Agriculture and Agri-Food Canada
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Water Quality Matters

Solar Powered Dugout Aeration

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DUGOUT AERATION

There are two ways a dugout can be aerated. They are:

- naturally through wind and wave action and photosynthesis. Usually, this only aerates the top portion of the dugout, leaving the bottom or lower half with little or no oxygen (anoxic conditions).
- artificial aeration, which is accomplished by injecting air into the lowest point of the dugout by means of a compressor and a diffusion device, such as an air stone or membrane diffuser. This produces a non-turbulent mixing action lifting the oxygen-depleted water from the bottom to the top to circulate with the oxygenated water, keeping the entire dugout well-aerated.

WHY AERATE?

Aeration improves water quality. Aeration is part of a good management plan to reduce overall water treatment costs and increase profits by increasing animal health, weight gain and dugout longevity.

It is important to remember that dugouts are miniature ecosystems that need adequate dissolved oxygen levels to maintain and provide the best quality water. This is not possible without supplemental aeration.

With high evaporation rates during the summer and anoxic conditions under ice cover in the winter, adequate dissolved oxygen levels are rarely maintained in dugouts. This leads to taste and odour problems and the release of phosphorous from sediment. This promotes algae growth and increases the amount of plant material that grows in the dugout. This organic decomposition is a continuous problem, which affects water quality in a dugout.

Continuous year round aeration through diffusion can offset these problems.

Dugouts are an important water source on the Prairies. It is necessary to maintain the best water quality possible

SOLAR POWER (PHOTOVOLTAIC, PV)

Photovoltaic, known as PV, relates to the production of electric current at the junction of two substances exposed to light. Photovoltaic systems consist of solar arrays (solar panel) that convert sunlight into direct current (DC) electricity, which can be used directly or stored in batteries.

Most DC systems are 6, 12 or 24 volts, or by using an invertor can be converted to alternating current (AC).

Solar panels consist of silicon cells, which have no moving parts, are durable and have a life expectancy of 25 years or more. Most solar arrays begin delivering power or charging batteries with as little as 10% of sunlight with each cell of the array converting approximately 14% of the available energy to DC power.

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SOLAR AERATION

Solar (DC) powered aeration systems are similar to electrical (AC) powered systems. A DC powered system allows power to be generated at a site that does not have access to the AC grid. What sets them apart is that solar panels generate electrical power (DC) needed to run the compressor, while storing excess energy in batteries. Batteries keep the system running during cloudy days and at night.

A solar aeration system consists of:

- solar panels (sized to supply enough power for calculated consumption)
- deep cycle batteries to store excess power
- a control board with regulator (charge controller)
- compressor
- weighted feeder hose
- air diffuser.

This type of system can be placed on the dugout bank or mounted on a small trailer for mobility.

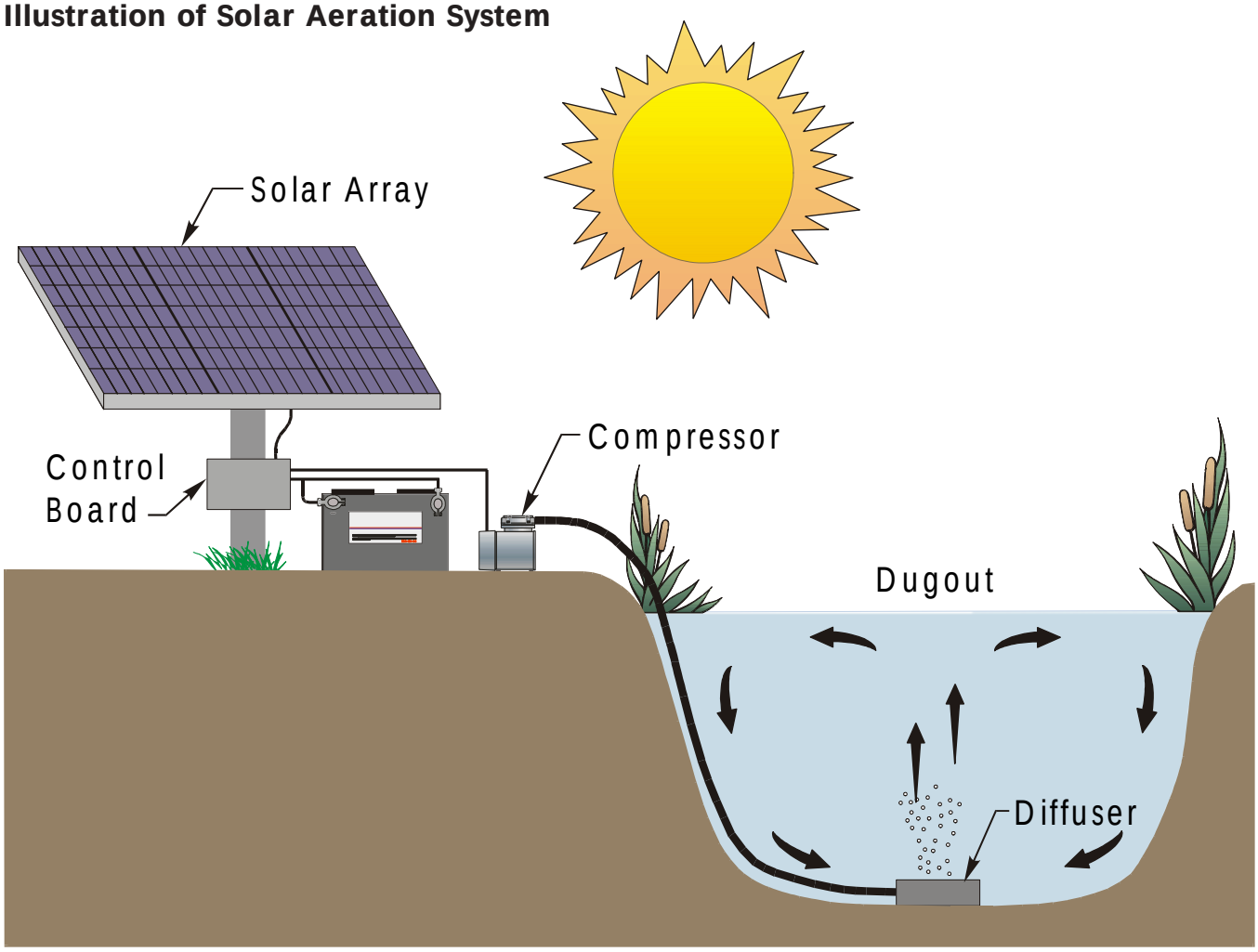
WHERE SHOULD SOLAR AERATION BE USED?

Solar aeration systems are custom-built for remote dugouts where AC power or an air line from a AC powered system is not practical.

For the aeration to improve the water quality, livestock must be excluded from the dugout . See **Water Quality Matters** publication "Alternatives to Direct Access Livestock Watering".

Solar panels can be sized and designed easily to supply power to a livestock watering pump.

Illustration of Solar Aeration System



Solar powered aeration installed on a trailer allows for mobility

SOLAR AERATION SYSTEM DESIGN

Designing a solar powered system can be done quite easily. For example, a pasture dugout of 2,400,000 litres can be aerated with a minimum of 0.5 - 1.0 CFM (cubic feet per minute). For proper system design, the compressor size and power requirements must be calculated for sufficient aeration. Once calculated, the number of solar panels and batteries can be determined.

The following formula is used to determine the number of solar panels required.

VOLTS X AMPS X HRS RUNNING X BATTERY EFFICIENCY FACTOR	=	WATTS/HR REQUIRED

Example: (based on summer use)

An average summer day will provide about 6.0-6.5 hours of charging time equalling a 12-volt compressor rated load of 3.8 amps (45.6 W) per hour. To determine the number of panels using the formula, the following is calculated.

12v x 3.8amps x 24hr x 1.1bf = 1,204 Watt/hrs

Based on this calculation, three solar panels are required. This assumes use of 64-watt panels, which produce (64 watts x 6 hrs) 384 Watt-hrs per day. Therefore, (1,204 ÷ 384) = 3.1, round to three panels.

When installing a solar powered system, one should determine the number of batteries needed or calculate how much battery power is required during cloudy periods or if the panels are disconnected. This calculation will depend on how often the system is inspected. PFRA recommends a battery storage capacity of three to five days.

In this example, if four days of storage is required and a six-volt 220-amp hour battery is used, then calculate the number of batteries needed using the following formula:

LOAD X DUTY CYCLE X RUN TIME	=	RESERVE CAPACITY

Load: volts multiplied by amps (Watts)
Duty cycle: running time percent
Run time: length of time required

To determine the number of batteries using the formula, the following is calculated:

45.6w x 1.0 x 96 hours = 4377.6 Watt/hrs

The number of 220 A/hr batteries required is 3.32, rounded up to four.

This is achieved because a 220 A/hr battery holds (220 A/hr x 6v) 1320 Watt/hrs, which, when divided into reserve capacity equals 3.32 batteries to get four days of reserve capacity.

PFRA recommends using six volt batteries because they provide the best storage life.

For a 12-volt system, the batteries must be used in increments of two in series equalling 12 volts; and for a 24-volt system, increments of four in series that equal 24 volts are required.

COST OF SOLAR AERATION

Depending on the system components used, dugout solar aeration can vary from as low as $1,200 (with no battery storage) to $2,500 - $8,500 for 24-hour aeration.

The following table indicates the approximate component costs for a solar powered aeration system.

Component	Approximate cost
64-watt solar panel	$600
220-amp hour 6-volt battery	$130
Air compressor	$300
Control regulator and LVD	$250
1/2 inch air line (weighted)	$30 - $100 depending on length
Air diffuser	$25 - $150

Mountings for panels, enclosures for batteries and compressor can be purchased from a local dealer or built at the farm. A system can be permanently located at the site or mounted on a trailer for easy relocation.

THE BIG PICTURE

Dugouts are an important water source on the Prairies. Water quality is very important to livestock health and potential weight gains. Therefore, it is important to maintain the best water quality possible in your dugout. Solar aeration is an ideal method to keep pasture dugouts healthy.

For further information on rural Prairie water quality and treatment technology:

- read other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA Website at www.agr.gc.ca/pfra
- read Prairie Water News available from PFRA, or on the internet at www.quanumlynx/water; or
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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