Irrigation and Drainage Structures Engineering Research/Vol.20/No.77/ Winter 2019/P: 73-88

Experimental Study of Parameters Affecting the Performance of Discharge Control Valve: Effects of the Spring Fatigue and Valve Assembly

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Received: 5 April 2019; Accepted: 28 September 2019

Extended Abstract

Introduction

Water distribution uniformity is a key in pressurized irrigation systems. Pressure fluctuations due to topographical changes, local and frictional head losses, and different water uses are considered of great concerns. Any mechanical device with the ability to keep an almost constant flow delivery, irrespective of the pressure fluctuations is of great practical importance. In this regard, a flow control valve is a useful tool. A flow control valve is a mechanical choked orifice plate structure including a float-spring mechanism inserted in an ordinary orifice (Zhang and Wang 2015). Such a valve is not yet produced commercially.

In this study, the effect of the spring elasticity mainly due to spring fatigue is investigated experimentally on the valve performance. Also, the changes in the installation location of the float, when the valve is in rest condition, may affect its performance. To quantify this effect a detailed experimental plan was performed.

Methodology

This study presents an experimental approach for testing the effects of the spring fatigue and spring installation location on the performance of the discharge control valve. In this regard, an experimental model was constructed at Imam Khomeini Intentional University, IKIU. It consists of a centrifugal pump, a motor drive to adjust the pump's rotational speed, and a Rosemont digital pressure gauge. The flow rate was measured by a calibrated Venturi meter. Two design discharges of 0.4 and 0.6 l/s were considered and the valves were fabricated based on the design guidelines proposed by Rezazadeh et al. (2019).

In order to quantify the valve performance PI index was used (Atashparvar *et al*., 2019).

$$PI = |DPID + DNID| + DPID + |DNID| \quad (1)$$

In the above equation, DPID and DNID are the total/summation of the positive and negative discharge deviations from the design value respectively.

Results and Discussion

According to the experimental curves of valves' discharge variations, PI values were calculated to identify the effects of the spring fatigue and inappropriate valve assembly (Fig. 1 and Fig. 2). The results indicated that, if the distance of the float to the orifice location, *b*, varies in the ranges of $0.5 \leq b$ (*mm*) ≤ 4.3 and $2.75 \leq b$ (*mm*) ≤ 5 for $Q=0.4$ and 0.6 *l/s* respectively, the valve performance is affected marginally (Fig. 1). It is found that for the design discharge values of 0.4 and 0.6 *l/s* the spring elasticity can decrease no more than 3% and 6% respectively (Fig. 2).

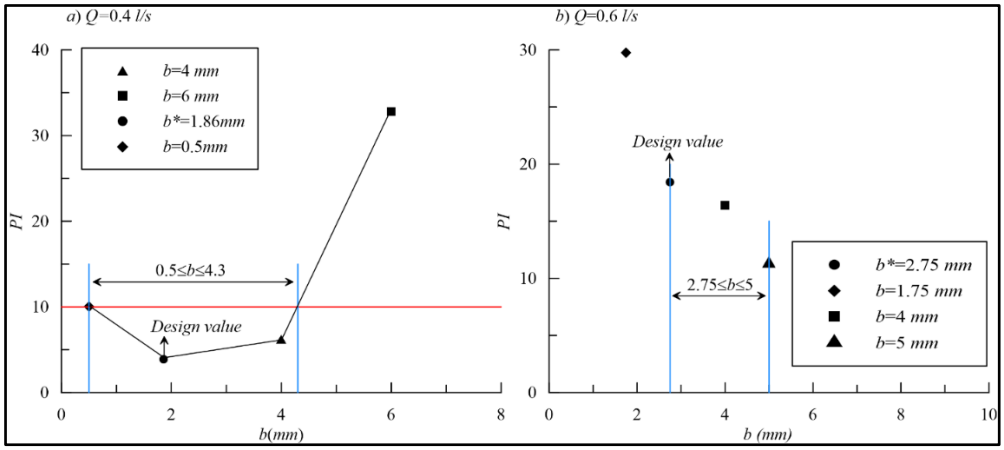

Fig. 1- PI-values of changing the distances of the float of MCOP

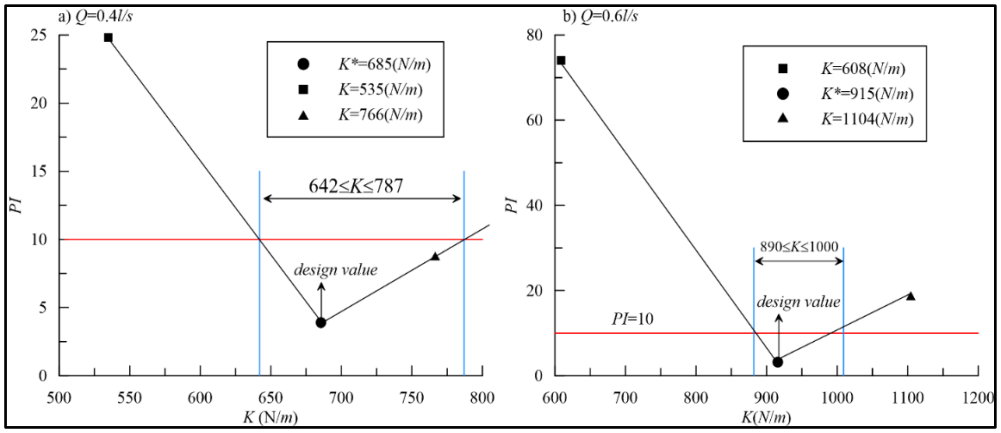

Fig. 2- PI-values of changing the MCOP's spring elasticities

Conclusions

Water distribution uniformity plays a pivotal role in pressurized irrigation systems. In this regard, flow control valve is a useful tool. The control valve studied in this investigation consists of a float moving into an orifice of a given diameter. The mechanism makes it possible to have a semi constant flow rate, being irrespective of the pressure fluctuations. Although the design criteria of the valve were proposed in 2015, it is not yet produced in commercial scale.

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Discharge control valve can be used in tape irrigation systems. Spring fatigue and inappropriate assembly can affect the valve performance. In this study, the effect of these parameters on the performance of the control valve were investigated experimentally. The results indicated that, if the distance of the float to the orifice location, *b*, and the spring elasticity, *K*, were 82% and 15% greater than their design values, the valve performance is affected by less than 5%. Spring elasticity variations due to the spring fatigue can affect the valve performance significantly. It is found that, for the design discharge values of 0.4 and 0.6 l/s the spring elasticity can decrease no more than 3% and 6% respectively.

Keywords: Constant Flow Rate, Flow Control Valve, Pressure Changes, Spring Fatigue