RESEARCH REGARDING THE APPLICATION OF LIQUID FERTILIZERS WITH IRRIGATION WATER USING MEDIUM PRESSURE INSTALLATIONS

CERCETĂRI PRIVIND APLICAREA ÎNGRĂŞĂMINTELOR LICHIDE ÎN APA DE UDARE CU INSTALAŢIILE DE MEDIE PRESIUNE

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Abstract: *Fertigation (fertilization + irrigation) represents the application process of the fertilizers directly with the irrigation water. The fertigation installation used to make such an operation contents a double diaphragm pump, which injects the fertilizer solution to a higher pressure than that of the irrigation installation. The main advantages of the fertigation process are: savings of labour and of the energy and a more effective use of the fertilizers, which are expensive. The technical solution of the fertigation installation represents the subject of the Patent –RO no. 121612/2007.*

Rezumat *Fertirigaţia (fertilizare + irigaţie) reprezintă procesul de aplicare a îngrăşămintelor direct cu apa de irigaţie. Instalaţia de fertirigaţie cu care se realizează această operaţie conţine o pompă cu membrana dublă, care injectează soluţia cu îngrăşăminte la o presiune mai mare decât a instalaţiei de irigat. Principalele avantaje ale fertirigaţiei sunt: economisirea forţei de muncă şi a consumului de energie şi o utilizare mai eficientă a îngrăşămintelor care sunt costisitoare. Soluţia tehnică a instalaţiei de fertirigaţie constituie subiectul brevetului RO nr. 121 612/2007.*

Key words: *irrigation, fertilizers, fertigation installation*
Cuvinte cheie: *irigaţii, îngrăşăminte, instalaţie de fertirigaţie*

INTRODUCTION

The application of the fertilizers and other chemical substances for the plants and soil treatment used in the agricultural technique simultaneously with plants watering is called fertigation method.

In case chemical fertilizers are replaced by organic fertilizers, the process is called bio-fert-irrigation.

The fertigation installation necessary for the application of the chemical or organic fertilizers consists in: a tank for substances storage, equipment (pumps, injectors etc.) for the introduction (injection) of the substances in the irrigation water, a control device and the watering equipment.

The equipment for the substances injection in the irrigation water are usually positive displacement piston or diaphragm pumps, with simple or reciprocating effect.

The precise dosing of the fertilizers is achieved by positive displacement pumps which perform also a right proportion between the injected flow and the installation flow.

The used pumps can be driven with electrical, thermal or hydraulic engines. The most used pumps at present are the pumps driven by hydraulic engines. These pumps use the hydraulic energy of the under-pressure water which supplies the irrigation installation.

The researches carried out by ICITID Baneasa Giurgiu have demonstrated that, at the hydraulic driven pumps (which run on the hydraulic transformers principle), the pump frequency rises when the operation pressure of the installation is increased. Because at higher frequencies the admission valves run is no longer good, the pump efficiency is lower and in order to eliminate this inconvenient simple effect pumps must be used. Due to the fact that the water used by the pump for driving can not be conducted in the watering installation (the water

is free discharged in the crop), in order to reduce the water consumption, big size pumps can not be used. Thus, at pressures higher than 0.3 MPa simple effect pumps can be used with good efficiency and at lower pressures, reciprocating pumps are to be used.

MATERIALS AND METHODS

The fertigation installation with simple pump consists of a simple diaphragm pump A (fig. 1), which injects the fertilizer, a low pressure irrigation installation B, with which water is spread to the plants, an injection control device C which check the pressure and the flow and an annex D, which makes the connection between the fertilizer tank – the pump and the irrigation installation.

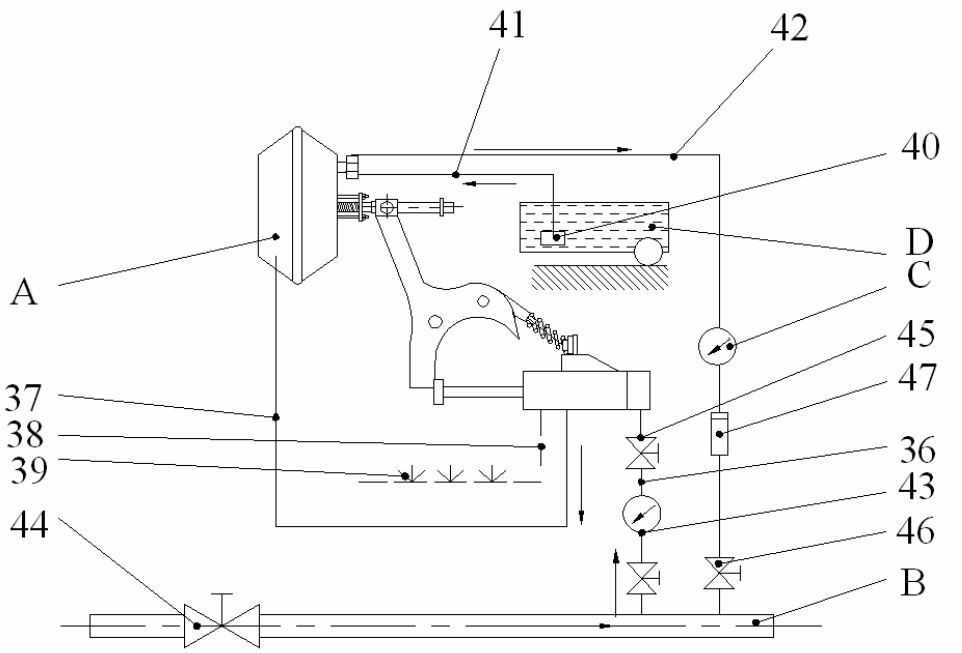

Figure 1. Simple diaphragm pump

Pump A (Figure 2), consists of a body E, where the hydraulic energy of the water is transformed into hydraulic energy necessary for the fertilizer injection, a distributor F, which directs the water flow and a spring mechanical drive G, which operates the distributor in order to change the moving direction.

The annex D (fig 1), consists of the fertilizer tank, one way valves 47 and some fast hydraulic couplings for installation connection.

The irrigation installation B (fig. 1), provides water with fertilizers to the plants and part of the water in installation is used to supply water to the pump and the discharged water is spread to the plants by some nozzles. It is recommended that the operation pressure of the installation to be higher for a better running of the pump described above.

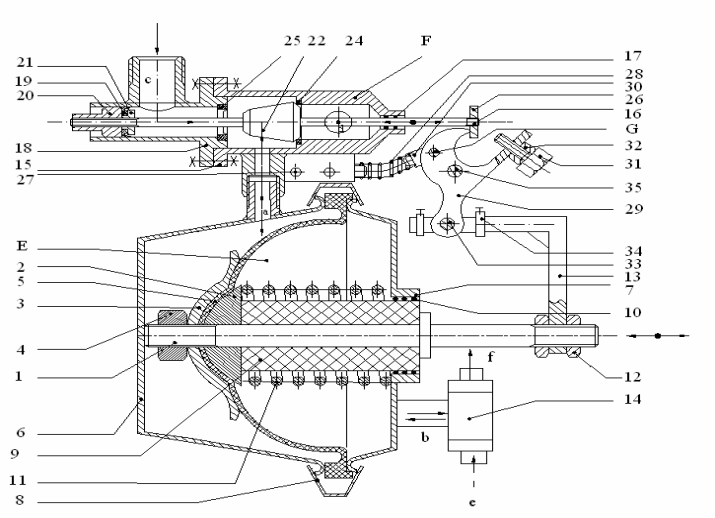

Figure 2.Pump – Details

The A pump body, E, consists of:
1- pump axle
2 - cup
3 - collar
4 - nut
5 - diaphragm
6 - left cover
7 - right cover
8 - bridle
9 - piston
10 - gaskets
11 - spring
12 - nuts
13 - lever
14 - check valves block
a, b - apertures

The distributor, F, consists of:
15 - distributor body
16 - distributor axle
17 - distributor gaskets
18 - distributor cover
19 - gasket
20 - nut
21 - collar
22 - check valve
23 - screws
24, 25- seats with check valves
26 - socket
27 - holder
c, d - apertures

The mechanical drive G consists of:
28 – spring
29 – gab
30 – faucet
31 – screw
32 – nut
33 – coupling
34 – limiting devices
e, f – apertures

The irrigation installation B (Figure 1) consists of:
36 - supplying circuit
37 – distributor connection to the pump body circuit
38 – discharge circuit
39 – nozzles
40 – fertilizer tank with filter
41 – inlet circuit
42 – injection circuit
The injection control device C (Figure 1) consists of:
43 – pressure gauges
44, 45, 46 - valves

RESULTS AND DISCUSSIONS

The fertigation installation with simple pump runs as follows: on the supplying circuit of the low pressure irrigation installation B (fig. 1), a simple diaphragm pump A is installed parallel together with the control device C and the annex D. Through the supplying circuit 36, the water of the installation B reaches the distributor F of the pump (Figure 2) and from here, through the circuit 37 (Figure 1) arrives in the lateral left chamber of the diaphragm 5 (Figure 2) of the pump body E.

The existent chemical fertilizer in the lateral right chamber of the diaphragm 5 is compressed and injected through the apertures b-f and circuit 42 (Figure 1) in the irrigation installation B, at a higher pressure than the existent one in the installation due to the smaller surface of the diaphragm in this chamber. The pressure practised on the diaphragm 5 (fig. 2), moves the piston 9 and, by the aid of the axle 1 and of the lever 13, the mechanical drive G is actuated, which, in the moment of the overturning, moves the axle 16 to the right. In this position, the water supply circuit of the distributor is closed and the discharge circuit is opened. The check valve 22 remains the out position due to the hydraulic force created by the gasket 19 and the increased section on the discharge way, which maintains the check valve, tightening also the axle 16 on the left end. The spring 16 which was compressed pushes the diaphragm 5, discharges the water from the lateral left chamber and absorbs the fertilizer in the lateral right chamber through the apertures e-b, the inlet circuit 41 (Figure 1) and filter 40. By left axle 1 moving (fig. 2), the lever 13 operates the mechanical drive G, which, at the end of its lift, moves the axle 16 to the right by the aid of the gab, allowing the water inlet and the fertilizer injection, and the cycle is resumed.

The fertigation installation with simple pump pumps the fertilizer discontinuously in the irrigation installation and due to the high pressure, the increased water speed (erratic flow) and of the distribution device positioning of the irrigation installation, the homogenization of the mixture fertilizer-water is achieved optimally even in these conditions. The fertilizer dose is constant too, because the check valves operate at low frequencies, even the operation pressure is higher (at simple pumps the chambers volume is bigger).

The mechanical drive with spring presented at the pump, facilitates also the pump running at low frequencies and bigger sections of the water discharge circuit, decreasing the head losses on pump. The parallel mounting of the pumps achieves their independence from the irrigation installation flow, but in order to inject a constant flow the pump pressure must be constant. By increasing the installation pressure and flow, the pump frequency is increased, so the pump should be dimensioned to keep a right proportion of the flows (of the pump and of the irrigation installation) in order to obtain a constant concentration.

In order to inject fertilizer at a higher pressure than the installation pressure, the principle of the surface difference was applied, so the diaphragm on the side with pump role has the operating section smaller than the other side of the diaphragm, which plays the role of a hydraulic engine.

In the table below, the pump technical features and parameters are presented.

Table 1

PUMP PD-20 Technical Features

Injected flow	Till 220 L/h depending on the installation pressure
Minimum pressure	1,3 bar
Maximum pressure	5 bar
Water consumption	2 volumes of water for 1 volume of fertilizers

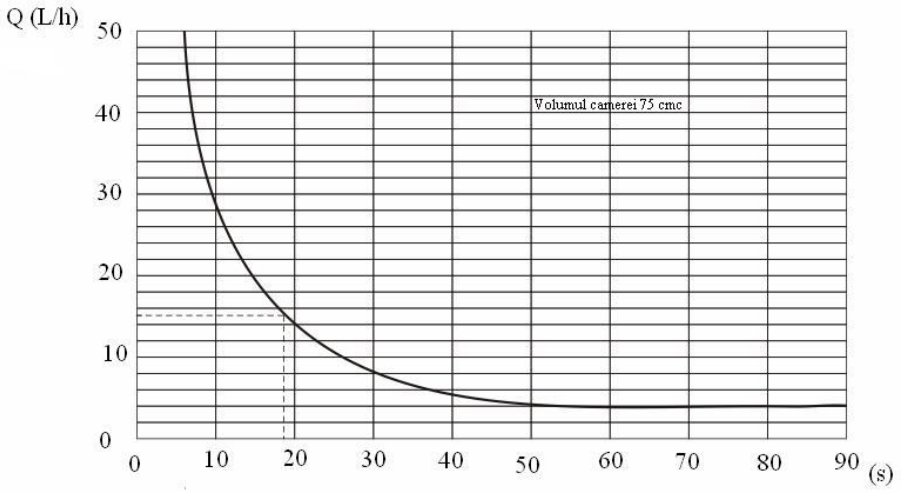

Figure 3. Simple pump curve

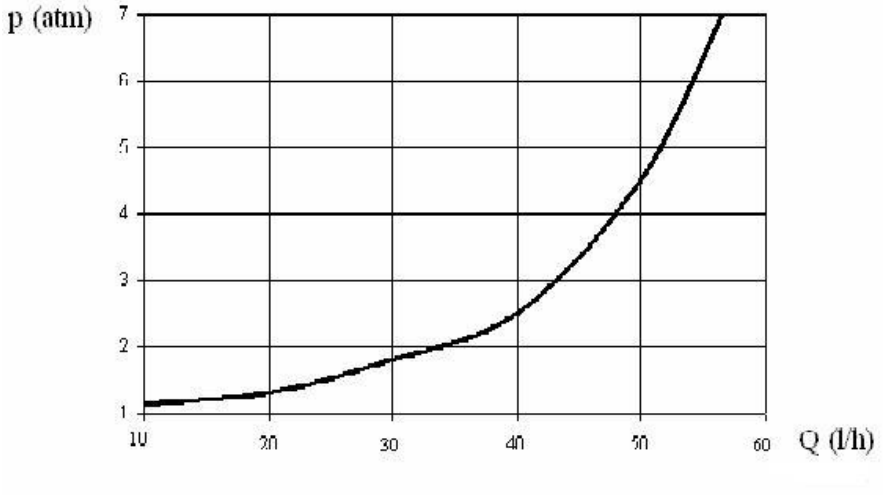

Figure 4. Pressure-flow correlation of the simple pump

CONCLUSIONS

- It is recommended the injection to be made in areas far from the distribution points for the mixture homogenization ;
- Operating pressure values can be around de 2 – 5 bar ;
- In order to operate with a higher efficiency (increased volumetric ratio) it is recommended that between the water feeding points and fertilizer injection to be a pressure loss (given by a valve, elbow etc.);

- The water discharged by the pump will be spread in the crop using nozzles or perforated pipes;
- The irrigation installation can be: a reel hose machine type, bearing type, linear type etc.

The technical solution of the fertigation installation represents the subject of the Patent –RO no. 121612/2007, holder of the licence being Mr. Ilie BIOLAN.

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