DESIGN OF SELF-COMPENSATING NOZZLE FOR GATED IRRIGATION PIPES

By

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A thesis submitted in partial fulfillment

of

the requirements for the degree of

DOCTOR OF PHILOSOPHY
in
Agricultural Science
(Agricultural Mechanization)

Department of Agricultural Engineering

Faculty of Agriculture

Ain Shams University

2010

Approval Sheet

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ACKNOWLEDGEMENTS

The author wishes to thank **"Allah"** for the completion of this work.

He further wishes to express his greatest appreciation and deepest gratitude to Prof. Dr. Abdel- Ghany M. El- Gindy, Prof. of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, for entrenching the principle of scientific research, for kind guidance, encouragement and providing all the required facilities.

Special thanks are due to Dr. Ahmed S. El-kot, Associate Research Professor of Agricultural Engineering, Soil Conservation Department, Desert Research Center, for his support and help to achieve this work.

Thanks to all who had helped to complete this research work.

ABSTRACT

Mohamed El-Sayed Abdel-Rahman: Design of Self-Compensating Nozzle for Gated Irrigation Pipes. Unpublished Ph. D. Thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2010.

Gated irrigation pipe is an important tool for improving surface irrigation, it's development on depends on replacing the gates by designed self-compensating nozzle (poppet nozzle).

The main objective of this study was to improve the distribution uniformity of water discharge along the gated pipe length, by developing a newly designed and locally manufactured self-compensating nozzles (poppet nozzles), to take the place of the gates.

Laboratory experiments were conducted at the Hydraulic Laboratory of Agricultural Engineering Department, Faculty of Agriculture, Ain Shams University, to test and evaluate the hydraulic characteristics of a self-compensating nozzle (poppet nozzle). Three disc diameters (25, 27 and 29mm) were selected for testing under pressure head ranged between 0.33- 3.4 m.

Field experiments were conducted in a maize field at a private farm in Ismailia Government. The poppet nozzle (25mm diameter) was evaluated under operating pressure head 50, 100 and 150cm.

The main results of this study showed the following:

Under operating pressure head ranged between 33cm to 340cm (3.3 to34 kPa), the mean discharge of poppet nozzle with disc diameters of 25, 27 and 29 mm were 0.63, 0.46 and 0.28 l/s, and the mean corresponding discharge coefficients (Cd) were 0.75, 0.79 and 0.9 respectively. Mean water discharge for 25mm disc diameter was constant (0.81l/s) in spite of pressure increasing as a next 10, 30 and 34kPa (100, 300 and 340cm) with mean flow (0.81l/s). While mean discharge for

27mm disc diameters was constant (0.48l/s) in spite of pressure increasing from 6.8, 30 to 33kPa (68, 300and 330cm). Water flow through poppet nozzle with 29mm diameter was shutting at operating pressure 12kPa (120cm).

The mean discharge of poppet nozzles along the pipes with initial pressure head (0.5m, 1.0m and 1.5m) were 0.5, 0.56 and 0.64l/s, with mean coefficient of discharge (Cd) 0.77, 0.75 and 0.72 respectively,

For initial pressure of 0.5, 1.0 and 1.5m the uniformity coefficient were 99, 91.7 and 90.2%, and the manufacture coefficient of variation is 0.094, 0.12 and 0.065 respectively.

Crop yield values were 10.4 and 11.9Mgm /ha for maize grain and one green cut of clover yield crops respectively. The field water use efficiency for maize grain was 1.5 kg/m^3, while it was 6.6 kg/m^3 for one cut of clover.

Key Words: surface irrigation, gated pipes, poppet nozzle, pressure, uniformity, maize, clover

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LIST OF SYMBOLS

SYMBOL		Definition
a	=	Cross section of flow area (m^2),
A	=	Characteristic frontal area of the body(mm^2),
Bp	=	Break horse power (Hp),
b	=	Foctor of the orifice dimentions,
C	=	Hazen-william's coefficient, for PVC 150,
C_d	=	Discharge coefficient,
C_i	=	Spring index,
D.C	=	price after depreciation (LE),
D_c	=	Drag coefficient,
d_d	=	Disc diameter,(mm),
D_i	=	Inside diameter of spring coil (mm),
D_m	=	Mean diameter of spring (mm),
d_n	=	Inside diameter for nozzle body,(mm),
D_w	=	Spring wire diameter (mm),
E	=	The overall efficiency, 55% for pump driven by internal combustion engine,
Ea	=	Application efficiency, %.where 60% in modified furrow irrigation,
E.C	=	Energy cost of diesel (LE/Hp),
E_i	=	Total system efficiency,
E.L	=	Expected life (year),
$E\ t_o$	=	Potential evapotranspiration, mm day^{-1}
F.C	=	Fuel price (LE),
F	=	Force at disk and spring (N),
F_d	=	Drag force (N),
g	=	Gravitinal acceleration (m/s^2),

G	=	Factor of Shearing ($80*10^3$ N/mm^2),
H	=	Annual operating hours (h),
h	=	Operating pressure head,
H_{sn}	=	Superimposed pressure head (m),
I	=	The interested (LE/year),
I.C	=	Initial cost (LE/ha),
IR	=	Irrigation water requirements, m^3/ha/day.
Kc	=	Crop Factor,
L	=	Space between PN and the first of the pipe line (m),
L_o	=	Free Length, The length of the unloaded spring (mm),
LR	=	Leaching requirements,
IS	=	Lateral installation cost (LE / year).
L_s	=	Solid length, the minimum length of the spring(mm).
MCV	=	Manufacture coefficient of variation for nozzles discharge (%),
N_a	=	Active coils,
PN	=	Poppet nozzle (self-compensating nozzle).
p	=	Pitch, the distance from center to center of the wire in adjacent active coils (mm),
q	=	Flow rate along the pipe(l/s),
Q	=	Water flow through flow area (m^3/sec.),
Q_{aver}	=	The mean of outlets discharge (l/s),
Q_d	=	Absolute deviation of each sample from the mean (l/s),
Q_n	=	Flow rate inside the poppet nozzle line just before any nozzle (1/s),
R_e	=	Pipe Reynolds number,
R & M	=	Repair and maintenance cost (LE / year).**R & M** cost taken as 3 % of initial cost,
Δr_o	=	Space from disc edge to inside body nozzle at first site (mm)
Δr_x	=	Space from disc edge to inside body nozzle at second site (mm)