GRAIN STORAGE
FACT SHEET
www.storedgrain.com.au

GRDC
Grains Research & Development Corporation
Stored Grain Project

CRC PLANT biosecurity

AUGUST 2012

Performance testing aeration systems

Aerating grain in storage creates cool, uniform moisture conditions throughout the grain bulk. Cool grain temperatures slow or stop, insect pest development and maintain grain quality.

A simple device called an 'A-Flow' has been developed to measure the air-flow rate of an aeration system to check its performance.

KEY POINTS

- Aeration cooling creates cool, uniform conditions to maintain grain quality.
- An 'A-Flow' device can measure air-flow rate of an aeration system, determining its capability for cooling or drying.
- Measuring air-flow is best done when the storage is full, which creates the normal back-pressure on the fan insuring actual operating conditions for testing.

Why measure aeration air-flow

Research and commercial testing of grain aeration systems in Australia has provided recommended air-flow rates for both 'aeration cooling' and 'aeration drying.' Aeration cooling flow rates of 2–3 litres per second per tonne (L/s/t) and aeration drying air-flow rates of 15–25L/s/t provide reliable results.

Throughout the grains industry a wide range of local and imported aeration fans are in use, fitted to a large variety of grain storage types and sizes. These storages hold a range of grain types from small-seeded canola to larger cereal or pulse grains. Grain, storage and aeration fan type, along with the numerous ducting and venting designs used with aeration systems, all impact on the final working air-flow rates.

Air-flow rates well below or above recommended rates can result in the aeration system being of no benefit, wasting both the capital investment and electricity.

In some cases inappropriate air-flow rates will cause serious grain damage. Accurately measuring airflow can be achieved by following the advice outlined below.

Making an A-Flow device

The A-Flow device consists of a tube with a slot, designed to be used with a vane anemometer (Kestrel®) to measure air speed. The design and dimensions of the A-Flow device, along with the procedure to measure air-flow are critical for obtaining accurate readings. Simply placing an anemometer directly in front of the fan air intake or even in front of the A-Flow device does not provide reliable readings.

This A-Flow device is suited to test aeration fans with an air intake diameter of less than 235 mm. Large fans and a few very small fans can not be tested using this size A-Flow device.

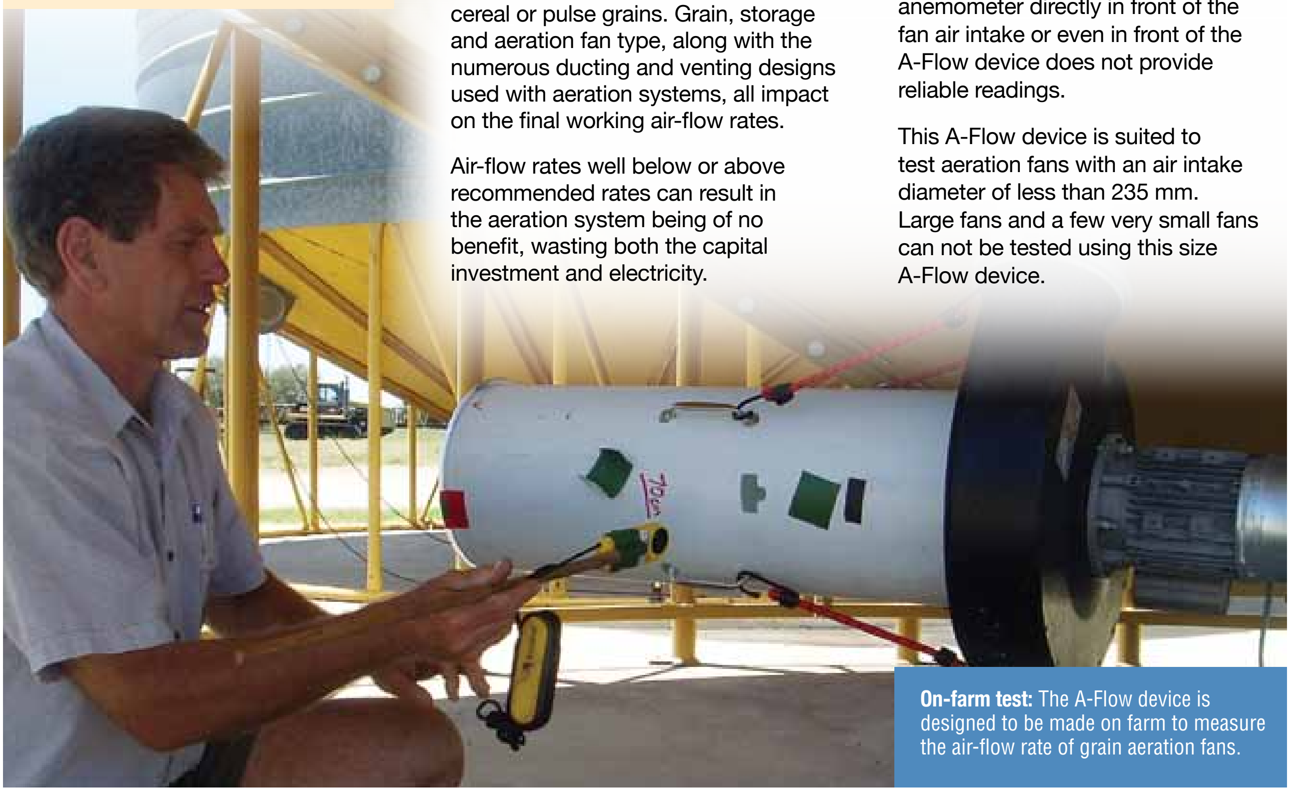


PHOTO: DAFF QLD

On-farm test: The A-Flow device is designed to be made on farm to measure the air-flow rate of grain aeration fans.

Level 1, Tourism House | 40 Blackall Street, Barton ACT 2600 | PO Box 5367, Kingston ACT 2604 | t. +61 2 6166 4500 | f. +61 2 6166 4599 | e. grdc@grdc.com.au | w. www.grdc.com.au

Shopping list

Key components required:

- ✔ 700 mm length of 250 mm diameter PVC stormwater pipe (approximate cost of $40)
- ✔ Kestrel® anemometer (models 3000 or 2500 approximate cost of $330)

Other components required:

- ✔ Four handles
- ✔ Four short (250 mm) octopus (occy) straps
- ✔ Cardboard and felt-tip marker
- ✔ 12 mm wooden dowel (550 mm long)
- ✔ Cloth tape
- ✔ Self-adhesive rubber seal (900 mm long — for example, Raven RP48 or Moroday door and window)
- ✔ 12 mm Nylex clear tubing (900 mm long)

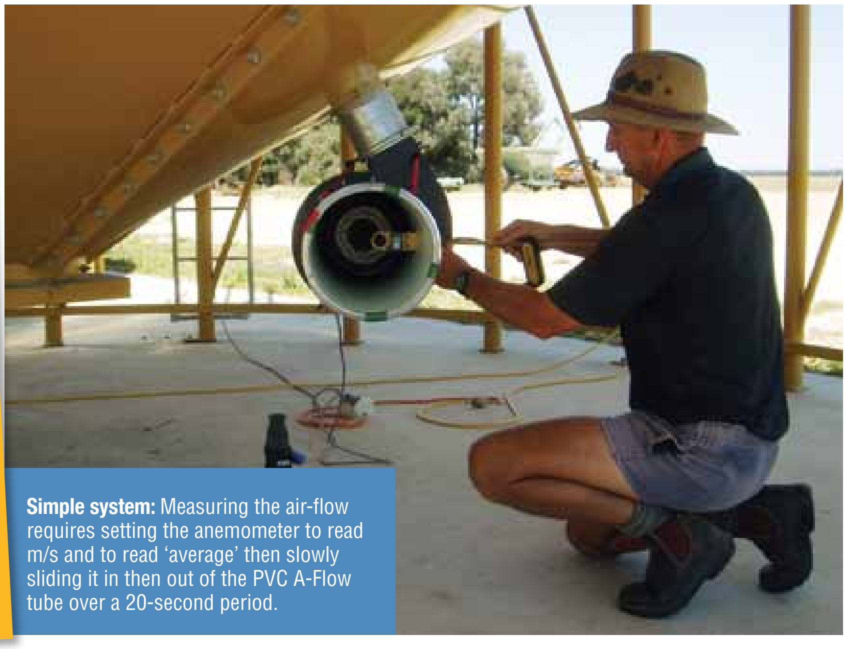


PHOTO: DAFF QLD

Simple system: Measuring the air-flow requires setting the anemometer to read m/s and to read 'average' then slowly sliding it in then out of the PVC A-Flow tube over a 20-second period.

Steps to making an A-flow device

Step 1

Ensure both ends of the 700 mm long PVC pipe are cut square. Mark one end of the tube as the 'fan' end. Mark the midpoint 350 mm from the fan end and fit four handles, spaced evenly around the outside in the middle of tube (see Figure 1). These handles will enable four short octopus straps to hold the A-Flow tube in place over the fan intake during the air-flow testing.

PHOTO: DAFF QLD

FIGURE 1

Handles fixed onto the PVC A-Flow tube enable octopus straps to hold the tube against the fan during testing.

Step 2

To make the anemometer entry slot, make a cardboard template with a hole that allows the anemometer to move through freely. Mark a point on the PVC tube, 265 mm from the fan end, and trace the cardboard template onto the tube with the mark in the centre of the rectangular hole. Drill multiple holes inside the rectangle to remove waste and then file to shape.

Step 3

Cut a 550 mm long piece from the 12 mm wooden dowel. Use a sanding disc to flatten an 80 mm long section on one end of the dowel. Rest the back of the anemometer on this flattened section and use the cloth tape to fix the anemometer to the dowel (see Figure 2).

Drill a 13 mm hole in the PVC tube next to the rectangular hole. Shape this to allow the anemometer, taped on the dowel, to move freely in and out of the tube.

FIGURE 2

A piece of wood dowel with a flattened end is secured to the back of the anemometer with cloth tape. A rectangle hole in the PVC A-Flow tube allows the mounted anemometer to slide in and out of the tube freely.

Step 4

To ensure the A-Flow tube forms an effective seal up against the aeration fan, fit a length of self adhesive 'rubber seal' to the fan end of the tube. (Raven RP48 or Moroday — Door & Window weather strip, EPDM rubber, 6 mm)

Step 5

Finally, to assist with smooth air entry into the A-Flow tube, take a length of the 12 mm Nylex clear tubing and carefully cut a slit along one side of the tube face so it can be fitted over the non-fan end. Use cloth tape to hold in place (see Figure 3).

PHOTOS: DAFF QLD

FIGURE 3

A piece of slit Nylex tube creates a rounded edge on the non-fan end of the PVC A-Flow tube to reduce turbulence as the air is sucked into the tube.

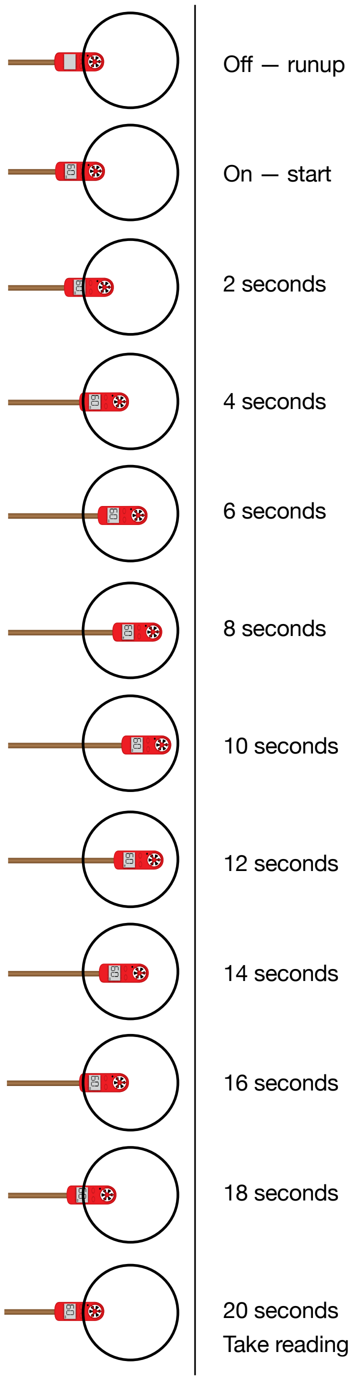
Using the A-Flow to take air flow measurements

The aim is to accurately measure the air speed (metres per second) going through a tube of a known diameter (239 mm). A simple calculation can then determine the volume of air (cubic metres or litres per second) the aeration fan is pushing into the grain storage.

For realistic measurements, carry out the test when the storage is full of grain. This creates the **normal operating back-pressure restricting air-flow**. Ensure the aeration system is running and the hatches or vents are open as under normal system operation.

- Mount the A-Flow tube to the face of the operating (on) aeration fan intake using the four octopus straps. Ensure the A-Flow tube is centered over the intake and an effective seal is achieved against the fan housing.
- Set the anemometer to read metre per second (**m/s**) air-flow. Select the averaging function '**AVG**' on the anemometer. The anemometer will now display the average air speed from when the instrument is turned on.
- Hold the anemometer, which is taped to the wooden dowel, and check it is set to m/s and displays AVG. Now turn the anemometer off.
- Insert the anemometer about 50 mm into the slot so the vane is spinning. You should still be able to see the blank screen of the anemometer outside the A-Flow tube.
  Allow the vane to get up to speed (5–10 sec) then turn the anemometer on and steadily push the anemometer through the tube over a 10-second period until it touches the far side. Steadily pull the anemometer back towards you over another 10-second period.
  Read the air speed 'm/s average' reading from the anemometer screen when the screen first appears out of the slot. This is the average air speed over the 20 seconds (see Figure 4).
- Repeat this process three times. These three readings of average air speed (m/s) should be of a similar value if you are careful (for example, 5.9, 6.1, 6.0 m/s). A practice run is usually helpful.

FIGURE 4 20-SECOND TEST



Calculating the air-flow rate

Step 1

Find the internal area of the PVC A-Flow tube using Лr². (Л = 3.142, r = radius)

Example:

Internal radius of tube = 119.5 mm, which is 0.1195 m

So internal area = 0.1195 x 0.1195 x 3.142 = 0.04486 m²
(If you've used the specified PVC tube with internal diameter of 239 mm the area is 0.04486 m²)

Write 0.04486 m² clearly on the outside of the PVC A–Flow tube.

Step 2

Multiply the average air-flow measured (for example, 6.0 m/s) by the area of the tube to give cubic metres of air-flow per second (m³/s).

Example:

6.0 m/s x 0.04486 m² = 0.2692 m³/s

Convert to litres of air per second by multiplying by 1000.

Example:

0.2692 x 1000 = 269.2L/s

Step 3

Now calculate L/s/t of grain by dividing the amount of grain in the silo by the air-flow rate.

Example:

If the storage contained 150 t of wheat, the calculation would be 269.2L/s divided by 150 t = 1.8L/s/t.

Multiple fans on a storage: If you usually operate two or more fans on a storage, take readings (m/s) on each fan while they are all operating. Calculate air-flow rates for each fan (L/s) and add these together to arrive at a total air-flow going into the storage.

Example:

180L/s + 150L/s = 330L/s

Divide this figure by the tonnes of grain in the storage to determine L/s/t.

Remember: if the amount of grain in the storage is reduced, or the grain type is changed (for example, from wheat to canola) this will significantly impact on air-flow rates. Testing is usually best carried out when the storage is filled to its usual level (full) with the usual grains stored.

Target flow rates for aeration cooling or drying

Aeration cooling: Efficient grain cooling and development of uniform moisture conditions are achieved with air-flow rates of 2–3L/s/t. When the standard automatic aeration controllers, time proportioning controllers (TPC), are used to operate fans the controller assumes fans are performing at these recommended air-flow rates.

Aeration drying: Effective and reliable moisture reduction of grain requires significantly higher air-flow rates than aeration cooling, in the range of 15–25L/s/t. Actual air-flow required for moisture reduction depends on the ambient weather conditions, the key is to understand that air-flow rates below 15–25L/s/t will risk grain damage and quality loss.

Aeration system performance

When an aeration fan is delivering well below or above the recommended flow rates, consider the following and make appropriate changes:

- Fan model or design is not suited to its current use (for example, storage size, grain type).
- Aeration system ducting, venting or other features are restricting fan performance.
- Maintenance or repairs are required on the fan or aeration system (for example, dust build-up on fan impeller).

PHOTO: CHRIS WARRICK, PROADVICE

Useful resources:

GRDC Grain storage extension project		**Web www.storedgrain.com.au**
Grain Trade Australia	**(02) 9235 2155**	**Web www.graintrade.org.au**
Graintec Scientific PTY LTD	**(07) 4638 7666**	**Web www.graintec.com.au**
Customvac Australia PTY LTD	**(07) 4634 7344**	**Web www.customvac.com.au**
Agridry International PTY LTD	**(07) 4631 4300**	**Web www.agridry.com.au**
Kotzur	**(02) 6029 4700**	**Web www.kotzur.com**
Kestrel Weather Australia	**(03) 9005 1708**	**Web www.kestrelweather.com.au**

Further reading

Aerating stored grain – cooling or drying for quality control (Booklet) Print	**1800 11 00 44**	**Email ground-cover-direct@canprint.com.au** **Web www.grdc.com.au/GRDC-Aeration-Book-2011**
Aeration cooling for pest control (Fact sheet) Print	**1800 11 00 44**	**Email ground-cover-direct@canprint.com.au** **Web www.grdc.com.au/GRDC-FS-Aeration-cooling-for-pest-control**
Keeping aeration under control (Kondinin Group Research Report)		**Web www.storedgrain.com.au**

Grain storage specialists

QLD and northern NSW, Philip Burrill	**0427 696 500**	**Email philip.burrill@daff.qld.gov.au**
Southern NSW, VIC, SA and TAS, Peter Botta	**0417 501 890**	**Email pbotta@bigpond.com**
WA, Chris Newman	**0428 934 509**	**Email chris@storedgrain.info**

Acknowledgements: Philip Burrill, DAFF QLD, CRCNPB. Andrew Ridley, DAFF QLD, CRCNPB. Chris Saunders, Adelaide University. Alan Andrews, Customvac. Andrew Kotzur, Downfields Engineering.

Produced by www.ProAdvice.com.au