Influence of Different Working Pressure on the Hydraulic Performance of Point-Source Subsurface Infiltrating Irrigation Pipe

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Abstract

This study compares the hydraulic performance of two new types of subsurface infiltrating irrigation pipes: the externally-overlaid and internally-embedded composite infiltrating irrigation pipe (EO-IE composite pipe) and the internally-embedded emitter infiltrating irrigation pipe (IE emitter pipe). The study quantifies key parameter differences under varying pressure conditions and reveals how the external overlay structure enhances pressure adaptability through the "channel expansion-resistance reduction" mechanism. ***Methods:*** Hydraulic tests were conducted at working pressures ranging from 0.02 to 0.18MPa. Parameters such as seepage rate, flow variation coefficient, flow exponent, and irrigation uniformity were analyzed for both pipe types. ***Results:*** Water seepage rates increased with working pressure and stabilized quickly. The stable seepage rate for the EO-IE composite pipe ranged from 1.31 to 3.96L/(m·h), while for the IE emitter pipe, it ranged from 1.50 to 4.27L/(m·h), with the latter slightly higher. Both pipes followed the Kostiakov model, with infiltration coefficients increasing with pressure. The EO-IE composite pipe demonstrated better flow stability with a lower variation coefficient. The optimal pressure range for the EO-IE composite pipe was 0.094-0.136MPa, and for the IE emitter pipe, it was 0.082-0.117MPa. Flow in both pipes followed an exponential function with a flow exponent of approximately 0.5, which belongs to the non-pressure-compensating emitter. The irrigation uniformity coefficient of both pipes is greater than 0.8. ***Conclusions:*** Both pipes maintain stable and efficient irrigation within their optimal pressure ranges. The externally-overlaid and internally-embedded composite pipe offers better pressure adaptability and lower flow sensitivity compared to IE emitter pipe, making it more stable under varying pressure conditions.

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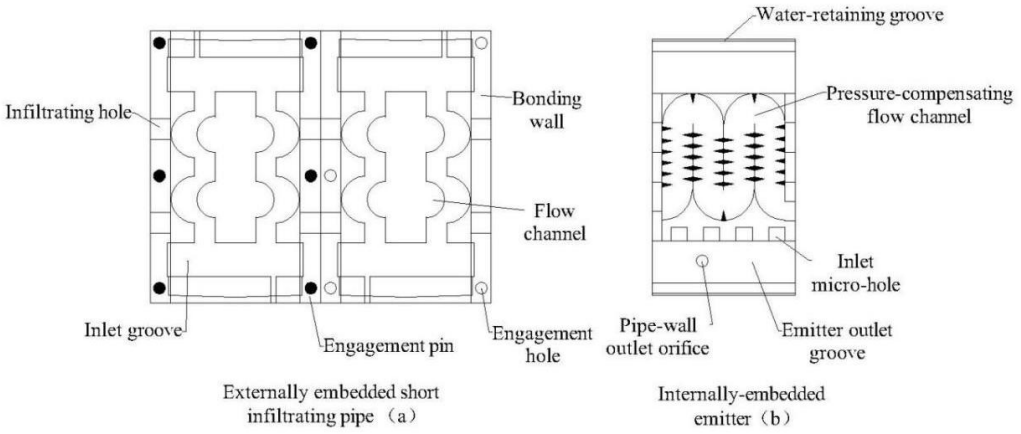

Innovative Description: The study quantifies key parameter differences under varying pressure conditions and reveals how the external overlay structure enhances pressure adaptability through the "channel expansion-resistance reduction" mechanism.