EVALUATION ON THE IRRIGATION WATER TEMPERATURE CHANGES INFLUENCING THE COMPENSATING AND NON- COMPENSATING EMITTERS HYDRAULIC PROPERTIES

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ABSTRACT

Discharge of emitters changes by various factors such as pressure, manufacturing coefficient of variation, obstruction and temperature of irrigation water. In order to review the effects of temperature on discharge of emitters, 10 types of emitters were tested in irrigation laboratory in Water Sciences Engineering Faculty of Ahwaz, "Shahid Chamran University", In this research, the effects of 4 different temperatures i.e. 10, 20, 30, 40 °c under 4 pressures i.e. 5. 10, 15, 20 m were reviewed. For experiments in temperature of 10° , the ice was used and in temperatures of 30° and 40° , a tank equipped with an element and controlling unit for temperatures respectively was used. Then by calculation of manufacturing coefficient in temperature of laboratory (20°c) and based on American Society of Agricultural Engineers Standard of variation in qualitative classification of emitters was done which, in result , four types were excellent, two ones, unusable and the rest were between both conditions. With regard to obtained results by raising temperature of irrigation water, the discharge of non-compensating emitters was increased. In compensating emitters, the temperature didn't have meaningful effect on discharge of emitters in 3 cases of temperature, but in two types caused up to 7decreased discharge. In final, result showed that Temperature doesn't have a meaningfull effect on manufacturing coefficient of variation.

Keywords: emitter, manufacturing coefficient of variation, water temperature, pressure

1. INTRODUCTION

According to the optimal use of water and soil resources, it is necessary to use new irrigation methods such as drip irrigation because of its high efficiency. In this method of irrigation, the selection of emitter is the most important factor of designing because the efficiency of a drip irrigation regime depends on the emitter selection and disregarding the problems of emitters causes the emission uniformity of water to be decreased, regime`s working time to be increased, and a constant replacement of emitters to be occurred.

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(Bralt racts and Kesner, 1983; Ehsani and Khaledi, 2009). Drip irrigation, slowly and regularly, applies water and fertilizers directly to the root zone of plants through a network of economically designed plastic pipes and low discharge emitters. The advantage of using a drip-irrigation regime is that it can significantly reduce the soil evaporation and increases the water usage efficiency by creating a low and wet area in the root zone. Due to water shortages in many parts of the world today, drip irrigation is becoming quite popular (Powell and Wright, 1998; Sahin et al., 2005). In 2000, more than 73% of all agricultural fields in Israel were irrigated using drip-irrigation regimes, and 3.8 million hectares worldwide were irrigated using drip-irrigation regimes (ICID, 2000).Many factors such as physical, chemical and biological obstruction, pressure, water temperature and manufacturing variations, affect the discharge of emitters and, finally, the distribution uniformity of water. The temperature of irrigation water influences the emitters `s discharge in various ways in which the constituents , geometric form ,and the flow duct in emitter can be changed under the temperature variations and influence the output discharge (Alizadeh, 2003) . The other effect is due to its influence on the water viscosity so that the Kinematic viscosity decreased as the temperature goes up and, as a result, the emitters` discharge would be increased. The discharge changes to viscosity of water depend on the in-emitter discharge controlling condition. The emitters with a regime of laminar flow have a higher sensitivity to viscosity of water so the changes of irrigation water`s temperature influence their discharge changes. Studies show that the discharge of emitters with turbulent flow was decreased linearly by irrigation water`s temperature rising but emitters with laminar flow was increased. Sinobas et al. reviewed the effect of temperature change on the discharge of emitters. In this research, the output discharge of compensating emitters did not change significantly in a 20 to 40℃ range and the conducted experiments showed that the by- temperature discharge changes depend on the emitter type so that, by the temperature raising, the discharge value in emitters with $x > 0.5$ and emitters with $x < 0.5$ increases and decreases, respectively(Sinobas and et al).Olivira et al. showed that the flow regime in the tested emitters was turbulent and, also, the discharge of emitter has just a 1.75 percent reduction caused by the water`s temperature which raised from 30 to 60℃ (Powell and Wright, 1998).

2.Material and methods

2.1 Identifying the emitters and collecting the required samples:

Provided in previous courses, samples were selected from the irrigation laboratory`s available emitters in the faculty of water sciences engineering in order to carry out the experimentation. Most of the selected samples were out of the country compensating emitters which supplied by sale agencies inside the country. For experiments, 10 types of emitters were selected and evaluated after coding. Their specifications are provided in table 1. ISO261 standard`s criteria were used during the research of in.

2.2 The method of the laboratory operations:

The types 25 emitters, after the identification of available emitters, were selected randomly from the available 100. Finally, 10 types of emitters were selected for the experiment. Each emitter, then, was particularly coded (A, B, C, D, E, F, G, H, I, M). For each experiment, initially, emitters were installed on a 16 mm diameter Polyethylene pipe line with a 20cm distance from each other in required length. Then, the pipe was connected to a tank equipped with a pump through a water supply conduct. For testing,

the effects of the four 10, 20, 30, and 40℃ temperature treatments under 4 pressures of 5, 10, 15, and 20 m were applied as:
The first experiment temperature was the 20℃ laboratory temperature (temperature changes were recorded and observed as a ± 1 level at different times of experiment). Using ice, at the second phase, the water temperature was lowered to 10℃ so that experiments were conducted at this temperature. Third and fourth phases (30 and 40℃) were carried out by using a separate tank equipped with an element for heating and a thermostat for controlling the temperature. Each experiment was repeated for 3 times and the average of these 3 repetitions was considered as the discharge applied supplied temperature. Finally, the quantity of the output water was measured by using calibrated cylinders and the discharge was calculated by dividing the time of experiment.

Table 1. Used emitters` properties

Discharge ($L\ h^{-1}$)	Pressure(m)	Type of emitter	Emitter
8	7-40	$on - line$	A
4	10	$in - line$	B
4	5-40	$on - line$	C
3.75	5-40	$on - line$	D
25	10-40	$on - line$	E
4	10	$on - line$	F
4	10	$in - line$	G
8	7-40	$on - line$	H
4	5-40	$on - line$	I
4	5-40	$on - line$	M

3. Results and Discussion

3.1 emitters` qualitative evaluation:

According to table 2 and based on the association of American agriculture engineers' standard, emitters were categorized based on the manufacturing coefficient of variation. This coefficient has obtained at 20℃ for all of cases. Considering the manufacturing coefficient of variation, as illustrated in table 2, A, B, D, and H samples are exceptional, F and M are unusable, and the rest are between these two conditions. After this phase, except emitters of the unusable group (F and M), the rest were tasted in order to evaluate the temperature effect on their hydraulic characteristics at other temperatures.

3.2 pressure–discharge relation in different emitters:

In table (3), x and y values in pressure- discharge equation has provided for each 8 types of emitters. According to the ISO 9261 standard, the compensating emitters have a x value lower than 0.2 (ISO,2004). As shown in table 3, B and G emitters are non-compensating but others are not. These emitters, according to compensating of pressure, are different and they have a better adjusting power if the x value become lesser, which the D type with a x value of 0.011 is the best pressure adjusting type.

Table 2. Manufacturing coefficient of variation for 10 emitters tested at 20℃

manufacturing coefficient of variation in variation pressure(m)				Emitter
20	15	10	5	
0.04	0.047	0.028	0.034	A
0.023	0.035	0.011	0.023	B
0.1	0.07	0.09	0.07	C
0.048	0.035	0.038	0.038	D
0.06	0.056	0.09	0.13	E
0.32	0.28	0.25	0.18	F
0.052	0.051	0.05	0.1	G
0.042	0.042	0.027	0.049	H
0.054	0.05	0.056	0.055	I
0.17	0.21	0.24	0.28	M

Table3. discharge-pressure equation`s coefficients in various emitters at 20℃

Emitter	*k*	x	R^2
A	6. 747	0.091	0.55
B	1.6	0.41	0.982
C	3.604	0.095	0.202
D	3.681	0.011	0.019
E	14.56	0.159	0.43
G	1.174	0.526	0.954
H	6.683	0.055	0.335
I	3.762	0.052	0.198

3.3 Temperature effects on discharge of emitters:

For evaluating the temperature effects on the emitters` discharge, first of all, the temperature effect was evaluated on different emitters` discharge in a random full block project. In this project the effects of 4 temperatures (10, 20, 30, and 40℃) and 4 pressures (5, 10, 15, and 20 m) were considered as treatment and block, respectively. For B, D, G, H, I emitters, the temperature effect on discharge was significant with a confidence level of 95% , but in the other ones it wasn't so. Emitters not affected significantly by the temperature changes are of compensating type. The process of average discharge changes in 4 temperature treatments is illustrated in figures 1 to 5. As the temperature increases, the discharge of I, G, and B increases but the other two types` discharge decreases.

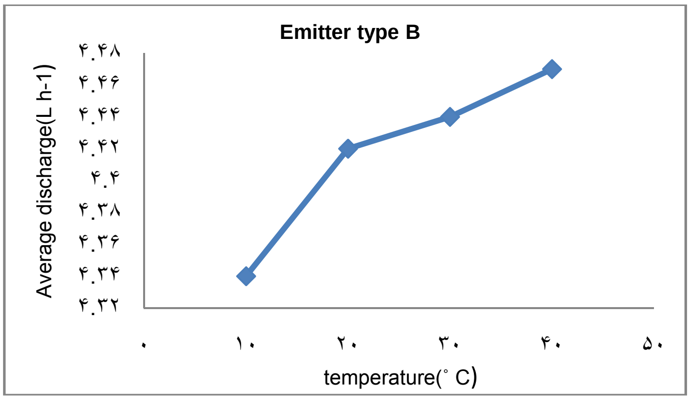

Figure 1 . discharge mean changes in various treatments for the B emitter

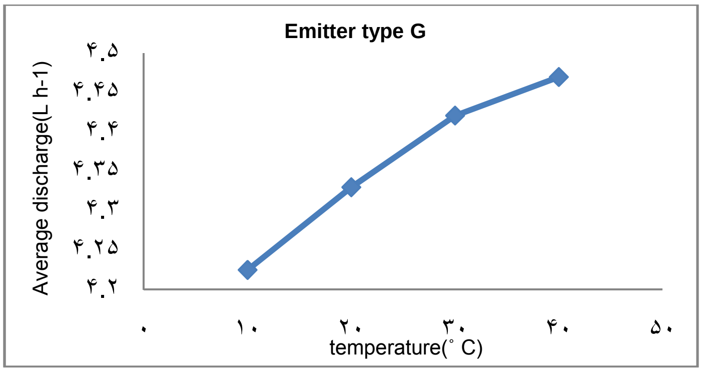

Figure 2. discharge mean changes in various treatments for the G emitter

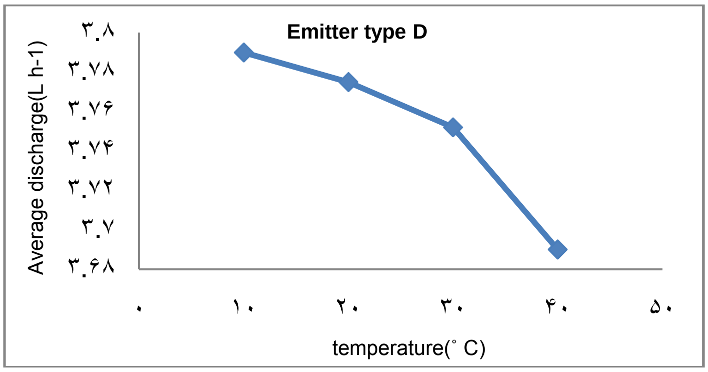

Figure 3. discharge mean changes in various treatments for the D emitter

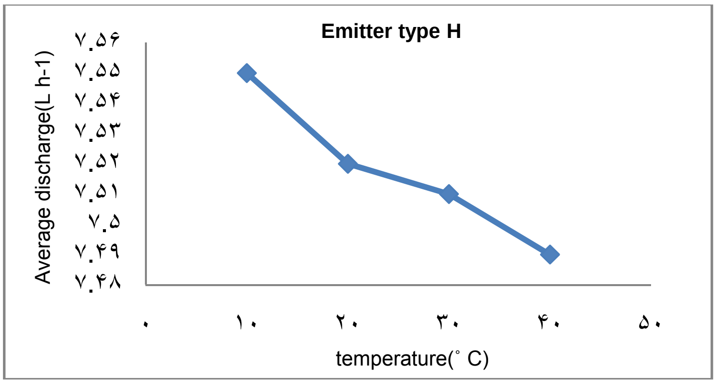

Figure 4. discharge mean changes in various treatments for the H emitter

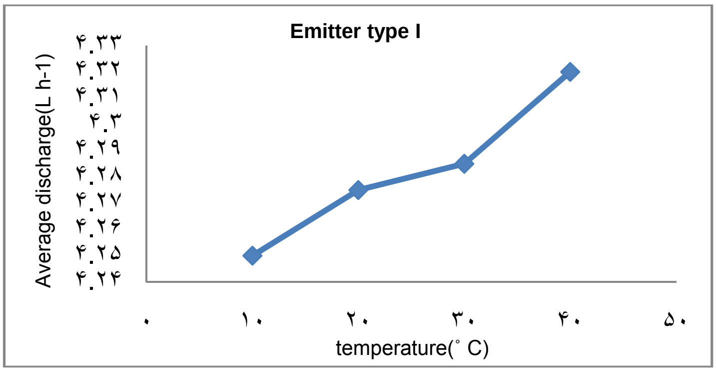

Figure 5. discharge mean changes in various treatments for the I emitter

3.4 Discharge–temperature relation of different emitters:

In the case of 5 types of the given emitters, the best temperature- discharge relation was obtained, which in all cases, it was linear. This model is as $y = Ax + B$,which the variables of x and y indicates the temperature and discharge, respectively; values of A and B are constant coefficients illustrated for each emitter in table 4. According to the equation's coefficients, the process of discharge changes with pressure is demonstrated in each emitter and different pressures.

3.5 Discharge–pressure relation in different temperatures:

In order to observe the effects of temperature in different pressures on pressure – discharge relation, this relation was obtained for each emitter in different temperatures. According to the table and the values of x in various emitters, it is apparent that in two types of non-compensating emitters (B and G), especially in type G, the value of x increases when the temperature goes up. In this emitter, the x value has raised from 0.519 at 10℃ to 0.567 at 40℃. In other words, irrigation water `s temperature rising in non-compensating emitters increases the $x$ value and, consequently, causes the pressure adjusting power to be decreased; an irregularity of the emitter`s output discharge is resulted, finally. In the case of compensating emitters, as illustrated in table 5, the x value is firstly increased and finally decreased by the temperature raising in H and I emitters. So, in this type of emitters, the change of temperature alters the pressure`s compensating power. For the D emitter, also, the x value has decreased from 0.061 at 10℃ to 0.014 at 40℃; although there wasn't a distinct procedure between those temperatures, x value was decreased.

Table 4. discharge-temperature equation`s coefficients in various emitters

Emitter		Pressure(m)			
		5	10	15	20
B	A	0.0027	0.0028	0.0031	0.0064
	B	3.62	4.1152	4.72	5.377
G	A	0.0012	0.0065	0.0098	0.0148
	B	2.6	3.9	4.7	5.3
D	A	-0.0024	-0.004	-0.0027	-0.0031
	B	3.8	3.8	3.85	3.9
H	A	-0.0206	-0.0087	-0.003	-0.0041
	B	7.94	7.72	7.67	7.85
I	A	0. 0024	0.0025	0.0014	0.0012
	B	3.95	4.1	4.14	4.3

3.6 Evaluating the temperature effects on emitter `s manufacturing coefficient of variation:

For each emitter, the effect of 4 temperature treatments on manufacturing coefficient of variation was evaluated by using the ANOVA test. Consistent with the previous investigation test results showed that there isn't a significant effect of temperature on the manufacturing coefficient of variation except one case. Only, in the case of I emitter, which is a compensating one, the effect of temperature affected the manufacturing coefficient of variation.

Table 5. discharge-temperature equation`s coefficients in various emitters at the tested temperatures

Emitter		Temperature			
		10	20	30	40
B	k	1.649	1.601	1.627	1.67
	x	0. 394	0.413	0.41	0.399
	R^2	0.96	۰/۹۸	0.98	0.98
G	k	1.17	۱/۱۱۸	1.115	1.096
	x	0.519	0.545	0.552	0.567
	R^2	0.94	0.94	0.96	0.96
D	k	3.64	3.68	3.65	3.564
	x	0.061	0.011	0.0115	0.014
	R^2	0.07	0.019	0.0212	0.05
H	k	8.103	6.79	6.74	6.78
	x	-0.019	0.051	0.043	0.039
	R^2	0.061	0.31	0.3	0.22
I	k	3.78	3.762	3.84	4.104
	x	0.043	0.052	0.044	0.032
	R^2	0.19	0.198	0.145	0.13

4. Conclusion

According to the compensating emitters mentioned above, the discharge has decreased by temperature rising in two cases, but in 3 cases, the effect of temperature on discharge was not significant and ,in one case, the discharge has increased by the temperature rising. In the case of non - compensating emitters, the discharge increased by the temperature rising. Based on the type of emitter, in general, the effect of temperature on discharge is dissimilar. Causing a vortex mode, the reason of discharge reduction by the temperature rising in compensating emitters can be the regime of an unstable flow in them so that emitters' pressure loss would be occurred. Based on this, the irritation water `s raised temperature decreases the discharge of these emitters. It can be concluded that the raised temperature of irrigation water increases the output discharge of emitters by increasing the value of x in pressure-discharge equation. In the other hand, of, the viscosity of irrigation water would be lessened by its temperature rising and the sensitivity of discharge to viscosity and temperature of water is more in a regime of a laminar flow than a regime of turbulent flow. The important point is that the temperature changes dependant on the type of emitter alters the pressure adjusting power and, finally, the uniformity of water distribution. Also, it can be said that in emitters with x >0.5, the discharge would be increased and the pressure adjusting power would be decreased by raising the temperature of irrigation water.

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