# Inside a clean dripper

## (Part 2)

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In Part 1 (SABI magazine June July 2017 edition), we discussed the following main criteria that contribute to keeping a simple non-pressure compensating (non-PC) dripper clean:

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.

Many PC drippers possess additional qualities to keep a dripper clean such as self-flushing, anti-siphon, and root intrusion prevention.

### These are discussed here in Part 2.

### The relationship between dripper flow rate and inlet pressure

With any dripper, the flow rate varies with the inlet pressure according to the following equation.

$$Q=AP^B$$

*Q = Dripper flow rate (litres/h)*
*A = Flow rate coefficient*
*P = Dripper inlet pressure (m)*
*B = Emitter exponent*

The emitter exponent of most current non-PC drippers is generally about 0,5. This means that a 10% change in the inlet pressure results in only a 5% change in the flow rate. Some modern non-PC drippers have an emitter exponent as low as 0,4 and a 10% change in pressure results in only a 4% change in flow rate.

PC drippers are defined as those having an exponent of 0,2 or less. (1). This permits a PC dripper up to a 2% change in flow rate from a 10% change in inlet pressure. As a rule, however, an exponent of zero is expected of PC drippers, so that within their operating pressure range, the change in flow rate is zero regardless of the inlet pressure.

### Diaphragm

To achieve this pressure compensation, PC drippers have an additional feature: a diaphragm. With increased inlet pressure, this diaphragm flexes and bears down upon a section of the dripper's flow path, increases the velocity at that section, which in turn increases the total head loss from inlet to outlet, and is designed in such a way that the flow rate remains constant.

Like the early non-PC drippers, PC drippers were unsophisticated and tended to plug just like their laminar flow non-PC cousins. From the early 1980s, the pressure compensation diaphragm was combined with a turbulent flow path. (See Figure 2).

Rather than hinder the ability of the turbulent flow path to keep the dripper clean, the addition of a diaphragm enhanced its ability to do so. The result was to revolutionise drip irrigation, particularly here in South Africa. Instead of its original purpose to simply increase the pressure range over which a dripper could operate, the increased cleaning ability made it the dripper of choice, even where pressure compensation for the system's hydraulics was not needed. This type of dripper remains the most widely used to this day.

Figure 1. A modern non-PC dripper with a turbulent labyrinth

Figure 2. A modern PC dripper combines an otherwise non-PC turbulent labyrinth with a diaphragm to make it a PC dripper.

### Pressure compensating mechanism

Water enters a dripper at the inlet and exits at the outlet in Figures 3 and 4. Increased inlet pressure flexes the diaphragm (in green) to move towards the outlet in Figure 4. Although the head loss between B in Figure 4 and the outlet increases, the velocity and pressure differential through the labyrinth itself as indicated by the arrows from A to B in Figure 4 remains constant. The diaphragm is designed to keep this pressure differential through the labyrinth constant. Thus, the flow rate remains constant.

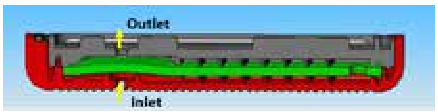

Figure 3. A PC dripper with the inlet in red, the outlet in grey and the diaphragm in green.

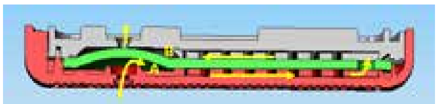

Figure 4. A PC dripper with a high inlet pressure flexing the diaphragm in green.

## Self-flushing mechanism

If particles become trapped in the labyrinth between A and B, the velocity will reduce and so will the pressure differential. The diaphragm will relax similar to Figure 3, the velocity in the labyrinth will then increase, flushing out the particles.

## Inlet filter

Part 1 discussed how important the area of the filter is at the inlet to the dripper in keeping a dripper clean. The greater, the better. In modern drippers, this area may almost cover the whole of the underneath of the dripper that surrounds the inlet. See Figure 5. So important is its area, that the slime covered dripper in Figure 6, is still dripping. The filter area covers the entire underside of the dripper, but a few pinprick holes remain through which to pass flow.

Figure 5. The filter area of a modern dripper may almost cover it underneath.

Figure 6. The filter area of a modern dripper may almost cover it underneath.

## Anti-siphon mechanism

The inlet filter is very effective in keeping large particles out of the dripper and keeping the dripper functioning. Yet large particles can be found in a dripper's flow path. As discussed in Part 1, the openings or gaps of the inlet filter are smaller than the labyrinth that follows. This means that if any solid particles larger than these gaps are found inside a dripper, they cannot have come from inside the dripperline. They can only have entered the dripper from the outside backwards in through the dripper outlet.

This can occur through suck-back, when there is negative pressure at the inlet to the dripper and when particles are sucked into the dripper from outside. This usually occurs when the dripper lines are switched-off after irrigation and is more prevalent in sloping fields where the dripper lines run uphill from the submain and in sub-surface drip irrigation (SDI). It is also more prevalent in smaller drippers than larger drippers.

The most important way to lessen the risk of suck-back is with the irrigation system design itself: correct block design, correct selection and placement of air-and-vacuum valves. Sometimes however, this is not enough and an anti-siphon mechanism in the dripper may help.

In an anti-siphon dripper, the diaphragm acts a bit like a mini non-return valve. An anti-siphon mechanism is simply a raised cone at the inlet to the dripper, upon which the diaphragm rests when the dripper is not pressurised. See Figure 3, where the green diaphragm is resting on the cone at the inlet. When the dripper is pressurised, the diaphragm lifts and the dripper operates normally. As soon as the inlet pressure is zero or negative, the diaphragm drops back onto the cone and reverse flow through the dripper cannot occur, thus preventing suck-back.

## Root intrusion

Root intrusion occurs when plant roots go looking for water during times of deliberate or unplanned water stress and enter the dripper via its outlet, potentially plugging up the dripper. This is more common in SDI and in mulched crops.

The most effective way of reducing the risk of root intrusion is the size and design of the 'bath' that is immediately before the dripper outlet. Roots entering the dripper will tend to grow around inside the bath. This provides a time buffer before the application of root inhibiting chemicals in normal drip system maintenance. The larger the area of this bath, the more space there is for this unwanted root growth to occur. The design of modern PC drippers makes it possible for the size of this bath to be a lot larger than non-PC drippers. In Figure 7, the bath of a non-PC dripper is on the left part of the dripper. The bath of the PC dripper by contrast is able to cover almost the whole of the topside of the dripper.

Figure 7. At the top is a non-PC dripper with its bath to the left. At the bottom is a PC dripper, whose bath covers most of the top of the dripper.

An additional feature that can contribute to lessening the risk of roots entering the dripper labyrinth is a barrier in the form of a raised wall around the outlet orifice that can be seen in the PC dripper in Figure 7.

A third additional feature that can contribute to inhibiting root intrusion is the use of root inhibiting chemicals. In earlier attempts at this, Trifluralin herbicide was added to the dripper material. This was slowly released into the soil from the dripper. Its banning in many countries curtailed its use. A recent alternative is adding copper oxide ($Cu_2O$) to the dripper material. It is not released into the soil from the dripper but inhibits root growth on contact with the dripper.

## Conclusion

This two-part article has dealt with the physical features of a dripper that contribute to keeping it clean. In Part 1, we saw the basic features in a non-PC dripper, all of which contribute to an effective clean dripper.

1. Dripper's inlet filter.
2. Labyrinth cross-sectional area.
3. Labyrinth length.
4. Turbulence coefficient.

In Part 2, we have seen how the additional features of a PC dripper have enhanced these first features.

1. Dripper diaphragm with a labyrinth.
   - Self-flushing
2. Anti-siphon mechanism.
   - Inlet filter and diaphragm design
3. Root intrusion.
   - Larger bath
   - Root barrier
   - Chemical inhibitor.

It should be noted though that these features are no substitute for best practices and even the best dripper can only go so far. A professional irrigation design and installation with an appropriate maintenance plan on lower-level drippers will likely win out over a poor system design and installation with minimum maintenance on top-of-the-range drippers.

## Reference

International Standards Organisation. (2004). International Standard ISO 9261:2004 (E). Geneva.