

THE DEVELOPMENT AND COMMISSIONING OF THE
FIRST AUSTRALIAN DESIGNED SOLAR POWERED
AERATOR/WATER CIRCULATOR



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ABSTRACT

Thermal stratification in water bodies is a major factor that creates a favourable environment for infestations of algal and aquatic weed species. Infestations of algal and aquatic weed species place limitations on the operational integrity and the aesthetic value of a water body.

Thermal stratification can be overcome via the introduction of aerators and/or water circulators.

Generally, the aerators and/or water circulators employed are powered by 240 Volt or 415 Volt mains power.

However in many instances, the water body requiring the aerators or water circulators has no access to conventional power and the capital required to have power made available to the site is not cost effective.

BioRemedy decided it would become the first Australian based company to develop a solar powered aeration/circulation unit that would meet industry requirements without the use of a battery powered storage system.

The aim of the project was to develop a system that would be capable of generating enough solar power to run an Acqua & Co Brio 1.0T aerator/water circulator during winter, for at least 6 hours per day, at an average efficiency of at least 85% of a conventionally powered unit while circulating 1 Megalitre per hour.

KEYWORDS

Solar power, aeration and circulation.

1.0 INTRODUCTION

BioRemedy is an Australian owned company, established in 1996, specializing in environmental solutions for water treatment. The BioRemedy team comprises staff with hands-on experience, degrees in Applied Science and Engineering and Trade Qualifications.

BioRemedy has been supplying Acqua & Co Aeration and Circulation units to Councils, Water Authorities, Golf Courses, Resorts and Aquaculture Facilities for 18 years.

Traditionally, as with all but diffuser aerating systems, the units have been powered by either 240 or 415 Volt mains power.

There are however, some negatives to powering aeration/circulation units via mains power, some of which are;

- Gaining access to mains power;
- Cost of infrastructure required to facilitate operation via mains power; and
- The ongoing operational electrical supply charges.

Over the 18 year period BioRemedy has been supplying the Acqua & Co range to industry and council, there has been a common question asked.

“Do you have Solar-Powered Aeration/Circulation units?”

As Private Industry and Government controlled organisations feel the pressure of rising electrical costs and increasing public pressure to consider the ramifications of not employing renewable power generation, BioRemedy decided to become the first Australian based company to develop solar-powered aeration/circulation units that would meet industry requirements.

The aim of the project was to develop a system that would be capable of generating enough solar power to run the Brio 1.0T aerator/water circulator during winter for at least 6 hours per day, with the propeller speed of at least 1200 revolutions per minute (RPM), without the use of a battery power storage system.

2.0 DISCUSSION

Prior to the development of this unit, the only option for solar powered aquatic aeration/circulation units, was to utilise a battery powered system that would supply air to diffuser pads via a compressor.

Unfortunately the current battery powered systems require a period of dormancy between 10 am and 2pm to recharge the battery system. This period of dormancy between these hours is highly detrimental to the maintenance of water quality within the water body as these hours are when thermal stratification is at its highest.

Another important component of removing the batteries from our system was the emphasis industry places on providing a system with the minimum physical weight and physical footprint possible.

For these reasons, BioRemedy deemed the removal of batteries from the system extremely important.

2.1 Unit Selection

After considering the types of water quality issues that were most common and upon reviewing the Acqua & Co range, the Brio 1.0T aerator/water circulator was selected as the unit that would best fit industry requirements.

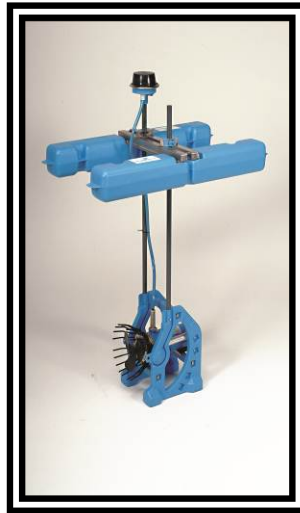


Figure 1: *Acqua & Co Brio 1.0 Water Circulator*

Table 1: *Acqua & Co. BRIO 1.0 - Technical Specifications*

Supply Requirement (V)	Rated Power (HP)	Rated Power (kW)	Rated Current (A)	Propeller Rotational Speed (RPM)	Mixing Volume Capability (kL/Hr)
220 (Three-Phase)	1.0	0.75	4.5	1400	1200

2.2 Configuration of the Solar Powered Brio Aerator/Circulator

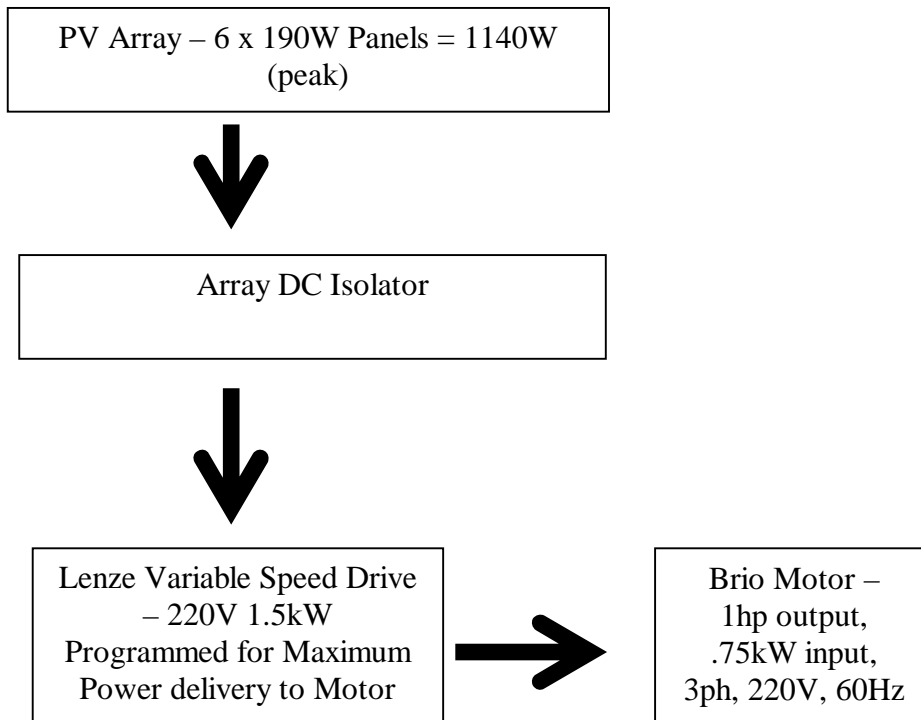


Figure 2: *Breakdown of Tested Brio Configuration*

2.3 Testing the Performance of the Solar Powered Brio

The factor that most affects performance of the solar PV powered Brio is the amount of solar energy available. The most useful information collected is propeller speed and the length of time the motor operates at full speed (or close to it) over a solar day. This relationship is shown in the figures below. Each figure shows the propeller speed in rpm and solar irradiance (I.e. Sun's Power in W/m^2) on the plane of the PV array (Berrill & Keenan-2013).

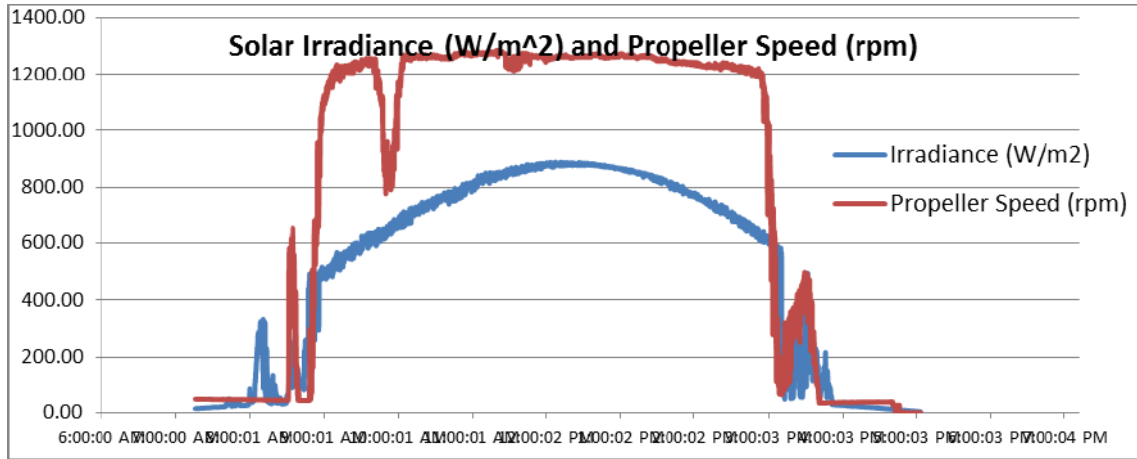


Figure 3: *Clear Day Performance – Daily Irradiation (5015 Wh/m^2) Data for 26/6/13*

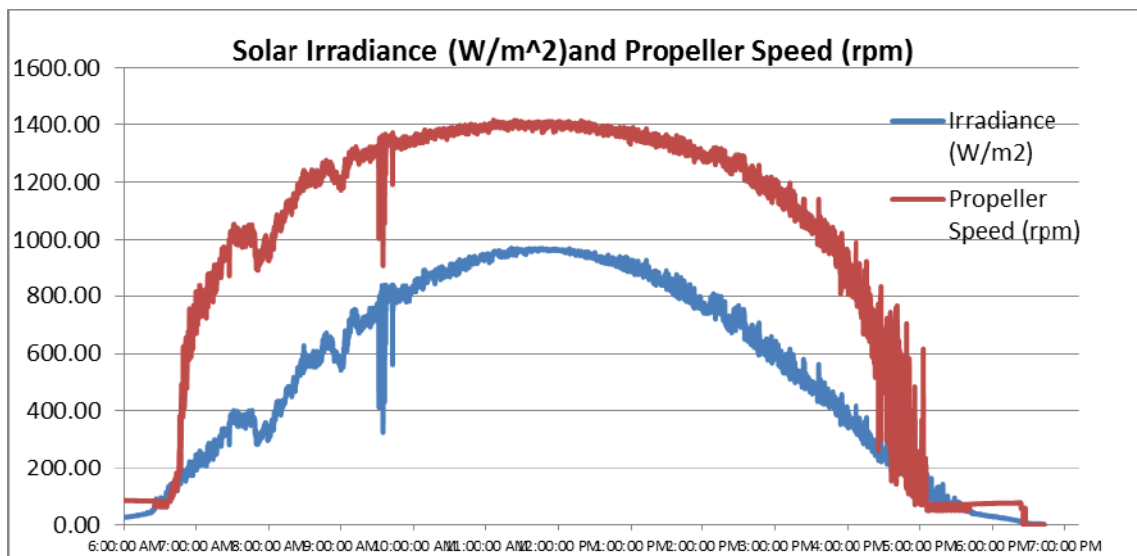


Figure 4: *Clear Day Performance – Daily Irradiation (6979 Wh/m^2) Data for 16/2/14*

Figure 3 and 4 show how the propeller speed varies throughout the day as the solar irradiance varies. It shows that the PV array and solarimeter are both shaded in the early morning and late afternoon due to trees.

Hence, the propeller speed is variable and very low at these times of day as the solar energy is variable and very low. Consequently, the PV array does not provide sufficient voltage and current under these conditions.

When these results are averaged over the period of the day, the data shows the units are experiencing a relatively small loss in performance.

The irradiance level in Figure 4 (Winter) is shown to climb quickly around 9am, the propeller speed then increases rapidly to its maximum around this time (the dip in propeller speed at 9:30am does not correspond to a dip in irradiance. This is due to the fact that part of the solar PV array below the solarimeter was shaded by trees).

In Figure 4 (Summer), it is shown that the levels of irradiance and propeller speed increase in a more gradual manner. This corresponds with the lengthening of daylight hours as winter changes to summer.

3.0 CONCLUSION

While analysing the data collected over the sample period it can be concluded that BioRemedy has developed a fully operational commercial water circulator/aerator that will operate at over 85 % efficiency over both the winter and summer seasons and utilises only solar power.

Table 2: *Acqua & Co. BRIO 1.0 – Performance During Winter and Summer*

Date	Radiation (MJ/m ²)	Air Temp.(C)	Energy (dc)	Average Propeller Speed (rpm)	Time Period of Average Speed
26/6/13 Clear day	18.1	17.3	5105	1232	9am to 3pm
16/2/14 Clear day	24.7	31.4	6979	1282	8am to 4pm

It should be noted that the solar powered Brio water circulator/aerator is the only unit available in Australia that does not require battery storage units.

The primary advantage of this is the unit does not require a period of dormancy during the middle of the day to recharge the batteries, as is a requirement of the solar diffuser aerators. As is seen in Table 2, the BioRemedy solar powered Brio is able to maintain maximum operational efficiency during the period the battery powered unit is dormant.

The performance specifications for the Brio provided by Acqua & Co (manufacturers of the Brio water circulator/aerator), indicate that under conventional mains power, the unit will circulate 1.2 million litres per hour at 1400 rpm.

Extrapolating the propeller speed data for both winter and summer, the propeller speed is between 1233 and 1282 rpm, (88 % to 92 % of maximum performance) for the majority of daylight hours. Using this data it has been determined that the Brio can circulate between 1.10 and 1.05 million litres per hour while the propeller is spinning at these speeds.

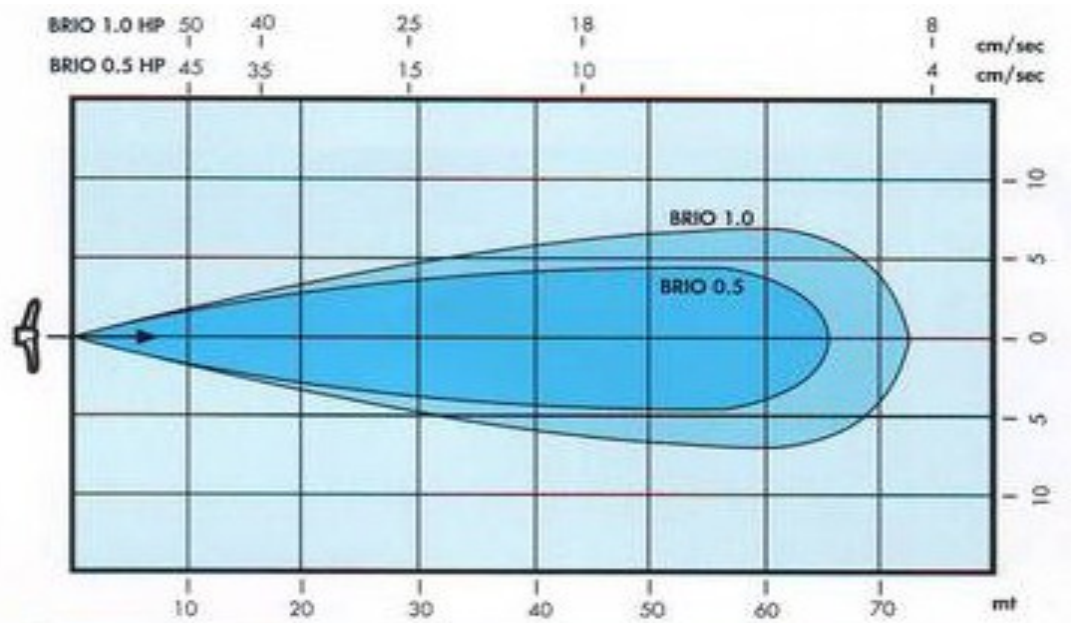


Figure 5: *Brio 1.0 Zone of Influence*

Figure 5, Zone of Influence, illustrates the pattern of circulation, the Brio water circulator/aerator achieves operating at 100% on mains power.

The above figure shows the Brio can provide direct influence over a water body greater than 70 metres long and 12 metres wide at a standard depth of 1 metre. The surface area of the water body covered by the zone of influence with those dimensions is 840m². Operating at between 88% and 92 % of maximum performance, the Brio water circulator/aerator will be able to provide a zone of influence between 730 and 760m².

The water body used during the testing of the unit has an approximate volume of 5 million litres. Results, both scientific and anecdotal show that the Brio water circulator/aerator has the ability to circulate the water body over five times per day and maintain water quality at levels residents say they haven't seen for a number of years.

4.0 REFERENCES

Berrill, T & Keenan D. *Report to Clayton Engineering Pty Ltd – Performance of Solar Powered Water Aerator/Circulator*. 2013.

Acqua & Co Brio Specifications. (2010). Retrieved February 10, 2014, from <http://www.bioremedy.com.au/>