Agriculture Notes

Centre Pivot Performance Check

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When you buy a centre pivot, you expect that it will perform as specified. Make sure that it does!

When you order a centre pivot, you specify (and will pay for) a particular system capacity, drive train, sprinkler pack and all the various components. Obviously, it is important to do your homework on the specifications before placing your order. However, it is also important to be satisfied that the installed system performs as you expect.

While systems should be designed, built and installed to the Australian Code of Practice for On-Farm irrigation, a survey of 23 pivots in New South Wales and Queensland (Smith and Jessen, 2006) found significant variation from the specified performance in many of the machines. In particular, application rates were often less than indicated, and the distribution uniformity was generally lower than the 90% benchmark.

You should be satisfied that the machine that you are purchasing performs as you expect it to.

- Does the pivot apply the designed volume of water?
- Is the uniformity of application satisfactory?
- Are the rate of travel and the application rate correct?
- Is the operating pressure at the pump *and* the sprinklers as designed? and
- Is the energy use / running cost as predicted?

These and other points can be confirmed by making the following checks against the system design specifications. While the checks are generally not complicated, you may prefer to use an independent consultant if you are not familiar with the technology.

Things to check:

- Pump & motor specifications
- Flow rate
- Sprinklers
- Pressures
- Application depth
- Travel speed
- Distribution uniformity
- End gun operation
- Energy consumption

It may be appropriate to include in the sale contract that 10 to 20 % of the purchase price will be paid after confirmation that the system is performing as specified.

Figure – It looks good, but does it do what you expect?

Pump and motor

Note the pump, motor and filter specifications and ensure that they match those in the design.

Flow rate

It is recommended that a flow meter be fitted to allow you to monitor pivot performance and water use.

Note the flow rate shown by the flow meter when the system is operating, with and without the end-gun operating (if fitted).

If the particular meter does not indicate the flow rate directly (many do), you can record the volume delivered over say a ten-minute period, and calculate the flow rate:

$$\text{Flow rate (ML/d)} = \frac{(\text{Reading 2} - \text{Reading 1 ML}) \times 60 \times 24}{\text{Time between readings (min)}}$$

Example - with meter readings of 105.6243 and 105.6592 ML taken 10 minutes apart, the flow rate is:

$$= \frac{(105.6592 - 105.6243) \times 60 \times 24}{10}$$

$$= 5.0 \text{ ML/d}$$

Repeat the measurement a couple of times to be confident of the figure you get.

The flow rate observed should be consistent with the system design – if it is not, either the system is not operating as designed, or the flow meter is inaccurate. It is important to resolve which is the case, and why?

Sprinklers

The sprinklers and regulators should be those specified, with the nozzle sizes (or numbers) in the correct positions – sometimes they can be installed in the wrong order.

If a dry-wheel pack is fitted (recommended), ensure that the half-throw sprinklers are aligned correctly, pointing away from the towers or "behind" the towers if on boombacks. You may need to adjust the direction of the half throw sprinklers for best results.

Pressure

Read the pressure gauges at the pump, at the pivot centre and near the end of the pivot, with the end-gun operating (if fitted). The pressures should be within 5 % of the design pressure, after correcting for the elevation of the gauge (see below).

In particular, the pressure at a sprinkler regulator close to the end of the pivot, at the highest part of the circle (if the site is not flat), and with the end-gun operating (if fitted), should be as designed. This should be at least the pressure specified for the sprinkler, plus 3.5m (5 psi) for the regulator. If it is less, the uniformity of irrigation could be affected, particularly on high ground or when the end-gun is operating. However, the pressure should not be greater than required, or pumping costs will be higher than necessary.

If the pressure in the span-pipe is less than that specified, check that the filter (if fitted) is not blocked.

Note –

- The relative elevation of the gauge is important – if the gauge is on the span pipe, say 1.5 m above the pressure regulator, the pressure shown will be 1.5 m (2.1 psi) *lower* than the actual pressure at the regulator, because of the pressure of the column of water. Ideally, install a gauge just above the regulator on the last sprinkler for a direct reading. Remember; the pressure will vary with elevation change around the circle.
- The cheap pressure gauges normally supplied should be accurate within 5 % (1 metre in 20), but don't rely completely on them. After exposure to weather and irrigation over a season or two, they will be even less reliable. Specifying better quality pressure gauges initially is desirable.
- Units: 1.0 metre (m) of water = 9.8 kilo Pascal (kPa) = 1.4 pounds per square inch (psi) (approximately).

Figure 2 Check the pressure gauges

Application depth

Measure the depth applied in a pass at several points along the span-pipe with catch cans or rain gauges. Make sure that the sprinkler distribution pattern passes completely over the cans.

Beware of measuring close to the towers –water intercepted by the tower or half-throw sprinklers fitted as a dry-wheel pack will affect the uniformity of application. Wind may also affect the uniformity.

If the *average* depth differs by more than 5 % from the expected depth (according to the supplied chart), check that the speed of the outer tower is as specified for the required depth.

Speed

Measure the **average speed** of the **outer tower** by measuring the distance travelled in say 5 minutes.

Example: 8.7 m in 5 minutes = 1.74 m/minute

Check this against your speed control dial or chart. If it is not within say 5 %, you can use your measured speed to correct your speed and application rates, or check with your supplier.

Distribution uniformity

Ideally, a distribution uniformity measurement with collectors each 2 to 4 metres along two radial lines to a specified standard would be undertaken. The distribution uniformity so measured should be **90 %** or better. This measurement is probably more involved than most farmers are prepared to undertake. However, if you are concerned about your pivot's distribution uniformity, check with your supplier or seek advice from DPI Tatura.

The distribution uniformity under an end-gun is likely to be significantly lower than for the pivot itself.

End-gun

If an end-gun is fitted, does it have a booster pump? (This is recommended, and should be specified at the design stage.) Observe an irrigation - does the end-gun turn on and off where it is supposed to?

Energy consumption

Calculate the energy consumed by the system:

- For an **electric** machine, read the electricity meter and the flow meter, say at the start and end of an irrigation. Calculate the electricity consumption (kWh) per ML pumped. This will depend on the total operating head of the system and the pump and motor efficiency, but should be of the order of 140 kWh/ML for a 35 m (50 psi) system, or 4 kWh/ML/m of head.
- For a **diesel**-powered system, measure the fuel used for a given number of ML pumped, and calculate the fuel consumption per ML pumped (L/ML). Again, this will vary with the total operating head and the pump and motor efficiency, but should be of the order of 40 L/ML for a 35 m (50 psi) system, or 1.1 L/ML/m of head.

Note:

- Total operating head (or total dynamic head) is the pressure at the pump, plus the suction head, which is the height of the pump above the water surface *plus* the friction losses in the suction pipe, typically about 1 m (say 1 psi).
- The above energy consumption figures include an allowance for the tower motors.
- An end-gun operated by a separate booster pump will require additional energy.
- A modern turbo-charged diesel may be 10 % more efficient than above.

If any of the above differ significantly from the specifications of the system which you have agreed to purchase, you should resolve the issue with your supplier, preferably before making your final payment.

References:

IAA, MCBC, NSW Agriculture Australian Code of Practice for On-Farm Irrigation

Smith, P and Jessen, M, Centre Pivot Irrigators: Traps for Operators and Installers, Proceedings of IAA National Conference 2006, Brisbane

Figure 3 End gun with booster-pump