RESEARCH REGARDING THE DIMENSION OF WATERING PIPE TO LOCALIZED IRRIGATION BY PERFORATED TUBES

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ABSTRACT

The paper presents a method for choosing the nominal diameter and the calculation of adequate maximum length at watering pipe (perforated tube). The selection of nominal diameter is in accordance with the energetic factor.

Key words: hydraulic, watering pipe, dimensioning.

INTRODUCTION

In Romania, two types of installations for localized irrigation have been produced: with perforated tubes (IUTP-1) and with drippings (IUP-1).

From hydraulic point of view, watering pipe (perforated tube) can be assimilated with a long pipe, smooth, with constant diameter on a port or on all pipe length. In Romania, perforated tubes are manufactured of low black density polyethylene (PE_{jd}), with the black color by content of carbon (C=2%).

Romania produces tubes of type I with nominal pressure 0.25 MPa, shock resistance dimensional stable at temperature and with k_1=0.010 mm.

This perforated tube is realized in four type-dimensions for nominal diameter (D_n) equal with the extern diameter: 16 mm, 20 mm, 25 mm and 32 mm.

The localized irrigation with IUTP-1 is recommended for vine and fruit tree plantation localized on soils with stable flow rate of infiltration of 2-15 cm^3/ s/ m and with base rock to depth bigger than 0.80 m.

MATERIALS AND METHODS

The selection of nominal diameter (D_n) is in accordance with the hydraulic factor (total head loose for economic speeds) and energetic factor (energy utilized manufacturing plastic tube comparatively with necessary energy for water distribution in area).

The following relations are used:

-energy used in the plastic mass manufacturing (E):

$$E = C_1 * M_s * \frac{L_t}{T}$$

[kWh/ha/year] (1)

-energy used for water distribution in area (e_s):

$$e_s = C_1 * M_b * H_{am}$$

[kWh/ha/year] (2)

where: C_1 – specific consumption of energy for PE_{jd} length necessary of perforated tube on unit of equipped area, in kWh/kg; M_s – specific weight for type-dimension tube, in kg / m; L_t – tube length, in m/ha; T – period of standard use, in years; C – transformation factor (C = 0.003797); M_b – irrigation raw rate, in m^3/ ha; H_{am} – up stream head pression, in MH_2O.

The admissible tolerance for non uniform flow and the hydraulic head loss (admissible and the unitary one), are calculated using the following relations [1]:

$$dq_a = 0.55 * \frac{(Q_a)_{max} - (Q_a)_{min}}{(Q_a)_{max}} \qquad (3)$$

$$(h_t)_{ad} \le \left[1 - (1 - dq_a)^2\right] * H_{am}$$

[MH_2O] (4)

$$j_a = a * \frac{Q^b}{D_i^{3+b}}$$

[MH_2O/100 m] (5)

where: dq_a – admissible tolerance for non-uniform flow, (dq_a=0,15…0,30); $(h_t)_{ad}$ – admissible hydraulic head loss; Q_a – distributor rate of flow, in cm^3/s; (a.b.) – experimental coefficients, are specific for plastic material of perfo-

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rated tube; D_i – interior diameter in dm, MH_2O – meter head of water, (1 MH_2O = 0.01 MPa).

The perforated tube flow rate (Q_d) in the case of across section placed to distance (d) of up stream, can be calculated using the relations [1]:

$$Q_d = Q_{tr + 0.55 * q * d} \quad [\ cm^3/s\ ] \qquad (6)$$

$$q = \frac{Q_{tr}}{L} \quad [\ cm^3/s/m\ ] \qquad (7)$$

where: Q_{tr} – transit flow rate in calculation across section, in cm^3/s;

If the calculation across section coincides with down stream, flow rate is calculated with the relation:

$$Q_{av} = 0.58 * q * L \quad [\ cm^3/s\ ] \qquad (8)$$

where: L – maximum length for perforated tube with nominal diameter (D_n), in m.

The maximum hydraulic head loose (h_t) using the following relations [1]:

$$h_t = Q_{av} * \frac{L}{K^2} \quad [\ MH_2O\ ] \qquad (9)$$

$$K = \frac{p}{4} * \sqrt{2g} * \sqrt{\frac{D_i^5}{l}} \qquad (10)$$

where: K- flow rate module, in $cm^{2,5} \times m^{0,5}/s$; l = 64/Re for linear regime and for turbulent regime:

$$l = 0.285 * \mathrm{Re}^{-0.241}$$

RESULTS AND DISCUSSIONS

1) The selection of nominal diameter (D_n) is in accordance with the hydraulic factor and energetic factor.

Example: M_s = 0.069 kg/m for D_n = 16 mm; M_s = 0.094 kg/m for D_n = 20 mm; M_s = 0.143 kg/m for D_n = 25 mm; M_s = 0.220 kg/m for D_n = 32 mm; M_b = 1200 m^3/ha; H_{av} = 0.05 MPa; Q_{av} = 145 dm^3/hour; equidistance distributors on tube = 5m; T = 20 years; L_t = 4600 m/ha; crop = vine; L = 100 m; C_1 = 83.3 kWh/kg.

In table 1, are presented (e_s) and (E) for those four type-dimensions of nominal diameter:

The following aspects resulted:

-the decisive influence of energetic factor specific to the construction material (E) compared with the hydraulic factor specific to the energy used for water distribution in area (e_s);

-maximum period for irrigation (T_u) is maximum 8 hours;

-comprised energy in PE_{jd} for D_n represents 93% from cumulative energy for D_n = 20 mm and D_n = 25 mm.

Table 1. The values of (e_s) and (E)

Element calculated		D_n [mm] 16	20	25	32
E [kWh/ha/year]		1322	1801	2740	4125
e_s [kWh/ha/year]	T_u=4hours	270	91	40	22
	T_u=6 hours	118	38	18	9
	T_u=8 hours	77	28	11	6
	T_u=10 hours	52	18	7	4
	T_u=12 hours	41	14	5	2

2) The maximum length for perforated tube (L) with interior diameter (D_i), in accordance with its longitudinal slope is calculated using the following relations, from the equations (3, 4, 5):

a) <u>*slope less than 0.0010:*</u>

$$L = \frac{\left\{3\left[1-\left(1-dq_a\right)^2\right] * H_{am} * D_i^{3+b}\right\}^{1/1+b}}{\left(a * q^b\right)^{1/1+b}} \quad [m] \qquad (11)$$

b) <u>*slope 0.0010 – 0.0500*</u>

$$\left|1-\sqrt{\frac{1+3 * I * L * D_i^{3+b} - a * q^b * L^{1-b}}{3 * H_{am} * D_i^{3+b}}}\right| - dq_a \le 0 \quad [m] \qquad (12)$$

where: q – in dm^3/s/m, ($q \le q$ stabilized of infiltration, measured *in situ* with specific device "infiltrometer"); I - gradient of perforated tube, it is directly (+) when is in the same sense with water circulation and indirectly (-), when is in opposite sense with water circulation.

Equation (11) and especially equation (12) can be resolved by iteration using an electronic computer.

The particularity of equations (11) and (12), consisting in the determination for the first time may by in the world of these geometric and hydraulic characteristics.

CONCLUSIONS

It is recommended to utilize the nominal diameter of 16 mm, 20 mm and 25 mm.

The optimum pressure of operation is 0.08 – 0.14 MPa, with minimum limit of 0.05 MPa and maximum limit of 0.16 MPa.

Perforated tube with length more than 50 m is telescopic dimensioned, starting with the higher value.

The maximum length for perforated tube (L) with interior diameter (D_i) depending on its longitudinal slope, can be calculated using the relations (11) or (12).

REFERENCES

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Table 1. Influence of aluminum ions, in reaction mixture, on the level of saccharasic activity in a reddish-brown soil fertilized with compost with different quantities (glucose+fructose-mg/100 g soil dw/24 hours)

A- Factor	B – Factor – COMPOST (t/ha)								Average (A)	
	b1-0	%	b2-0	%	b3-0	%	b4-0	%		%
a1–without Al^{3+}	b 3287	100	b 4028	100	b 2579	100	b 3472	100	b 3341	100
a2- with Al^{3+}	a 4228	129	a 5019	125	a 3472	135	a 4528	130	a 4312	129
Average (B)	3757 c		4523 a		3025 d		4000 b			

LD P	5%	1%	0,1%
A	291	673*	2143
B	101	142	201*
AB	302	628*	1799
BA	144*	201	284

Table 2. Influence of aluminum ions, in reaction mixture, on the level of saccharasic activity in a chernozem mineral fertilized or manured with farmyard compost (glucose+fructose-mg/100 g soil dw/24 hours)