# A system for dripper comparison

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**A farmer and his crop care not about the specifics and technical details of a dripper. Their only concern is what the dripper delivers. They need a dripped supply of water into the wetted bulb-shaped root zone, on demand, during the lifespan of the crop. This dripped supply must never vary or decrease over time. It must be accurate and constant over the crop's lifespan. For a farmer, this is the essential feature of a dripper.**

A dripper is a dripper is a dripper? Not really. We know that there is a vast difference between drippers and, specifically, dripper quality. Sometimes for good reason and other times not. The water's quality of supply to the root zone requires a commensurate quality dripper.

A good quality dripper can be defined as one that emits a predetermined flow rate that is accurate and constant over its intended lifespan.

This article proposes a method of evaluating and comparing drippers for use in a given situation when a choice needs to be made.

In previous articles, Inside a Clean Dripper (Parts 1 and 2), published in the June/July 2017 and February/March 2018 issues of SABI Magazine, we looked at the features that contribute to keeping a dripper clean and working. Essentially, these features are those that contribute to the dripper's quality.

The main structural features that were mentioned in Part 1, such as the filtration area, the labyrinth depth, width, and length, are common to all drippers. These are all measurable. Other features that were mentioned in Part 2, such as the anti-root intrusion and anti-siphon devices are unique to a specific dripper. These features are not measurable.

Figure 1. The filter at the inlet to a modern boat-shaped non-PC dripper

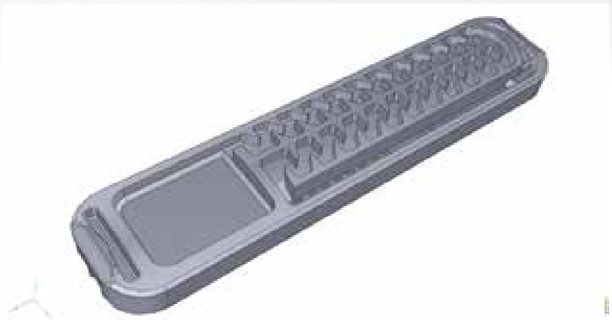

Figure 2. The labyrinth of a non-PC dripper with the exit 'bath' to the left, where a hole would be made through the dripperline wall for the droplet to exit the irrigation system

A method has now been devised that quantifies these common features and formulates a score by which one dripper's quality can be compared with another's. This make it possible to make an educated choice in choosing a dripper that best suits the application in question.

The concept simply involves two aspects: the dripper's net filtration area and its turbulence coefficient.

## The turbulence coefficient

In *Part 1* mentioned above, we defined a dripper's structural features as 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 and goes into the root zone.

With the exception of the inlet filter, the turbulence coefficient embraces all of these structural features of a dripper that contribute to dripper quality. In essence, the higher the turbulence coefficient, the lower the dripper's sensitivity to clogging and the better its ability to maintain its constant flow rate over its intended life. This is achieved by the vortexes that develop in the labyrinth that create a self-cleaning stream which purges contaminants out of the dripper.

The higher the turbulence coefficient, the better the quality.

$$K = \frac{254 * P * (W * D)^2}{N * Q^2}$$

**K** - turbulence coefficient

**P** - pressure differential through the labyrinth in metres

**W** - width of labyrinth water passage in mm

**D** - depth of labyrinth water passage in mm

**N** - number of teeth in the labyrinth

**Q** - labyrinth flow rate in litres per hour

Let us look at the effect of these features on the turbulence coefficient.

**The depth and width of the labyrinth: the greater, the better.**

**Dripper A**

At 10m pressure, the flow rate is 1.0 litre per hour through a labyrinth with 44 teeth and width x depth dimensions of 0.60mm x 0.59mm. The resulting turbulence coefficient is 7.2.

$$K = \frac{254 * 10 * (0.60 * 0.59)^2}{44 * 1.0^2}$$
$$K = 7.2$$

**Dripper B**

If Dripper A's depth and width were increased by 0.01mm to 0.61mm x 0.60mm and all other measurements remained the same, that is the same pressure differential through the same number of teeth still produced a flow rate of 1.0 litre per hour, the turbulence would have to have been greater and the turbulence coefficient would increase to 7.7

$$K = \frac{254 * 10 * (0.61 * 0.60)^2}{44 * 1.0^2}$$
$$K = 7.7$$

**The length of the labyrinth: the shorter the better.**

If a flow path is shorter, it will have less teeth.

**Dripper C**

This dripper has the same flow rate as Dripper A at the same pressure: 1.0 litre per hour at 10 metres. However, the flow path is longer. There are 82 teeth instead of 44. The turbulence coefficient reduces to 3.7.

$$K = \frac{254 * 10 * (0.60 * 0.59)^2}{82 * 1.0^2}$$
$$K = 3.9$$

**The quality of the design and manufacture of the dripper labyrinth.**

The better the quality of design and manufacture of the labyrinth and especially actual teeth themselves, the greater the turbulence coefficient.

**Dripper D**

We are now left with just one measurement: the differential pressure through the labyrinth. If Dripper A's features in all respects remained the same but the pressure differential to achieve 1.0 litre per hour increased to 12m, then the turbulence coefficient would increase from 7.2 to 8.7.

$$K = \frac{254 * 12 * (0.60 * 0.59)^2}{44 * 1.0^2}$$
$$K = 8.7$$

It may not of course be desirable to increase the required pressure, in which case to return to the original 10 metres pressure with the current labyrinth design, the manufacturer would change the labyrinth dimensions such as reducing its length; in other words, reducing the number of teeth. Less teeth: higher turbulence coefficient.

Keeping all other measurements the same, an increase in pressure differential as seen in Dripper D, can only be achieved by the actual design and manufacture of the dripper itself. It is a fact that the higher the quality and precision of manufacture, the shorter the flow path will be. Conversely, the lower the quality and precision of manufacture, the longer the flow path will be that is necessary to achieve the same pressure differential.

The length of the flow path suggests that there is less of a path to become clogged. Indeed, this is true. More important however, is that a shorter flow path indicates stronger turbulence and therefore better resistance to clogging.

## The effective filtration area

At the entrance to a dripper's labyrinth is a filter whose total area is usually larger than the labyrinth's width x depth dimensions. It is common belief that the true filtering area is the total area of the inlets. However, the size of the dripper filter is not necessarily an indication of the real filtering area. The effective filtration area is the area that the water passes through on its way to the dripper labyrinth. It is this value that we take.

Effective Filtration Area - EFA in $mm^2$.

## Dripper quality score

The dripper quality score (DQ) is a comparative figure. It is used to compare two drippers for the same application.

The dripper quality score combines effective filtration area in millimetres with the turbulence coefficient. At this point, the exercise becomes subjective.

Dripper quality score (DQ) = EFA + K

The two cannot be logically combined by simply adding the two values together as above, as the turbulence coefficient is a dimensionless value but the EFA is a value in $mm^2$.

Further, the two factors, namely EFA and turbulence coefficient, do not necessarily contribute equally to dripper quality.

To overcome this, the score brings in a weighting to each.

$$DQ = (W1 * EFA) + (W2 * K)$$

W1 - Filtration area weight factor

W2 - Turbulence coefficient weight factor

The value of these two weighting factors is chosen by the user doing the comparison.

The EFA is usually a value between 10 $mm^2$ and 100 $mm^2$ and the turbulence coefficient a value between 1 and 10. Numerically, EFA is generally ten times that of turbulence coefficient.

To bring them into line and treat them as contributing equally to dripper quality, it would be reasonable then to choose their values as:

| | |
|---|---|
| W1 = 1 | Filtration area weight factor |
| W2 = 10 | Turbulence coefficient weight factor |

Let us compare Dripper A with Dripper C and a new Dripper E. All three are 1.0 litre per hour drippers but have differing EFAs and turbulence coefficients.

| | | |
|---|---|---|
| Dripper | A- | EFA = 24.0 $mm^2$, K = 7.2 |
| | C- | EFA = 47.2 $mm^2$, K = 3.9 |
| | E- | EFA = 36.3 $mm^2$, K = 2.4 |

If we choose to weight as above, with approximately equal contributions to dripper quality, we will get the following:

| | | |
|---|---|---|
| Dripper | A- | DQ=(1*24)+(10*7.2) = 96.3 |
| | C- | DQ=(1*47.2)+(10*3.9) = 86.2 |
| | E- | DQ=(1*36.3)+(10*2.4) = 60.3 |

In other words, if we decide that ETA and the turbulence coefficient contribute equally to the dripper quality, then Dripper A scores the best.

If we should say that the EFA significantly contributes more to dripper quality than turbulence coefficient, say double, then the weight for EFA would be 2 instead of 1.

| | |
|---|---|
| W1 = 2 | Filtration area weight factor |
| W2 = 10 | Turbulence coefficient weight factor |

We will get the following:

| | | |
|---|---|---|
| Dripper | A- | DQ=(2*24)+(10*7.2) = 120.3 |
| | C- | DQ=(2*47.2)+(10*3.9) = 133.3 |
| | E- | DQ=(2*36.3)+(10*2.4) = 96.6 |

In this case, Dripper C with a larger EFA but lower turbulence coefficient than Dripper A scores best, because of its EFA, but Dripper E, which also has a larger EFA than Dripper A, does not score higher because its turbulence coefficient is not sufficient.

If we should say that the turbulence coefficient contributes more to the dripper quality than EFA and we were to place the weighting in favour of the turbulence coefficient, then we could double its original weighting from 10 to 20.

| | |
|---|---|
| W1 = 1 | Filtration area weight factor |
| W2 = 20 | Turbulence coefficient weight factor |

We will get the following:

| | | |
|---|---|---|
| Dripper | A- | DQ=(1*24)+(20*7.2) = 168.7 |
| | C- | DQ=(1*47.2)+(20*3.9) = 125.2 |
| | E- | DQ=(1*36.3)+(20*2.4) = 84.3 |

Dripper A, which has the far superior turbulence coefficient scores highest as expected and the ranking would be the same as when the two weighting factors were more even.

## Classes of drippers

We began by defining a good quality dripper as one that emits a predetermined flow rate that is accurate and constant over its intended lifespan. The lifespan of the dripper is dependent on the crop for which it is used.

If we look at a high-end dripper, Dripper F. This is still a 1.0 litre per hour dripper, but its labyrinth is so short that it has only 11 teeth and its turbulence coefficient is 9.3. It has a large EFA of 42 mm$^2$. If we choose the weight as above, with approximately equal contributions to dripper quality,

| | |
|---|---|
| W1 = 1 | Filtration area weight factor |
| W2 = 10 | Turbulence coefficient weight factor |

We will get the following:

| Dripper | |
|---|---|
| A- | DQ=(1*24)+(10*7.2) = 96.3 |
| C- | DQ=(1*47.2)+(10*3.9) = 86.2 |
| E- | DQ=(1*36.3)+(10*2.4) = 60.3 |
| F- | DQ=(1*42)+(10*9.3) = 134.8 |

Dripper F wins hands down. But Dripper F is a pressure compensating dripper intended to irrigate a field crop over a five- to ten-year period. The other three are non-pressure compensating drippers that are intended to irrigate a field crop for no more than two or three seasons. There would be no reason to consider Dripper F in comparison to the other three drippers if the use was for instance, only a few seasons of vegetables. This is, unless Dripper F was less expensive, which is highly unlikely given that it is pressure compensating.

It is necessary to have a system of defined dripper classes and only compare scores within a given class.

### Class 1 – High-end pressure compensating dripper

These are drippers that would typically be used for longer than ten years in orchards and the like, over varying terrain, slopes and long distances, as well as with water of questionable quality.

### Class 2 - Standard pressure compensating dripper

These are drippers similar to Class 1, but the required lifetime may not be as long: ten years or less. An example would be sub-surface drip on sugar cane. (Dripper F is a Class 2 dripper).

### Class 3 – High-end non-pressure compensating dripper

These are drippers similar to Class 1 with regards to lifetime (ten years or more), but without the ability to handle slopes, distances and questionable water quality.

### Class 4 - Regular non-pressure compensating dripper

These are non-pressure compensating drippers like Class 3, but are only required to last a few growing seasons: less than ten years. (Drippers A, C and E are Class 4 drippers).

## Comparing equals

Such a system of quantifying a dripper's quality and using that measurement for its specific use, as defined by the class, allows you to compare apples with apples. Or rather, drippers with drippers.

Constructing a calculator would be the next logical step, whereby a user simply inputs the parameters as defined above for as many drippers as they choose to compare, and a score is immediately calculated.

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