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Comparison of numerical, experimental and empirical results for flows over simple vertical drop

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Abstract

In this paper, the hydraulic characteristics of simple vertical drop have been studied numerically with used of Fluent software to solve the finite volume method. The volume of fluid (volume of fluid) was used for modeling the free surface. Flow characteristics such as downstream depth, pool depth and energy loss, frees surface profile, and velocity characteristics of falling jet were calculated and compared with the experimental and empirical values. Different turbulent models and grids have been studied. The numerical results with a 57512-node grid, 1.5 meter downstream channel length, standard $k-\varepsilon$ turbulence model and standard wall function showed the best agreement and The numerical free-surface profiles followed the theoretical equations very well The numerically calculated velocity profiles mimicked the experimental results all over the falling jet regions.
Keyword: Drop Structure, flow characteristics, free-surface, subcritical flow, energy loss

1. Introduction

Drops are hydraulic structures that are commonly used in irrigation and waste water collection networks. A vertical drop balances the elevation difference between the channel slope and ground slope. The structure causes an either sub- or supercritical flow passing over a vertical fall and descends into a stilling pool downstream from the drop. Thus the flow structure is comprised of a falling jet (free overfall), a sliding or skimming jet and a circulating or mixing zone. This pattern causes the significant portion of flow energy to be dissipated through jet impact and turbulent mixing.

Earlier investigations on this structure have mainly focused on experimental studies of the hydraulic characteristics (Bakhmeteff 1932, Rouse 1936, Moore 1943, White 1943, Gill 1979, Rajaratnam and Chamani 1995, Chamani and Beirami 2002, and Chamani . …. . 2008). Chamani . …. . (2005) investigated the hydraulic characteristics of vertical drops with adverse apron and upstream subcritical flow. They showed that the relative pool depth and relative downstream depth for adverse apron drops were larger than those with horizontal apron. The energy loss also increased as the invert angle changed from zero to 5 degrees.