Inside a clean dripper

(Part 1)

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A dripper has the difficult task of delivering and maintaining a low flow rate of anything between 0,5 to 5 litres per hour through a relatively large flow path with its subsequent low velocities and at the same time keeping clean, so that the flow rate does not decrease over time from sediment build-up or even a complete blockage.

The internal features of a dripper

Fifty years ago, in the formative years of drip irrigation, a dripper's flow path was simply a long tube with a circular cross section that created little more than simple friction loss. The shape of the whole dripper body was a cylinder whose diameter approximated that of the dripperline into which it was inserted.

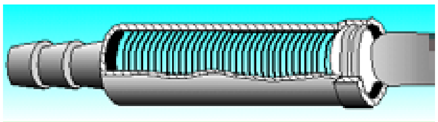

Figure 1. An old-fashioned dripper

The flow was laminar. With laminar flow, friction loss creates a slower velocity near the wall of the tube and a higher velocity in midstream. See Figure 2. Sediments suspended in the water are deposited on the wall where the velocity is lowest.

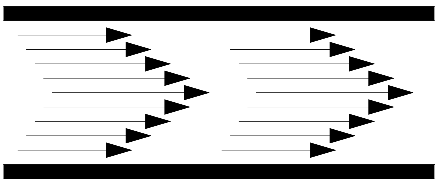

Figure 2. Laminar flow

A modern dripper is more sophisticated with a flow path whose cross-section is no longer circular but rectangular and whose length is designed into special shapes: specifically, teeth. The shape of the whole dripper body may be cylindrical like the old drippers or maybe a 'boat shape' and welded onto the inside wall of the dripperline.

Figure 3. A modern 'boat-shaped' non-PC dripper, welded onto the inside of a dripperline

In a non-pressure compensating dripper (non-PC), the main features are usually an inlet filter, an inlet orifice, a flow path whose shape is a labyrinth with teeth, an exit 'bath' and finally an orifice that is made through the wall of the dripperline from which the droplet leaves the irrigation system

Figure 4. The filter at the inlet to a modern boat-shaped non-PC dripper.
(This is the underside of the dripper in Figure 5).

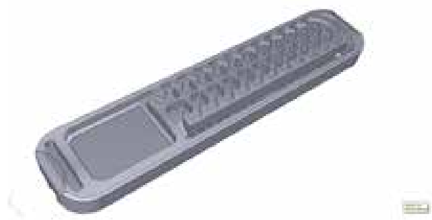

Figure 5. The labyrinth of a non-PC dripper with the exit 'bath' to the left, where a hole would be made through the dripperline wall for the droplet to exit the irrigation system

Pressure compensating drippers (PC) have additional features such as a flexible diaphragm that serve to keep the flow rate constant regardless of the pressure at the inlet to the dripper.

Inlet filter

The filter at the inlet is there to prevent solid particles from entering the dripper and potentially blocking its flow path. This means that the openings or gaps of the inlet filter need to be smaller than the passage of the labyrinth that follows. Thus, if a particle manages to get through the filter, it should be sufficiently small not to block the labyrinth once it gets in there.

The gaps of the inlet filter tend to be about 25 to 30% less than the width and depth of the labyrinth.

Of equal important is the actual size of the inlet filter. This needs to be as big as possible. If particles do get trapped on filter, there needs to be sufficient space on the filter for the full flow rate to get through.

Labyrinth

The dripper's inlet filter by itself is not sufficient to keep the labyrinth clean.

The crucial aspect of the labyrinth is the creation of turbulence: the more, the better.

The more the turbulence, the less likely will sediments be deposited on the walls of the flow path and the more likely will they remain in suspension until the water has left the irrigation system.

This turbulence is created by the design of a labyrinth with teeth of varying shapes and configurations. See Figure 6.

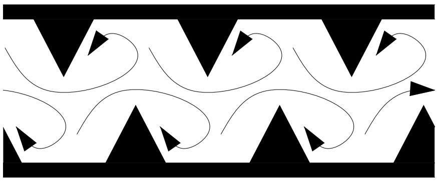

Figure 6. Turbulent flow through a labyrinth

The designs of labyrinths are many and varied. The most effective are those where the ends of the teeth are sharp instead of rounded and where there is a slight gap between the pitch of the ends of the teeth. See Figure 7 and compare it with Figure 8, whose teeth are meshed. The latter's design moves away from turbulent flow and tends towards laminar flow, just changing directions.

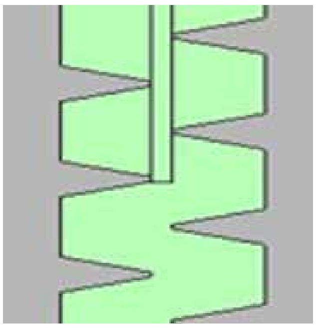

Figure 7. Labyrinth with a gap between the pitch of the ends of the teeth

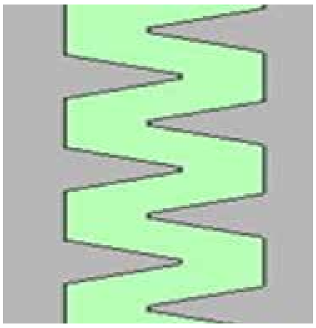

Figure 8. Labyrinth with meshed teeth.

Turbulence coefficient

The ability of a dripper flow path to create turbulence is measured by the turbulence coefficient.

$$k = \frac{254\ \Delta P\ (w\ d)^2}{Q^2 n}$$

k = *Turbulence coefficient*
ΔP = *Pressure differential through the labyrinth (m)*
w = *flow path width (mm)*
d = *flow path depth (mm)*
Q = *labyrinth flow rate (litres/h)*
n = *number of teeth*

In a non-PC dripper, this pressure differential is generally the inlet pressure of the dripper at its nominal flow rate (usually 10m). In a PC dripper, this is the pressure differential across the labyrinth only, which is constant and is not necessarily the difference between the pressures at the inlet and the outlet of the dripper.

A dripper with high turbulence would have a turbulence coefficient of about 8 to 10 or more. Medium turbulence coefficients are about 5 to 6 and lower coefficients tend to be in the region of 3 or lower.

The non-PC dripper in Figure 5 has flow path dimensions of 0,60 mm x 0,59 mm, 44 teeth and a flow rate of 1,0 litre per hour at a pressure of 10 m. Its turbulence coefficient is 7.

The same flow rate in a costlier PC dripper with a wider passage of 0,83 mm x 0,74 mm, 46 teeth and a flow rate of 1,0 litre per hour at a constant pressure differential of 5 m across the labyrinth has a turbulence coefficient of 10.

The qualities of a dripper to keep itself clean

Generally speaking, the following criteria contribute to a clean dripper.

1. The area of the dripper's inlet filter. The greater the better.
2. The cross-sectional area of the labyrinth: width x depth. The greater, the better.
3. The length of the labyrinth. The shorter, the better.
4. The turbulence coefficient. The higher, the better.

Smaller drippers would tend to detract from these criteria but that does not mean that they should necessarily be avoided. Smaller drippers have less material and are less expensive.

It makes sense to use a thin wall dripperline for a seasonal crop, where the dripperline itself is not expected to last more than a season or so, with a small dripper that too only needs to last a season or so.

Likewise, it makes sense to use a larger dripper for a long-term crop.

Many PC drippers possess additional qualities to keep a dripper clean such as self-flushing, anti-siphon, and root intrusion prevention. These will be discussed in Part 2.