FVS SCHEME FOR STEADY AND UNSTEADY FLOWS IN PIPE NETWORKS WITH THE IMPROVED WATER HAMMER EQUATIONS

GENG YANFEN, WANG ZHILI, and JIN SHENG

State Key Laboratory of Coastal and Offshore Engineering,
Dalian University of Technology, Dalian 116024, China
(Tel: +86-411-84708509, Fax: +86-411-84674141, e-mail: geng_y_f@yahoo.com.cn)

The classical governing equations for water hammer have been widely adopted in the research of water hammer (Greyvenstein, 2002; Hossein and Alireza khayatzadeh, 2002). Although the method will primarily be used for transient simulations, its ability to accurately predict steady state flows is very important since the steady state solution is often used as the initial condition for transient simulation. The classical equations however can't be used to describe steady state in pipe systems at all, although generating satisfactory results due to the special method of characteristics. Therefore, those classical equations are not theoretically ideal.

In the investigation of the numerical methods based on the MOC, it is found that the MOC tolerates the wrongness in the classical governing equations due to the large acoustic speed in hydraulic projects, about $1000\,m/s$. It is natural that the very small factor makes the wrongness of the equation of continuity unimportant in numerical simulation. Resultantly it is meaningful to give new governing equations for water hammer.

In this study, a new equation which fit not only unsteady flow but also steady flow is analyzed and an efficient numerical method is developed by the flux split technology to simulate the steady and unsteady flow problems in single and multiple pipe networks with the proposed equations. The conception of the fictitious cell as Fig.1 at the junction is developed. The proposed scheme has several desirable properties, such as, accurate, efficient, robust, high shock resolution, conservative and stable for Courant number. The experiment with friction as Fig.2 and steady flows in a satellite town multiple supply pipe networks as Fig.3 are implemented to test the proposed numerical method. The good agreement between computation and experiment will warrant the extensive application of the proposed method to complicated pipe networks.

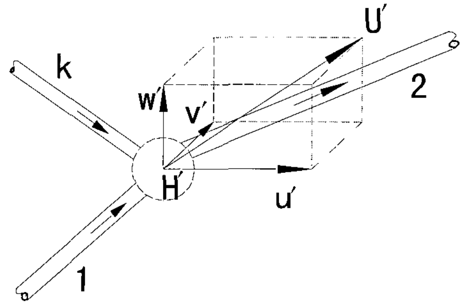

Fig.1 Sketch map of the fictitious cell at the junction

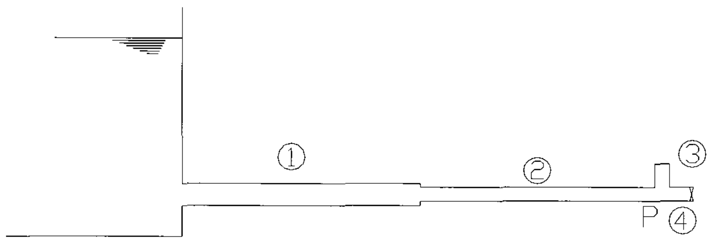

Fig.2 The example of complex pipes

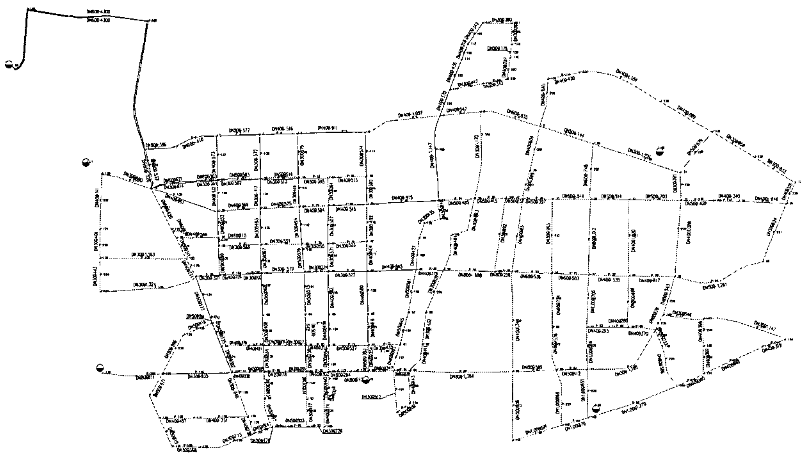

Fig.3 The sketch map of pipe networks

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