Intra-Wellbore Head Loss with both *Kinematic and Friction*

*Quanrong Wang[1], Hongbin Zhan[1,2]

1.China University of Geosciences (wuhan), 2.Texas A&M University

Riverbank filtration or withdrawal of groundwater from the bank of a river is commonly practiced in many countries for obtaining sustainable and good quality of water. Groundwater flow to a well installed at the bank of a river is closely related to the aquifer-steam interactions. Up to present, most studies associated with riverbank filtration are concentrated on the vertical wells that may produce a large drawdown cone near the well. In recent decades, horizontal wells have become an interest of research among hydrogeologists, environmental scientists and engineers, due to many technical advantages over the vertical wells for thin aquifers, such as the decreasing operational cost and many technical advantages over the vertical wells. However, many previous studies on the flow into horizontal wells were based on the uniform flux boundary condition (UFBC) when treating horizontal wells, which could not reflect the physical processes of flow inside the well accurately. In this study, we developed solutions of transient flow into the horizontal well in an anisotropic confined aquifer between two streams for three types of boundary conditions of treating the horizontal well, including UFBC, uniform head boundary condition (UHBC), and mixed-type boundary condition (MTBC). The MTBC model considered both kinematic and friction effects inside the horizontal well, in which the kinematic effect referred to the accelerational and fluid inflow effects. The solution of UFBC was analytically derived by superimposing the point sink/source solutions along the axis of the horizontal well with a uniform strength. The solutions of UHBC and MTBC were obtained by coupling the analytical and numerical methods. Based on this study, one can draw the following conclusions: (1) At the early stage, well specific inflow (WSI) increases with the distance along the wellbore for the MTBC model, and follows a cubic polynomial function. (2) When the point of intake is at the well heel, the values of specific capacity (SC) follow the orders of UFBC, UHBC and MTBC from high to low. (3) Comparing the solution of UFBC, UHBC, $MTBC_{Friction}$ and MTBC, one could find that the difference between them is obvious, and the dimensionless drawdown of UFBC and UHBC solution are independent to the flow rate. However, the difference of the dimensionless drawdown between $MTBC_{Friction}$ and MTBC increases with the greater flow rate. The new solution can be used not only to interpret the aquifer test data, but also to provide reference solutions to check the accuracy of numerical simulators.

Keywords: Accelerational effect, Mixed-type boundary condition, Specific capacity

