LA RECHERCHE PUR L'INGENIERIE DE L'AGRICULTURE ET DE L'ENVIRONNEMENT

DIVISION OF HYDRAULIC WORKS AND IRRIGATION EQUIPMENT

TEST REPORT NR. 201

(Translated from French)

The DRIPPER: DIS-PC 2 l/h

Requested by **DIS – Drip Irrigation Systems, Ltd.**
5125-A Renaissance Ave.
San Diego, CA 92122
USA

24/5/1998

DRIPPER DIS 2 l/h
Integrated self pressure compensated

1 IDENTIFICATION AND BRIEF DESCRIPTION OF THE DRIPPER

- Brand: **DIS-PC**
- Type: **PC 2 l/H integrated self pressure compensated**
- Manufacturer: **DIS – Drip Irrigation Systems Ltd.**
  5125-A Renaissance Ave.
  San Diego, CA 92122
  USA
- Supplier:
  in
  France

The D I S - PC 2 l/h, a pressure compensated dripper is integrated in a pipe of 16mm outside diameter. According to the manufacturer, the dripper's flow rate is 2.2 l/h at a range of pressure between 0.7 to 4 bar. The spacing between drippers along the dripline is variable, depending on the type of crops to be watered.

2 Tests

The test of the drippers was intended to determine:
- the manufacturing uniformity (homogeneity),
- pressure (m) VS flow rate (l/h)

2.1 MANUFACTURING UNIFORMITY (HOMOGENEITY)

In micro-irrigation, a dripper has to comply with a very accurate technical specification, indicated by the manufacturer, namely the value of the delivered flow rate at a reference to pressure or nominal pressure.
For the dripper under test the flow rate value, according to the manufacturer, is 2.2 l/h at a pressure between 0.7 to 4 bar.
The manufacturing uniformity test consists of flow rate tests of 25 emitters sampled at random, under the conditions defined in ISO 9260 regarding: **"distribution devices for micro-irrigation: specifications and test methods"**.
The manufacturing uniformity is evaluated based on the variation coefficient CV, according to the following classes and classification.

Value of CV In %	0	5	10	15
Classification By class	excellent	good	poor	bad

2.1.1 Test Conditions

The 25 drippers have been numbered in advance, then installed in groups of 5, so as to constitute 5 pieces of dripline with adjustable flow rate at the inlet.

The feeding of the 5-dripline pieces was achieved by a multiple-cell electrical pump group equipped with an adjustable flow rate by-pass, drawing water from a 500 l tank. The driplines were protected upstream by a screen filter of 80 µm. the test pressure was controlled by an electronic pressure sensor at the head of each dripline. The pressure was kept constant by a computer controlled automatic valve.

The test pressure was 2.5 bar. The emission rate for each dripper was measured by the volume collected in a test tube of about 2 liters. A pressure sensor at the base of each test tube enabled the measurement of the collected volume. The collecting time was indicated by the clock of the micro-computer.

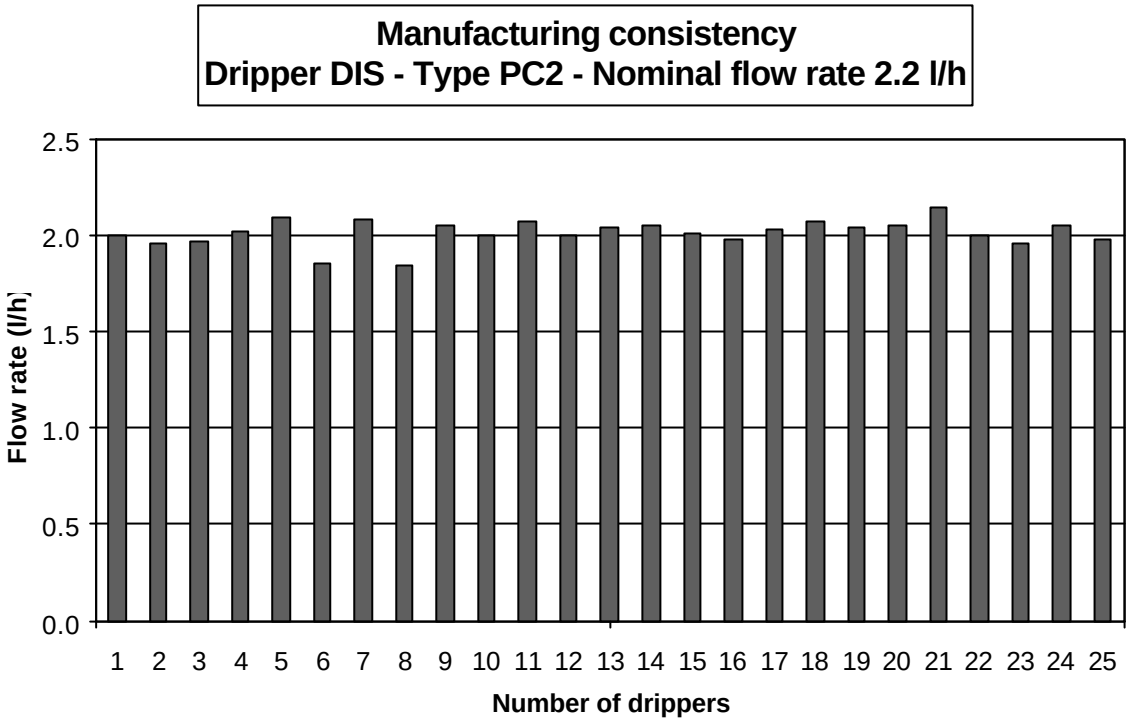
The temperature of water during tests has been maintained automatically at 23° with a maximum deviation of plus/minus 1-degree.

2.1.2 Test results

A number of factors have been calculated based on these measurements, enabling to evaluate the manufacturing uniformity of the emitter. These various results are shown in the table below.

Nominal flow rate qn in l/h, at 1 bar	2.2
Number of tested drippers	25
Test pressure in MWC	25
Water temperature in C°	23
Mean emission rate	2.01
Maximum flow rate in l/h	2.15
Minimum flow rate in l/h	1.83
Deviation of mean flow rate from nominal flow rate in % $\frac{qm - qn}{qn} \times 100 =$	8.6
Flow rate variation index (CV) in %	3.6

The analysis of the above leads to the conclusion of an excellent manufacturing uniformity (CV<5%). The declared nominal flow rate is bigger than the measured flow rate.



2.2 THE PRESSURE – FLOW RATE RELATIONSHIP

2.2.1 The formula of relationship

The relationship between the flow rate q of a dripper and the pressure h in the dripline can be expressed in the following equation:

$q = k \times h^x$

k and x are two constants, characterizing the emitter hydraulic performance.

Subsequently:

$\log q = \log k + x \times \log h$

The value of k and x may be obtained by using the method of minimum squares:

$$\log k = \frac{\sum \log q_i \times \sum (\log h_i)^2 - \sum (\log q_i \times \log h_i) \times \sum \log h_i}{m \times \sum (\log h_i)^2 - (\sum \log h_i)^2}$$

$$X = \frac{m \times \sum (\log q_i \times \log h_i) - \sum \log q_i \times \sum \log h_i}{m \times \sum (\log h_i)^2 - (\sum \log h_i)^2}$$

m is the number of measured pairs of q_i and h_i

2.2.2 Test conditions

Similarlyto the previous one, this test has been performed in accordance with the specifications of ISO 9260 regarding the pressure compensated drippers.

The 25 drippers of the previous test have been numbered by increasing order according to measured flow rates, from 1 to 25 (the number 1 being assigned to the dripper with the lowest emission rate, the number 25 to the dripper with the highest flow emission).

The tests intended to establish the relationship flow rate – pressure have been performed on all 25 emitters. The tests have been performed at heighten different pressure levels : 5 – 10 – 15 – 20 – 25 – 30 – 35 and 40 meters of water column with increase and decrease values of pressure.

The flow rates have been measured in the same way as for the previous test.

2.2.3 Measurements

The mean flow rate values of the 25 drippers for each pressure level are indicated in the table below.

Pressure In mCE	Mean flow rate q_m In l/h	$\frac{qm - q_n}{q_n} \times 100$ (in %)
5	1.82	-16.9
10	2.13	-2.9
15	2.07	-5.8
20	1.98	-10
25	2.022	-8.1
30	1.99	-9.5
35	2.03	-7.7
40	2.18	-1

2.2.4 Results

The tolerance to pressure variations is evaluated based on the value of the exponent x in the flow rate – pressure formula :

$$q = k \times h^x$$

There are two different classifications, one for the pressure compensated emitters and the other for the non pressure compensated emitters.

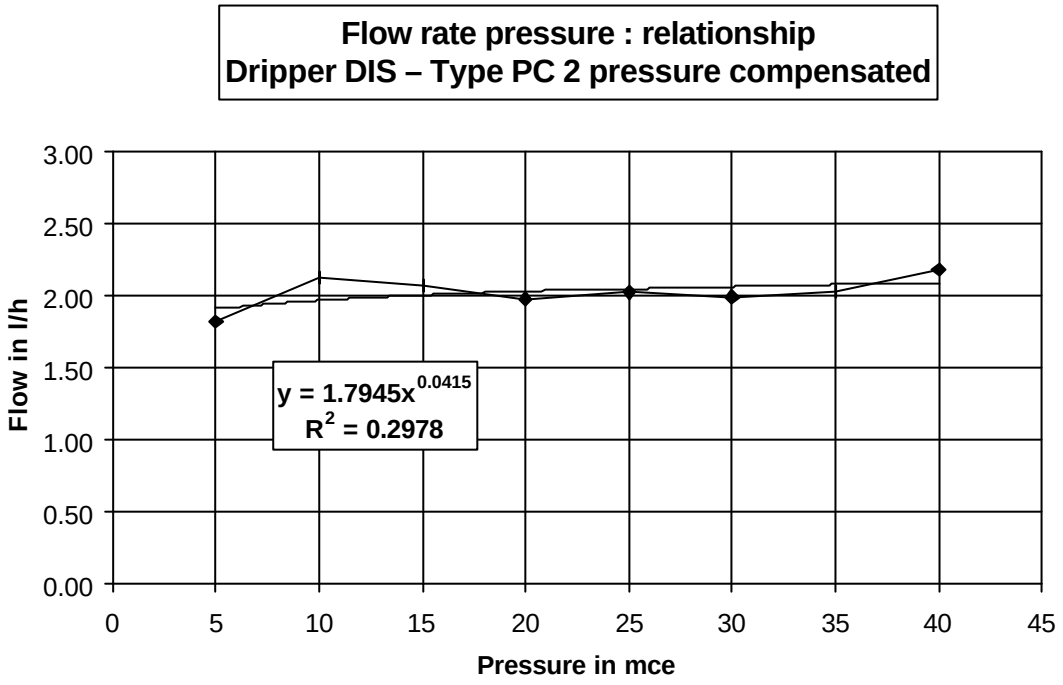
Non pressure compensated emitters

Value of x	0.2	0.5	0.6	0.8
Evaluation by class	Very tolerant	Tolerant	Slightly tolerant	Very slightly tolerant

Pressure compensated emitters

Value of *x*	0	0.05	0.1	0.15	0.2
Evaluation by class	Very good	Good	Poor	Bad	Out of spec.

The values of k and x in a formula like $q = k \times h^x$ may be obrained by using the method of minimum squares mentioned above, applied to various measured pairs of mean flow rate/ pressure.



The formula obtained has the expression :

$$q = 1.79 \times h^{0.037}$$

With a correlation index R^2=0.3
The flow rate *q* is in liters per hour and the pressure is in meters fo water column.
Since the value of the pressure's exponent is lower than 0.05, the self compensating pressure os this dripper is considered as very good.

Aix en Provence
September 1998