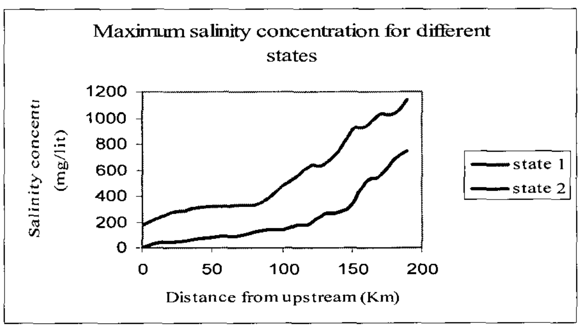

Fig. 1 Maximum salinity concentration for different states

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