



**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

**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-Ștefan BIRIȘ	ROMANIA
	Dr. Gabriel-Paul NEGREANU	ROMANIA
	Dr. Valentin VLĂDUȚ	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



SARTOROM

Garantează. Inovează. Excelează

Sos. Bucuresti - Magurele nr. 232

051434 Bucuresti 5, Romania

Tel: [+40 21 255 31 32](tel:+40212553132)

Fax: [+40 21 255 30 66](tel:+40212553066)



Str. Mihail Kogălniceanu nr. 60

Roșiori de Vede, Jud. Teleorman, Romania

CONFERENCE PROGRAMME

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

1. Investigation of the efficiency of air solar collector	
D. Atanasov, M. Minchev, A. Tashev.....	1
2. Economic and thermal analysis of steam turbines for biomass CHP plants	
V. Berbece, G. Negreanu.....	7
3. Ecological education, a national priority	
E.O. Epurescu.....	13
4. The new educations - environmental education	
E.O. Epurescu.....	17
5. Development of the demanded information for introduction of porous systems in thermal power stations of power plants	
A.A. Genbach, K. Olzhabayeva, I. K. Iliev.....	21
6. Optimization of the excess cooler in the capillary-porous cooling system in thermal power plants	
A.A. Genbach, V.O. Babeykova, I. K. Iliev.....	27
7. Exhaust heat recovery using Organic Rankine Cycle	
M. Ghilvacs, T. Prisecaru, H. Pop.....	33
8. Energy saving in a heating boiler	
I. V. Ion, Fl. Popescu, O. Zbarcea.....	39
9. Experimental analyze of the hydrogen impact of solid biomass combustion for the development of innovative efficient technologies	
Gh. Lăzăroiu, L. Mihăescu, I. Pîșă, E. Pop, C. Ciobanu, M. Dragne, U. Desideri, G. Simion.....	45
10. Investigation of refrigerant mass flow rate effect on Organic Rankine Cycle performance	
M. H. K. Aboaltaboog, T. Prisecaru, H. Pop, V. Badescu, V. Apostol, M. Prisecaru, C. Petcu, E. Pop, C. Ciobanu, Gh.Popescu, A.M.Alexandru.....	51
11. Simulation comparison of the plume rise using ANSYS CFD-CFX and AERMOD model	
O. Maruntalu, Gh. Lazaroiu, D. A. Bondrea, A. N. Stan.....	57
12. Burner retrofit solution from CHP Isalnita for staggered combustion with low emission of NOx	
L. Mihăescu, G. Negreanu, I. Pîșă, I. Oprea, A. Adam, Cr. Mândrean, I. Bărbieru, V. Gherghina.....	63
13. Aspects of the hydrogen use at a truck compression ignition engine	
I. Mirica, Al. Cernat, C. Pana, N. Negurescu, Cr. Nutu.....	67
14. Influence the method to regulate the cold power and external conditions on the efficiency of two-stage refrigeration compressors	
P. Mushakov.....	73
15. Brown gas generators sourced with solar energy	
I.Y. Nedelchev, R. N. Vasilev.....	79
16. Optimization of the flash pressure of a geothermal plant	
G. Negreanu, N. Gheorghe, L. Mândrea.....	83
17. Economic studies on producing energy from seed oil	
B. Niculescu.....	87

18. Increasing the efficiency of high power TPP with steam cycle through lowering the cold source average temperature, by serializing the condensers cooling circuits	
M. Norișor, G. Darie, V. Cenușă, D. Tuțică, Fl. Alexe.....	91
19. Experimental study of liquefied petroleum gas use to fuel a truck diesel engine	
N. Cr. Nutu, C. Pana, N. Negurescu, Al. Cernat, I. Mirica, O. H. Z. Obeid	97
20. Steam Turbines for Advanced Ultra-Supercritical Cycles	
I. Oprea.....	103
21. An experimental comparison between corrugated and porous plates of solar air heaters at various flow rates	
Q. A. Abed, A. Ciocanea, V. Badescu.....	107
22. A possibility to improve the efficiency of a household natural gas boiler based on the waste heat recovery of the exhaust gases	
B. Radu, Al. Racovitză, R. Chiriac.....	113
23. Electro hydraulic installation for actuating the brush of a machine for washing PV panels	
R. Rădoi, M. Blejan, I. Ilie, Al. Hristea.....	119
24. Practical psychomanagerial application in order to build a behavioral holistic model of eco-awareness based on order psychology-quantum psychology® (POPQ®)	
C. Sofronie, R. Zubcov.....	125
25. Results from an energy audit of municipal buildings in the municipality of Sliven	
S. Tasheva, I.Binev, V. Rasheva.....	129
26. Ecological burning of gas fuel	
D. Temirbayev, I. K. Iliev, B. Ongar	135
27. Aspects on biomass to gas fuel conversion using different gasifying agents	
R.N. Tîrtea, A. Badea, Cosmin Mărculescu.....	141
28. Economic study on producing energy from agricultural biomass	
M. Toader.....	147
29. The effect of the air extraction system quality, on sizing the equipment for maintaining the vacuum in steam turbine condenser	
Diana Tuțică, G. Darie, V.E. Cenușă, M. Norișor, Fl.N. Alexe.....	151
30. Simulation of a passive house for thermal comfort-analysis	
I. Udrea, I. Nastase, R. Crutescu, Cr. Croitoru, V. Badescu.....	157
31. Energy efficiency project for a factory producing sweets and baked goods	
M. Velikanov, V. Kamburova, V. Rasheva.....	163
32. Investigation of the development of the wind energy project	
N. Zlatov.....	169
33. On cycle variability of supercharged spark ignition engine fuelled with bioethanol-gasoline blends	
Z Obeid, Al. Cernat, C. Pana, N. Negurescu, Cr. Nutu.....	175

SECTION 2: RURAL DEVELOPMENT AND RENEWABLE ENERGY

- 34. Conservative tillage technologies - state of the art**
S.Șt. Biriș, V. Vlăduț, E. Marin, N. Ungureanu, S.T. Bungescu, A. Atanasov.....181
- 35. Machine for regenerate degraded grassland in the context of the ecological requirements**
D. Cherciu, E. Marin, M. Mateescu, C. Cheptea, D. Manea, A. David.....187
- 36. Research regarding grists granulometric distribution at a divide-sorting passage within a milling unit of 4.2 t/h**
G.A. Constantin, Gh. Voicu, M.E. Ștefan, G. Paraschiv.....193
- 37. Chromium removal from wastewater using carbon nanotubes**
Cr. I. Covaliu, G. Paraschiv, S.Ș. Biriș, Cr. Cîrtoaje, I. Filip, E. Petrescu.....199
- 38. Considerations on factors influencing seeding precision of seeders for weeding plants**
D. Cujbescu, Gh. Voicu, Gh. Bolintineanu, V. Vlăduț, I. Găgeanu, G. Gheorghe, S. Ș Biriș, G. Paraschiv.....205
- 39. Methods for applying the composite materials / nanotechnologies to active parts of technical equipments for soil processing**
Al. David, G. Gheorghe, E. Marin, D. Manea, V. Vlăduț, I. Dutu.....211
- 40. Rural development in sustainability conditions within the European Union**
O. David, S. Maiduc (Osiceanu), O. E. Epurescu.....217
- 41. The substrate influence on the anaerobic digestion process**
M. Dinca, Gh. Voicu, M. Ferdes, G. Paraschiv, G. Moiceanu, N. Ungureanu, M. Ionescu, P. Voicu.....221
- 42. The importance of the byproduct biochar achieved in the process of obtaining energy from biomass**
P. Drumea, G. Matache, I. Pavel.....227
- 43. Modeling the agricultural mobile tractor – mounted machine unit**
M. Fl. Duțu, I.C. Duțu, M. Begea, C.O. Rusănescu.....233
- 44. Effect of nitrogen sources on growth and pigmentation of *Rhodotorula Rubra* in submerged culture**
M. Ferdes, E. Maican, M. Stefan, M. Dinca.....239
- 45. Theoretical considerations on the granulation (pelletizing) of biomass**
I. Găgeanu, Gh. Voicu, G. Bunduchi.....245
- 46. Renewable energy for drying grain**
C. Iancu, M. Bădescu.....251
- 47. The experimental stand for drying cereal**
C. Iancu, M. Bădescu.....257
- 48. Researches regarding the obtaining process of vegetable oil using presses**
M. Ionescu, Gh. Voicu, S.Șt. Biriș, M. Dilea, M. E. Ștefan, N. Ungureanu.....263
- 49. Improve plant stand and conserve energy in greenhouse with led lighting system**
G. Ipate, Gh. Voicu, C. Girleanu, P. Voicu.....269
- 50. The influence of diesel concentration on soil microbiota**
I. A. Istrate, M. Ferdeș, I. Ștefan.....275
- 51. Theoretical considerations on the influence of the inclination angle of the knife over the power of an equipment for chopping fodder**
G. Lazăr, R. Ciupercă, A. Păun, E. Voicu, A. Zaica.....281
- 52. Continuous pretreatment process for bioethanol production**
Ed. Maican, A. Coz, M. Ferdeș.....287

53. Machine for regenerate degraded grassland in the context of the ecological requirements	
E. Marin, D. Cherciu, M. Mateescu, C. Cheptea, D. Manea, Al. David A.....	293
54. Innovative technology for establishment of onion culture in sustainable system	
M. Mateescu M, A. Păun, E. Marin, G. Gheorghe.....	299
55. Preliminary researches regarding Miscanthus stalks grinding with centrifugal impact mill	
G. Moiceanu, Gh. Voicu, G. Paraschiv, M. Dinca, M. Chitoiu.....	303
56. Experimental research on the quality of the mechanized harvesting process of chamomile inflorescences	
A. Muscalu, L. David, A. Pruteanu.....	307
57. Contributions regarding the testing of kneading characteristics on wheat flour dough	
Gh. Muscalu, Gh. Voicu, E.M. Stefan.....	313
58. Influence of the flow angle function by working pressure	
M. Nițu, V. Vlăduț, M. Matache, M. Duțu.....	319
59. Analysis of influence factors over the traction resistances of the plows	
Cr. Nuțescu, L. David, I.C. Duțu.....	325
60. Considerations on working process equipment for spreading fertilizer by centrifugation	
A. Petcu, L. Popa, R. Ciuperca, A. Paun, V. Stefan, M. Dutu.....	331
61. Study on biochemical characterization of plant extracts in order to valorize them	
A. Pruteanu, M. Ferdes, L. David, A. Muscalu, G. Gageanu.....	335
62. Monitoring wind direction and intensity of Bucharest in 2012	
C.O. Rusănescu, S. Șt. Biriș, G. Paraschiv, Gh. Voicu, M. F. Dutu, M. Begea.....	341
63. Wastewater treatment in Macrophytes lagoons	
V. V. Safta, M. Dinca, A. Boureci.....	345
64. Volumetric pump for infusion of liquid fertilizers into the irrigation water	
A. Sava, Gh. Sovaiala, G. Matache	351
65. Some problems of water indicators in trout farm	
G. C. Simion.....	357
66. Technical equipments designed for the cultivation technology of Miscanthus energy plant	
E. Sorica.....	363
67. Considerations on physical and mechanical properties of solid organic fertilizers	
V. Ștefan, L. Popa, L. David, I. Pirnă, R. Ciupercă, A. Petcu, M. F. Duțu, I. Găgeanu	369
68. Measuring devices, experimental stands and equipment used for the study of artificial soil compaction	
N. Ungureanu, Gh. Voicu, S.-Șt. Biriș, G. Paraschiv, M. Dilea, M. Ionescu, V. Vlăduț, Mihai Matache.....	375
69. Non conventional measurements to evaluate the urban and rural area powder pollution	
M. Vasile, F. Lamonaca, D. L. Carni, M. Riccio, A. Nastro.....	381
70. Specialized structures for a continuous monitoring of surface water quality	
C. Vîlcu, Gh. Voicu, G. Paraschiv, C. Lehr.....	387
71. Conservative soil tillage technologies	
I.D. Vlăduț, E. Marin, S.St Biriș, B. Ivancu, D. Manea, V. Vlăduț, Al. David, G. Gheorghe, N. Ungureanu, M. Duțu, S. Bungescu, D.I. Mircea.....	393
72. Apparatus and equipment for determination of soil physical and mechanical characteristics	
L. Vlăduțoiu, A. Tudor, V. Vladut, C. Muraru, O. Radu, A. Petcu.....	399

- 73. Researches regarding organization of the experiments for energetic characteristics determination when using Miscanthus planter**
Gh. Voicu, M. Dinca, G. Matache, I. C. Poenaru, P. Cardei, P. Voicu, V. Vladut.....405
- 74. Theoretical aspects regarding the process of drying the fodder plants**
A. Zaica, T. Căsândroiu, A. Nedelcu, R. Ciupercă, I. Pirnă, G. Lazăr, V. Ștefan.....411

SECTION 3: ENERGY RECOVERY FROM INDUSTRY WASTE

- 75. Experimental research on anaerobic digestion of distillery wastewaters**
C. Băbuțanu, G. Oprina, L. Mândrea.....417
- 76. Explosion risk assessment in waste treatment and recovery plants**
L. V. Bălănescu, A. Ion, M. Șerban, C. R. Mocanu.....423
- 77. Energy recovering from tanneries by biodiesel production**
D. A Bondrea, C. R. Mocanu, Gh. Lăzăroiu, O. Mărunțălu, A. N. Stan,
M. M. Toader.....429
- 78. The animal fats use as fuel at diesel engine**
Al. Cernat, C. Pana, N. Negurescu, Cr. Nutu.....435
- 79. Improvement of wastewaters treatment processes – key factor of environmental protection**
Gh. Coara, C. R. Mocanu, F. Ölçer, M. S. Florescu.....441
- 80. Cost-benefit analysis for green tannery implementation**
Gh. Lazarioiu, C. R. Mocanu, M. Florescu, M. Roscia, D. A. Bondrea.....447
- 81. Energy recovering from tanneries by biogas production**
M. Mavrodin, C. R. Mocanu, Gh. Lăzăroiu, D. A. Bondrea, B. Niculescu,
R. Cipollone.....453
- 82. Leather carbon footprint**
M. Mavrodin, Gh. Lăzăroiu, C. R. Mocanu.....459
- 83. Energetic and ecologic analysis regarding the production and use of biogas from fermentation of tannery waste**
L. Mihăescu, Gh. Lăzăroiu, E. Pop, V. Berbece.....463
- 84. Tanneries wastewater treatment**
C. R. Mocanu, L. V. Balanescu.....467
- 85. Pollutant factors in processing of hides and skins**
C. R. Mocanu, B. Niculescu, Gh. Lăzăroiu, D. A. Bondrea, A. N. Stan,
M. Mavrodin.....471
- 86. Energetic characteristics of animal fats waste from tannery for energy production**
E. Pop, L. Mihăescu, Gh. Lăzăroiu, I. Pîșă, G. Negreanu, M. Dragne.....475
- 87. Equipment for water treatment in rural areas where the sources are polluted by nitrates**
R. Sauciuc, I. Lepadatu, L. Dumitrescu, A. Ciocanea, I. Stamatina.....479
- 88. EU 2020 targets from the members state perspective**
O. Udrea, Gh. Lazarioiu, M. Roscia, D.A. Bondrea.....485

VOLUMETRIC PUMP FOR INFUSION OF LIQUID FERTILIZERS INTO THE IRRIGATION WATER

Sava Anghel¹, 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:

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

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.

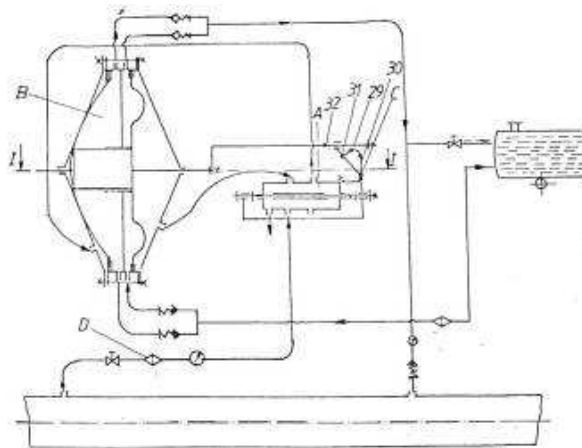


Figure 2. Schematic diagram of the PD-1 dosing pump

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).

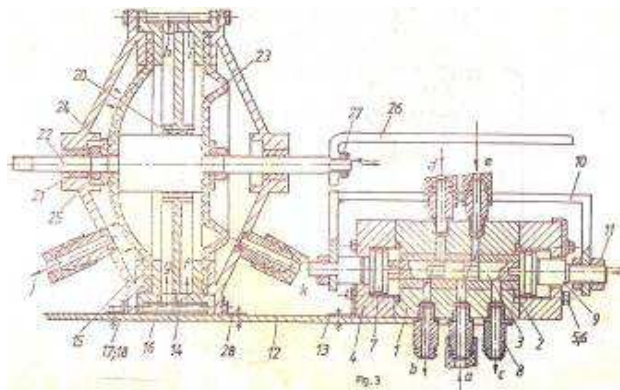


Figure 3. Longitudinal section through the PD-1 dosing pump

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.

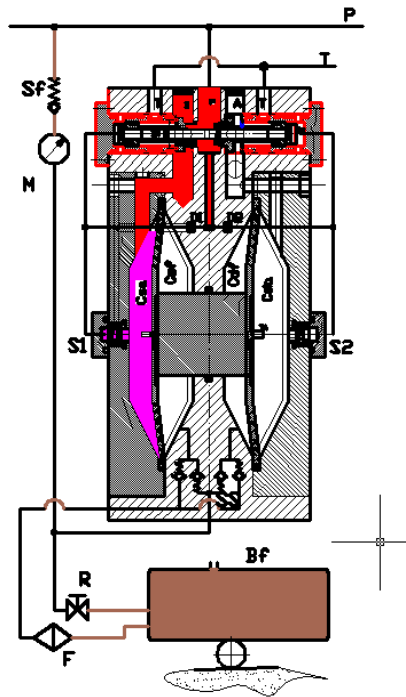


Figure 4. The membrane pump with directional control valve driven by check valve opening at stroke end

$$D > d; AD > Ad; \text{ so } F_D > F_d$$

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.

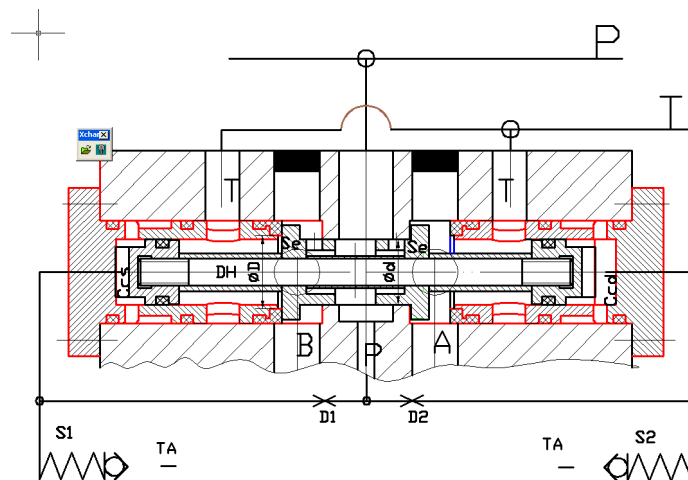


Figure 5. Hydraulically controlled directional control valve

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., Ștefanic, Gh., Popescu, A., Oprea, G., *Cercetări în domeniul chimiei și 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 și fertilizarea dirijată a solului*, 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 științifice- 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 application 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](http://www.comefim10.pub.ro), MCT 2/2011-Mecatronics Review No. 2/2011, pp. 75-78.