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A METHOD FOR DEVELOPING THE OPERATING CURVE OF SLITS IN IRRIGATION PIPES OF A DRIP IRRIGATION SYSTEM

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Abstract. The article presents a method for developing the operating characteristic curve of openings in irrigation pipes used in drip irrigation systems. The research on developing the operating characteristic curve of irrigation pipe openings was conducted in the Hydraulics Laboratory at the Department of Hydraulics and Hydroinformatics. The “DVT BBO DB Drip Irrigation Pipe Testing” apparatus was used in the experiments. The results obtained at irrigation pipe pressures of 40, 60, 80, and 100 kPa are presented.

Keywords: drip irrigation, pressure, pipe, water flow rate, operating characteristic curve, opening.

Annotatsiya. Maqolada tomchilatib sug’orish tizimi sug’orish quvurlari tirqishining ishchi grafigini tuzish usuli keltirilgan. Tomchilatib sug’orish tizimi sug’orish quvurlari tirqishining ishchi grafigini tuzish bo’yicha tadqiqtlar “Gidravlika va gidroinformatika” kafedrasi qoshidagi “Gidravlika” laboratoriyasida olib borilgan. Tadqiqotlarni olib borishda “DVT BBO DB tomchilatib sug‘orish tizimining quvurlarinii sinash” qurilmasidan foydalanilgan. Sug’orish quvurida bosimning 40-60-80-100 kPa qiymatlarida olib borilgan tadqiqot natijakari keltirilgan.

Kalit so’zlar. Tomchilatib sug’orish, bosim, quvur, suv sarfi, ishchi grafik, tirqish.

Аннотация. В статье представлен метод построения рабочей характеристики отверстий оросительных труб системы капельного орошения. Исследования по построению рабочей характеристики отверстий оросительных труб системы капельного орошения проводились в лаборатории «Гидравлика»

при кафедре «Гидравлика и гидроинформатика». При проведении исследований использовалась установка «DVT BBO DB для испытания труб системы капельного орошения». Представлены результаты исследований, проведённых при значениях давления в оросительной трубе 40, 60, 80 и 100 кПа.

Ключевые слова: капельное орошение, давление, труба, расход воды, рабочая характеристика, отверстие.

Introduction: The depletion of freshwater resources and the growing problem of water scarcity are being observed not only in our region but also worldwide. These challenges, in turn, contribute to a reduction in the area of irrigated agricultural land, an increase in abandoned agricultural areas, and a decline in the production of food and other agricultural products. To mitigate these problems, the use of water-saving technologies has become essential. The practical effectiveness of drip irrigation, one of the water-saving technologies used in irrigated agriculture, has been demonstrated, and this technology is now widely applied worldwide [1]. In particular, drip irrigation systems have been implemented in irrigated areas of the Republic of Uzbekistan for several years.

Problem Statement: When designing drip irrigation systems, it is necessary to take into account the water discharge through each opening located along an irrigation pipe. The irrigation duration is determined based on the discharge through these openings [2]. During the design process, manufacturers' specifications are generally used to determine the discharge through irrigation pipe openings. For almost all manufacturers, the discharge rates specified for irrigation pipe openings are based on a pressure value of 100 kPa. Accordingly, the discharge corresponding to a pressure of 100 kPa in the irrigation pipe is used in the design process to determine the irrigation duration [3].

A review of the literature and the results of the research indicate that maintaining a constant pressure throughout irrigation pipes is not always feasible. The

main reasons include hydraulic losses and improper irrigation management [4]. Based on the analysis of the processes described above, it can be concluded that there is a need to develop an operating characteristic curve for each irrigation pipe.

Research Methodology: The operating characteristic curve of an irrigation pipe describes how the water discharge through its openings changes in response to variations in pressure within the pipe. Developing such a curve requires conducting experiments under field or laboratory conditions.

To develop the operating characteristic curve of irrigation pipes, experimental studies were conducted in the laboratory of the Department of Hydraulics and Hydroinformatics at the National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers."

The laboratory experiments were performed using the "DVT BBO DB Drip Irrigation System Pipe Testing" apparatus (Figure 1). The apparatus was manufactured in Türkiye. It allows four to five experiments to be conducted simultaneously. The apparatus is equipped with a sensor panel that enables the monitoring and control of pressure and time variations.



Figure 1. DVT BBO DB apparatus for testing pipes in drip irrigation systems.

Using this apparatus, laboratory tests are conducted to determine the pressure-dependent variation in the water discharge of drip irrigation pipes used for crop irrigation, as well as their pressure resistance. The quality of drip irrigation system pipes is also evaluated.

The laboratory experiments are carried out in the following sequence:

The diameter of the drip irrigation pipe is determined.

The number of water outlet openings in the drip irrigation pipe is recorded (nn, units).

The pressure value displayed on the apparatus screen is recorded (pp, kPa).

The time value displayed on the apparatus screen is recorded (tt, min).

The volume of water in the apparatus reservoir is recorded (WW, cm^3). The water volume in the reservoir can be measured using a graduated cylinder or calculated from the piezometer readings using the following formula:

where: W — volume of water in one reservoir of the apparatus, cm^3; h — piezometer reading, cm.

The water discharge through the outlet openings of the drip irrigation pipe is determined using the following formula:

Research Results: Laboratory tests were conducted to evaluate drip irrigation pipes manufactured domestically and imported from abroad. During the experiments, products manufactured by Company N1 were tested. The irrigation pipes produced by Company N1 had a diameter of d=16d = 16 mm, with a spacing of 25 cm between the outlet openings.

The experimental tests were conducted at pressure values of 40, 60, 80, and 100 kPa. The results showed that the water discharge through the pipe outlets was 0.48 L/h

at a pressure of 40 kPa, 0.90 L/h at 60 kPa, 1.23 L/h at 80 kPa, and 1.61 L/h at 100 kPa (Table 1).

Table 1

Water Discharge through the Outlets of Drip Irrigation System Pipes (Products Manufactured by Company N1)

№	d, mm	n, pieces	p, kPa	t, min	h, sm	W, sm^3	q, l/hour	$q_{o'r}$, l/hour
1	16	4	40	10	3,2	303,95	0,46	0,48
2	16	4	40	10	3,5	332,45	0,50	
3	16	4	40	10	3,4	322,95	0,48	
4	16	4	40	10	3,3	313,45	0,47	
5	16	4	60	10	6,5	617,40	0,93	0,90
6	16	4	60	10	6,4	607,90	0,91	
7	16	4	60	10	6,3	598,41	0,90	
8	16	4	60	10	6,2	588,91	0,88	
9	16	4	80	10	8,5	807,37	1,21	1,23
10	16	4	80	10	8,4	797,87	1,20	
11	16	4	80	10	8,6	816,87	1,23	
12	16	4	80	10	8,9	845,37	1,27	
17	16	4	100	10	11,3	1073,33	1,61	1,61
18	16	4	100	10	11,2	1063,83	1,60	
19	16	4	100	10	11,4	1082,83	1,62	
20	16	4	100	10	11,4	1082,83	1,62	

The results of the laboratory experiments were analyzed, and a graph illustrating the variation in water discharge through the irrigation pipes manufactured by Company N1 as a function of pressure was plotted (Figure 2).

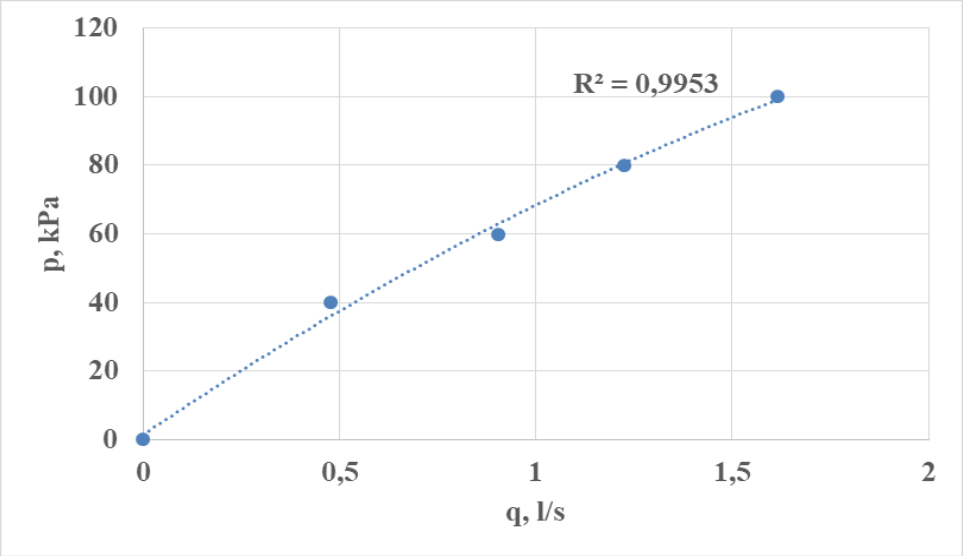


Figure 2. Operating Characteristic Curve of the Irrigation Pipe

Conclusion: Manufacturers generally specify the water discharge through the outlets of drip irrigation systems at a single pressure value, namely 100 kPa (1 bar). However, during operation, pressure varies due to head losses along the pipes and at local resistances. As a result, the irrigation duration and water consumption may increase.

The operating characteristic curve presented above makes it possible to determine how the water discharge through the outlets of drip irrigation pipes varies depending on pressure. By calculating the pipe length, estimating head losses along the pipes and at local resistances, and using this curve, designers can evaluate the water discharge through the outlets of drip irrigation systems under different operating conditions.

Furthermore, this apparatus can be used to determine the water-carrying capacity of various drip irrigation systems manufactured domestically or imported from abroad, as well as to assess changes in water discharge as a function of pressure.

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