μ-PIV characterization of the flow in a milli-labyrinth-channel used in micro-irrigation

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Micro-irrigation is a technique based on the use of one centimeter diameter lines on which are inserted emitters, often consisting of a 1 mm section-labyrinth-channel which incorporates baffles. This technique has many advantages; such as low human efforts, water and energy in comparison with sprinkler irrigation. The main disadvantage is the clogging which significantly reduces the emitter life and constitutes an obstacle to its development. Clogging maybe physical caused by the agglomeration and aggregation of mineral particles suspended in irrigation water. It appears that this clogging is strongly linked with flow characteristics [2], [3], [5] and [6]. So, flow characterization is very important for improving emitter performances. The existing baffles, which play an important role for generating pressure losses [4] and ensure the flow regulation on the irrigation network, produce low-velocity vortices. These vortices favor the deposition of particles or other biochemical development causing emitter clogging [4]. When designing emitters, clogging can be prevented or at least significantly reduced by decreasing, as much as possible, the size of the vortex zones. The global objective of the study is to analyze the clogging phenomenon and the sensitive areas in order to prevent it and improve irrigation material. The flow characterization has been numerically carried out before [1]. The experimental and numerical results on this labyrinth-channel show that there are two different regions; one is the main flow and the other is the vortex zones, which are characterized by a low velocity as described above [1]. These two regions may vary from one turbulence model to another. Micro particle image velocimetry (μ-PIV) has been performed in order to characterize the flow structure. It appears that the μ-PIV in a baffle-fitted labyrinth-channel of micro-irrigation emitter is rarely investigated [2]. In this paper, μ-PIV experiments are performed on ten-baffle repeating of the labyrinth-channel fabricated in plexiglas with real scale and a section of 1 mm. This method allows measuring the instantaneous velocity fields and describing the flow topology and fluctuating velocity second-order moments along the labyrinth-channel. In our work, Reynolds number varies from 400 to 800. Then, the flow is analyzed to verify the turbulent flow hypotheses used in fluid modeling. This study focus on the vortex zones at the downstream side of the baffles, which are favoring the deposition mechanism. It is found that the flow is composed of a main flow and vortex zone. It is developed from the third baffle. The surface roughness has no effect on mean velocity above 0.25mm from the wall. The flow is not isotropic. The RSM model used by [1] does not predict the flow in the labyrinth-channel.

References


