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Assessment of Fluent Software Performance for Flow Estimates in Long Path Drip Emitter

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Extended Abstract

Introduction

Drip irrigation in which water is only available to the plant, is increasingly used in recent years. Since the flow behavior inside the emitter is difficult due to their complex structure and small size, in present study an attempt was made to assess the flow behavior of the emitters using mathematical and physical models. It needs to be mentioned that analysis of flow behavior of water in labyrinth channels is difficult because of micro-characteristics of the emitter. In this context Zhang et al. (2007) modeled the emitter's flow path using fluent software. In this investigation two physical models namely: laminar and turbulent were used to simulate the flow. Also numerical models that have been tested in experimental conditions, were used in the hydraulic analysis of Emitters. Next, Fluent software was used to simulate the behavior of the flow inside the two long- path emitters for calculating the discharge -pressure relationship of the models and results were compared with results obtained from experimental results.

Methodology

In this research, two types of T-Tape emitter were used in three replications. Tape emitters are from the type of long-path emitters that are assembled inside the drip line system. In this study Fluent software was used to simulate flow in labyrinth channels of Tape Stripe emitter and the relation between pressure and rate of discharge under 3 pressure levels (4, 5 and 6 mH_2O) was determined. For turbulent flow, in addition of Navier-Stokes Equations that were used in the laminar model, also the simplified equations of the standard k-ε model were used. Also, meshing was done by GAMBIT software and for this purpose; four-sided meshes were used. In order to minimize computational error, the network model was adjusted in four steps, and finally, for the Side labyrinth type and injection emitters, 313540 and 407145 computational cells were considered.

Results and Discussion

Results showed that. The model was not able to model the discharge from the droplet in laminar and turbulent conditions, and that the estimated output by the Fluent model for various pressures and laminar and turbulent conditions calculated were respectively 23 and 25 percent more than examined test. In laminar and turbulent flow at the pressures of 4, 5, 6 m, the difference between model and test were:

0.28, 0.23, 0.2 and 0.27, 0.23, 0.19 lit/ hr. respectively. Results also show that in case of the experimental emitters, a change in the pressure gradient mainly occurs in the corners of the ducts, and when the flow reaches the corners, it changes its direction, and consequently a large local loss occurs, which is the main reason for the dissipation of the hydraulic energy. Thus, the pressure loss in the corners of the micro channels determines the degree of hydraulic energy loses.Further results showed that higher values under different model pressures, which indicates that higher estimations happens with increasing applied pressure.

Conclusions

- The discharge values of the emitter have a significant difference with the numerical modeling values and we should be careful in using this software to model this type of emitters.
- The side labyrinth emitter discharges estimated by the model are very close for laminar and turbulent flows, but significantly differ with the results of the physical model.
- According to the velocity distribution in the channel of both types of drip emitters, sharp angles along the flow path can be reduced to prevent clogging.

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Keywords: Hydraulic Pressure, Laminar Flow, Simulation, Turbulent Flow, Velocity Distribution