4th International Conference on Thermal Equipment, Renewable Energy and Rural Development

TE-RE-RD 2015

Posada Vidraru
4-6 Iunie 2015

4th International Conference of Thermal Equipment, Renewable Energy and Rural Development

TE-RE-RD 2015

(CD-ROM)

ORGANIZERS:

University "POLITEHNICA" of Bucharest
Faculty of Mechanical Engineering and Mechatronics -
Faculty of Biotechnical Systems Engineering -

National Institute Of Research – Development For Machines And Installations Designed To Agriculture And Food Industry – INMA

Chamber of Commerce and Industry of Romania

Chamber of Commerce and Industry of Arges County

PROCEEDINGS

Editors:

Prof.dr.ing. Lucian MIHĂESCU
Assoc. Prof.dr.ing.Gabriel-Paul NEGREANU

Posada Vidraru – Romania
4-6 June 2015
I

ISSN 2457 – 3302,
ISSN-L 2457 - 3302

Editura POLITEHNICA PRESS

COVER: Gabriel-Paul Negreanu

HONORARY COMMITTEE

Prof. Mihnea COSTOIU	ROMANIA
Prof. Ecaterina ANDRONESCU	ROMANIA
Prof. Tudor PRISECARU	ROMANIA
Prof. Gigel PARASCHIV	ROMANIA
Dr. Ion PIRNA	ROMANIA
Prof. Viorel BADESCU	ROMANIA
Dipl. Eng. Mihai DARABAN	ROMANIA

SCIENTIFIC COMMITTEE

Dr. Atanas ATANASOV	BULGARIA
Prof. Alexandru DOBROVICESCU	ROMANIA
Prof. Ion DONA	ROMANIA
Prof. Iliya ILIEV	BULGARIA
Dr. Ion V. ION	ROMANIA
Prof. Silvio KOSUTIC	CROATIA
Dr. Edmond MAICAN	ROMANIA
Prof. Milan MARTINOV	SERBIA
Prof. Nicolay MIHAILOV	BULGARIA
Prof. Constantin PANA	ROMANIA
Prof. Ionel PÎȘĂ	ROMANIA
Prof. Marija TODOROVIC	SERBIA
Prof. Tanay Sidki UYAR	TURKEY
Prof. Gheorghe VOICU	ROMANIA
Prof. Lubomir SOOS	SLOVAKIA

ORGANIZING COMMITTEE

Chairman	Prof. Lucian MIHĂESCU	ROMANIA
Co-chairmen	Prof. Sorin-Ştefan BIRIŞ	ROMANIA
	Dr. Gabriel-Paul NEGREANU	ROMANIA
	Dr. Valentin VLĂDUŢ	ROMANIA

Members	Dr. Cristian-Gabriel ALIONTE	ROMANIA
	Dr. Valentin APOSTOL	ROMANIA
	Prof. Mircea BADESCU	ROMANIA
	Dipl.Eng. Viorel BERBECE	ROMANIA
	Dr. Craita CARP-CIOCARDIA	ROMANIA
	Dr. Cristina COVALIU	ROMANIA
	Dr. Mihaela DUTU	ROMANIA
	Dr. Iulian DUTU	ROMANIA
	Dr. Elena POP	ROMANIA
	Msc. Ec. Valentin-Simion ZANFIR	ROMANIA

Secretary

Dr. Mirela DINCĂ	ROMANIA
Dipl.ing. Cristina Mihaela CIOBANU	ROMANIA
Dipl. ing. Gabriel GHEORGHE	ROMANIA

CONFERENCE SPONSORS

CONFERENCE PROFRAMME

Thursday, June 04	Friday, June 05	Saturday, June 06
	Breakfast	Breakfast
14.00-15.00 Registration of participants	08.30-09.30 Registration of participants	09.00-13.00 Possible trip
15.00-15.30 Opening ceremony	09.30-11.00 Oral presentations "Sections 1 and 2"	13.00 – 14.00 Brokerage Section ”Green Partners”
15.30-18.00 Plenary session	11.00-11.30 Coffee break	14.00- Participants departure
18.00-20.00 Welcome cocktail	11.30-13.00 Oral presentations Section 1 and 2"	
	13.00-14.30 Lunch	
	14.30-16.00 Oral presentations "Sections 1 and 2	
	16.00-16.30 Coffee break	
	16.30-17.30 Workshop1:”Conceptual models of energy recovery from waste leather industry” Workshop 2: ”Education and training in Hydrogen based economy”	
	19.30-22.00 Conference dinner	

CONTENTS

SECTION 1: THERMAL EQUIPMENT AND RENEWABLE ENERGY

SECTION 2: RURAL DEVELOPMENT AND RENEWABLE ENERGY

SECTION 3: ENERGY RECOVERY FROM INDUSTRY WASTE

VOLUMETRIC PUMP FOR INFUSION OF LIQUID FERTILIZERS INTO THE IRRIGATION WATER

Sava Anghel[1], Gheorghe Sovaiala, Gabriela Matache
INOE 2000-IHP, Bucharest

ABSTRACT

This paper presents research concerns to achieve a volumetric pump for infusion of liquid fertilizers into the irrigation water. Precise dosing of the fertilizer is carried out with volumetric pumps, which also create proportionality between the injected flow and the flow in the facility. The devices shall be serially connected to the irrigation facility- full flow or paralleled- by-pass, and the pressure loss along the supply circuit of the facility is recommended to be as small as possible. INOE 2000-IHP owns a patent application A/00828-14.09.2010 which proposes the development of an automatic pump for infusion of fertilizers into the pressurized pipelines of the installations for crop irrigation. The pump has the advantage of automatic drive by hydraulic actuation made using a hydraulically controlled directional control valve by two check valves that sense the end of the membrane stroke.

Worldwide fertigation has reached a major scale because it allows the development of new agricultural technologies in giant greenhouses located on nutrient-poor soils but with favorable conditions in regard to the other necessities of plants, heat, light etc., which makes them very cost-effective. Plants are grown in greenhouses on artificial soils, and nutrients are supplied along with the irrigation water. Such giant greenhouses have appeared in desert areas in countries such as Spain, Israel, France, USA etc.

There are known companies such as NETAFIM, AMIAD, PLASTRO GVAT, NAANDAN, DOROT, TAVLIT - Israel, DOSATRON - France, TMB - USA., which produce a wide range of devices and equipment for administering liquid fertilizers. Fertilizing solution is achieved out of water and the water-soluble chemical fertilizer, and dissolving or diluting the fertilizer is made in various proportions.

The injection equipment inserts the *primary solution* (with concentration C_m) into the irrigation water present in the irrigation system to create the fertilizing solution, and this nutrient solution is called the final solution or *fertilizing solution* (with concentration C_s). The concentration of the primary solution C_m is calculated with the ratio:

$$C_m = \frac{M}{V} \quad [g/l], \text{ where:}$$

M - the amount of solid fertilizers dissolved in a given volume, in (g);
V- the volume of water in which the fertilizers were dissolved, in (l).
A dilution takes place at the point of injection, depending on the flow rate (Q) of the irrigation system and *injection flow rate* (q) of the primary solution injection equipment.

In order to achieve a uniform distribution of fertilizer and water, it is necessary that the dispensing devices existing on irrigation equipment and injection pumps work with high coefficients of uniformity, at clearly defined working pressures, and the flow rate injected by the pump be constant along carrying out the process of fertigation.

[1] 14 Cutitul de Argint, Bucharest; +4021 3363991; sava.ihp@fluidas.ro

The equipment for injecting substances into the irrigation water is usually represented either by Venturi static devices or piston or membrane, single or double effect volumetric pumps.

Precise dosing of the fertilizer is carried out with volumetric pumps, which also create proportionality between the injected flow and the flow in the facility. The devices shall be serially connected to the irrigation facility - full flow or paralleled- by-pass, and the pressure loss along the supply circuit of the facility is recommended to be as small as possible.

The most effective fertigation devices are those with pump with hydraulic motor, differential piston or membrane, using as a drive fluid energy of the water existing in the supply pipeline of irrigation facility; injected dose is constant and volumetric ratio (efficiency) - high.

Operation of injectors of fluid chemical fertilizers Venturi type is based on the Venturi effect, shown in Fig. 1, according to which, at the flow of a fluid under pressure through a given section, with sudden narrowing and progressive loosening, there occurs the phenomenon of suction. VENTURI injectors made within the limits 3/4″-2″, require operating pressures higher than 4.5 bar, the ratio of primary solution flow rate and fertilizing solution flow rate being 1/5 - 1/50 for the model 3/4″ and 1/5- 1/100 for the model 2″. Fertilizing solution flow rates achieved, depending on the model size (3/4″-2″), range between 193-2640 l/h.

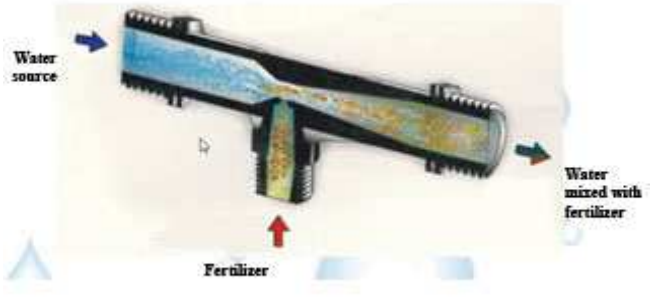

Figure 1. The operating principle of VENTURI type injector

Concerns for the development of dosing pumps have led to the models PD-1 and PD-2 developed at ICITID Băneasa Giurgiu, protected by the patent Ro no. 102887.

This dosing pump (Figures 2, 3 and 4) consists of a directional control valve (A) driving the water circuit toward the pump body (B), an actuation mechanism of the directional control valve (C) and a control and adjustment device (D), both for the water circuit and the chemical fertilizer circuit.

The directional control valve (A) consists of a body 1, where there is pressed the bushing 2 (made of antifriction material), through which slides the sliding valve 3. In the body there are cut 5 threaded holes, this being a 5-ways and two working positions directional control valve (5/2 directional control valve), which is continued with 5 radial holes into the bushing. Into those 5 threaded holes there are mounted the hose connections, 8. By movement of the sliding valve within the pressed bushing into the body there are established between the five internal toroidal chambers the circuits required for pump operation.

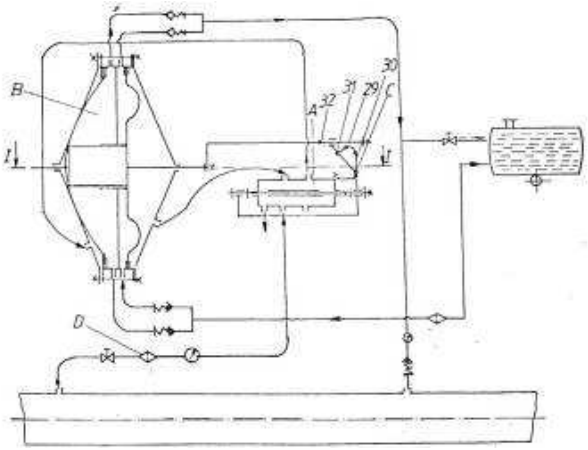

Figure 2. Schematic diagram of the PD-1 dosing pump

The directional control valve has two side covers 4, fastened with screws 5, covers in which there are placed two buttons 7, having the role of limiting the stroke of the sliding valve. The connection between the fittings of the hydraulic directional control valve and the fittings of the drive chambers of the dosing pump is provided through hoses.

The buttons 7 are driven by the buffers 9, fixed to the external frame 10 with nuts 11.

The directional control valve is fixed to the chassis 12 using the cradle 13.

The pump (B) consists of a central body 14, provided with suction connections f, g, respectively discharge connections h, i of liquid chemical fertilizers, and two side covers 15, fixed to the central body, provided with the connections j, k, for water supply - discharge to/from the drive chambers (which are connected to the consumers d, e of the directional control valve).

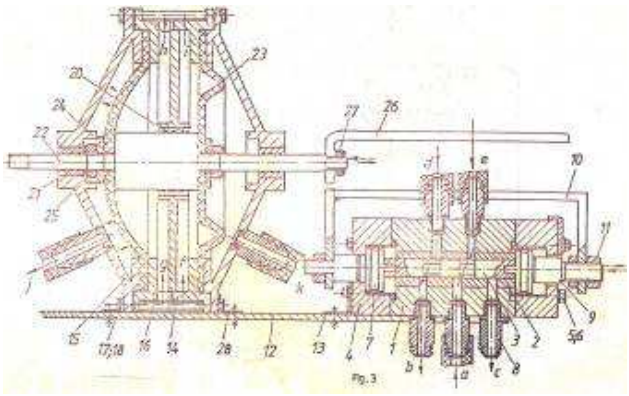

Figure 3. Longitudinal section through the PD-1 dosing pump

The main body and the covers are fitted with bearings, consisting of the bushings 20 and ″O″ ring seals 21. Inside the body there slides the rod 22, to which there are fixed two membranes 23, using disks 24 and nuts 25.

To the end of the rod there is fixed the lever 26, connecting to the actuation mechanism of the directional control valve (C). The pump body is fixed to the chassis using the soles 28.

The actuation mechanism of the directional control valve is made up of a spring 29, which sets the connection between the drive lever 30 and the receiver lever 31. The drive

lever is integral with the buffers 9 of the directional control valve, and the receiver lever has one free end, which oscillates between the limiters 32.

The control and adjustment device (D) consists of the filter 33, tap valve 34 for adjusting the flow rate of the driving agent (the irrigation water), the gauge 35 and the check valves 36. The connection between the supply pipeline of the irrigation facility 37 and the hydraulic directional control valve, between the inlet - fertilizer injection chambers and the container 38, respectively irrigation pipeline, between the motor pump and the directional control valve is achieved using hoses.

The dosing pump works on the principle of variable volume chambers (two chambers for the drive fluid and two chambers for fertilizer).

INOE 2000-IHP owns a patent application A/00828-14.09.2010 which proposes the development of an automatic pump for infusion of fertilizers into the pressurized pipelines of the installations for crop irrigation. The pump has the advantage of automatic drive by hydraulic actuation made using a hydraulically controlled directional control valve by two check valves that sense the end of membrane stroke.

The pump, according to Figure 4, sucks the fertilizing fluids from the basin <Bf> through a filter <F> and a battery of valves <Ss>, and injects them through the non-return valve <Sf> into the irrigation pipeline <P>. The pump is double membrane, these forming the drive chambers <Csa, Cda> and the injection chambers <Csf, Cdf>. The pump consists of a mobile subset of two membranes attached to a shaft, and two drive rods <TA>. Two covers clamp the two membranes, so as to form four chambers, two outwards <Csa> and <Cda>, and two inwards <Csf> and <Cdf>.

In the covers there are mounted two check valves controlled by the rods <TA>. Between the devices in the body there are made internal connections, between A/B of the directional control valve and <Csa>/<Cda> inside the pump body. Internal connections are also between the valves S1/S2 and the drive chambers of the directional control valve Ccs/Ccd and nozzles D1/D2.

The nozzles are connected to the irrigation water through the pipe P. For control there is used a directional control valve which is supplied with pressurized water from the irrigation pipe <P> and distributes it alternatively in the two membrane chambers <Csa> and <Cda>. In this way the chambers <Csf> and <Cdf> increase or decrease their volume sucking or discharging fluids through the valves <Ss> in the basin <Bf>. Active surface of the chambers <Csf> and <Cdf> is smaller than the one of the drive chambers <Csa> and <Cda>; thus at the output in the non-return valve <Sf> there is obtained a higher pressure than that in the pipeline, allowing the injection of liquid fertilizer into the irrigation water.

The directional control valve, according to Figure 5, is a symmetrical construction consisting of two valves and two pistons mounted on a shaft. The valves <Se> shut the consumers A and B towards the basin in the front on a rubber seat, the other openings being on axial cylindrical surfaces. The distributor is composed of a central shaft on which there are mounted two valves <Se> and two control pistons.

The valves seal in the front on a rubber seat, and in the retracted position sealing is made on the cylindrical surface of the valve when in contact with the body of the directional control valve. Under the action of water, due to the difference between the surfaces the

pressure is acting on, there is obtained a force that opposes switching the directional control valve.

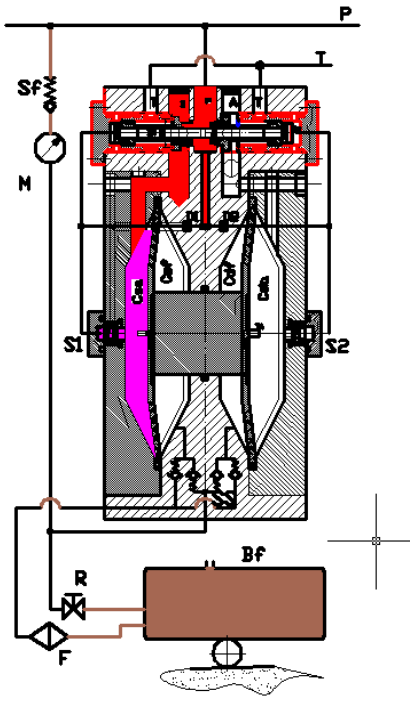

Figure 4. The membrane pump with directional control valve driven by check valve opening at stroke end

D>d; AD>Ad; so FD>Fd

where D, d - diameters of sections the water pressure is acting upon; A_D, A_d - areas of the two sections; F_D and F_d - forces acting on the valve assembly $F = A_p$. When switching, by pressure drop, there occurs unbalancing of forces.

$F_D < F_d + F_{ccd}$,

where F_{ccd} is the force caused by pressure on the control piston end which is no longer balanced.

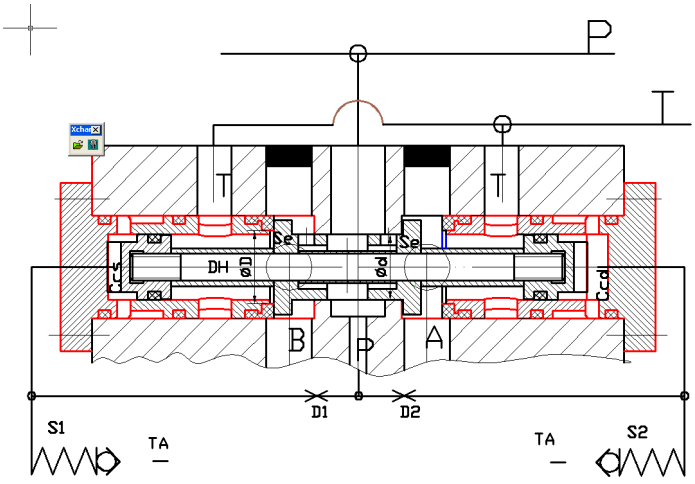

Figure 5. Hydraulically controlled directional control valve

Under the action of pressure, the movable system of the directional control valve gets unbalanced since the closing surface on the seat <D> is greater than the closing surface sliding valve type <d>. Thus there occurs a force that maintains in position the sliding valve of the directional control valve until it gets unbalanced as a consequence of pressure drop in the drive chamber caused by opening the valves done by the actuating rods <TA>.

Operation

When the membrane assembly reaches one stroke end the rod TA opens the check valve S1/S2, resulting in lowering the pressure on the pipeline and therefore the pressure in the drive chambers Ccs or Ccd, unbalancing the valve assembly of the directional control valve, which switches to symmetrical position, changing the connection from P to other pump chamber, and T (the atmosphere) is connected to the chamber where there was pressure. As a result, the direction of travel of the membranes reverses.

The technical solution described, eliminating the disadvantages of the existing systems, consists of control of the directional control valve by sensing the performing of the membrane assemblies' stroke by means of a check valve which opens under the action of a rod <TA>; pressure drop on a circuit which connects with the left or right drive chamber of the directional control valve lead to switching the directional control valve. The control pressure is conveyed to the ends of the pistons of the sliding valve and to the check valves on the closing direction through two nozzles, <D1> and <D2>, from the circuit <P>. The nozzles allow separation of the two control circuits and balancing the sliding valve after its actuation.

The solution has the advantage of developing a compact device automatically operated by hydraulic pressure generated by opening the valves by the rods <TA> over the last millimeters of the membrane stroke, achieving high efficiency and safe operation.

Acknowledgments

Research presented in this paper has been developed with financial support of UEFISCDI (Executive Unit for Financing Higher Education, Research, Development and Innovation) under PCCA 2013 Programme, Financial Agreement no. 158/2014.

References

[1] Biolan, I., Serbu, I., Sovaiala, Gh., Mardare, F., *Tehnici si tehnologii de fertirigare a culturilor agricole*, A.G.I.R., ISBN: 978-973-720-344-1, 2010.

[2] Avram, M., *Actionari hidraulice si pneumatice. Echipamente si sisteme clasice si mecatronice*, Editura Universitara, Bucuresti, ISBN 973-7787-40-4, 2005.

[3] Ghinea, L., Ştefanic, Gh., Popescu, A., Oprea, G., *Cercetări în domeniul chimiei şi biologiei solului*, An. I.N.C.D.A. Fundulea, Vol. LXXV, 2007, Volum jubiliar.

[4] Gumaniuc, A., Marinescu K., Demcenco, E., *Diminuarea impactului ecologic prin irigarea şi fertilizarea dirijată a solulu*i, Mediul ambient-Cercetari stiintifice, Nr. 2 (20) Aprilie 2005, Republica Moldova.

[5]. Biolan, I., Sovaiala, Gh., Anghel, S., Alexandrescu St., Nicolescu, C., Bucur, D., - *Studies regarding the technique used for applying fertirrigation on agricultural crops*, The Ion Ionescu de la Brad University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, Lucrări ştiinţifice- Seria Agronomie, Vol. 53/2010, ISSN 1454-7414, pag.6.

[6] Sovaiala, Gh., Biolan, I., Anghel, S., Alexandrescu St., Nicolescu, C., Bucur, D., *Equipment for apllication of fertirrigation at horticultural crops*, COMEFIM 10, The 10-th International Conference on Mechatronics and Precision Engineering, Bucharest 19-21 May 2011, http:// www.comefim10.pub.ro, MCT 2/2011-Mecatronica Review No. 2/2011, pp. 75-78.