Design and testing of an emitter dedicated to treated waste water distribution : From fluid mechanics simulation to prototyping

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Phytoremediation and more generally, extensive wastewater treatment methods, rely on plants for cleaning polluted waters taking benefits of soil and roots activity. Thus it proposes a cost effective alternative to standard WWTP (Waste Water Treatment Plants). Nevertheless, the type of water used may contain particles and chemicals that may rapidly hamper spreading systems performance. G-EAU has developed a new emitter designed to distribute wastewater in reuse fields. This emitter is able to withstand particles of up to 1mm size without clogging under a pressure between 0.5 and 4 bars, delivering around 100l/h. Flow rate regulation is achieved by a flexible membrane inserted in the emitter. Such solution reveals to be cheap and easy to use as an irrigation emitter.

Initial studies (Deborde, 2011) were performed on EPDM membrane (Ethylene-Propylene-Diene Monomer). The membrane deformation was simulated with Computational Structure Dynamics (CSD) software. These results were used to model the emitter flow with a Computational Fluid Dynamics (CFD) software. This led to the creation of a single-step coupling method where solid and fluid calculations were performed successively. In the meantime, laboratory and field tests were conducted to validate hydraulic behavior and clogging resistance. Geometry and membrane design were able to regulate the flow and prevent clogging thanks to the membrane movements. A patent deposit for the emitter (PP000222, 09/2012) concluded these first development step.

Then, the work was continued integrating solid and fluid simulation within the same calculation. This helps to improve the emitter shape and find a membrane material less sensitive to aging than EPDM. Easier to mold, we select a silicone which is characterized by mechanical properties really close to EPDM. To integrate in the same numerical model fluid/solid interaction we used ANSYS® FSI model. Such simulation requiring the accurate determination of the membrane material physical properties, deformation tests (uniaxial NF EN 12311-2 and biaxial NF EN 14151A) had been performed to determine the new hyperelastic constitutive law. The prototypes for the new emitter shape was produced from 3D printing. In-lab hydraulic tests confirmed that initial emitter hydraulic performance was preserved. FSI simulations are thus under process in order to improve emitter design.