

How To AERATE Your DUGOUT

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AERATING WITH ELECTRIC AIR COMPRESSORS

Research by PFRA has shown that continuous, year round aeration improves dugout water quality. PFRA has also demonstrated that electric air compressors represent an effective way of aerating dugouts. This **Water Quality Matters** publication provides information on how to aerate using an electric air compressor.

THE BASIC COMPONENTS OF AN AERATION SYSTEM

AERATION SYSTEMS CONSIST OF FOUR BASIC COMPONENTS:

1. The compressor which supplies the air.
2. The gauges and valves. The pressure gauge (0 to 25 psi) allows the operator to determine if the system is working properly. The pressure release valve (set to about 15 psi) vents air from the system and prevents damage to the compressor and to the air line. The check valve (less than 2 psi) prevents water from coming into the air line, if it is disconnected from the compressor or if the compressor is not working.
3. The air line, which carries the air from the compressor to the bottom of the dugout.
4. The diffuser, which make small bubbles dramatically increasing the efficiency of the aeration system.

CHOOSING A COMPRESSOR

Small diaphragm compressors work best for dugout aeration because they perform well at the pressure ranges (up to 15 to 20 psi) needed to aerate dugouts. An air compressor of 1/4 to 1/8 hp putting out about 1 cubic foot per minute (cfm) is sufficient to aerate a dugout up to 5 million litres (1 million gallons). Several manufacturers produce suitable compressors which are available in Western Canada at farm supply stores. These compressors, which have a low power demand (100-200 watts), should run continuously.



A compressor with the pressure gauge and the pressure release valve installed at a dugout

CHOOSING A DIFFUSER

Aeration is most effective when the air bubbles are very small. Small bubbles increase diffusion of oxygen from the air into the water. More importantly, the rising bubbles circulate the water in the dugout. The smaller the bubbles, the more efficient they are at both oxygen diffusion and circulating the water.

The three basic types of diffusers which work well are air stones, linear diffusers and membrane diffusers.

Air stones are the most readily available type of diffuser. The size of the air stone must be matched to the volume of air being pumped so it is important to obtain an air stone designed specifically for dugout aeration (aquarium air stones are not appropriate). Air stones should be removed and cleaned at least once a year for them to remain effective. Scrub them with a wire brush or coarse sand paper to remove attached material.



An air stone or a membrane diffuser greatly increases the effectiveness of any aeration system



Linear diffusers are the most efficient type of diffuser. Two types exist. One is made of 1/2" diameter plastic tubing with 1/4" slits every 3" or 4" along the tubing with a plastic coating lead keel to weigh it down. The other type of linear diffuser is made of two attached rubber tubes, the top tube (3/4" outside diameter) has very small puncture holes every 1/2" and the second tube (1" outside diameter) is filled with sand to act as a keel.

Linear diffusers should be checked and cleaned at least twice a year to remove mineral deposits.

Membrane diffusers are made from rubber tubing which has fine slits in it. They produce fine bubbles and require low maintenance as the rubber will stretch and self clean when deposits form around the slits. Membrane diffusers have the lowest maintenance requirements.

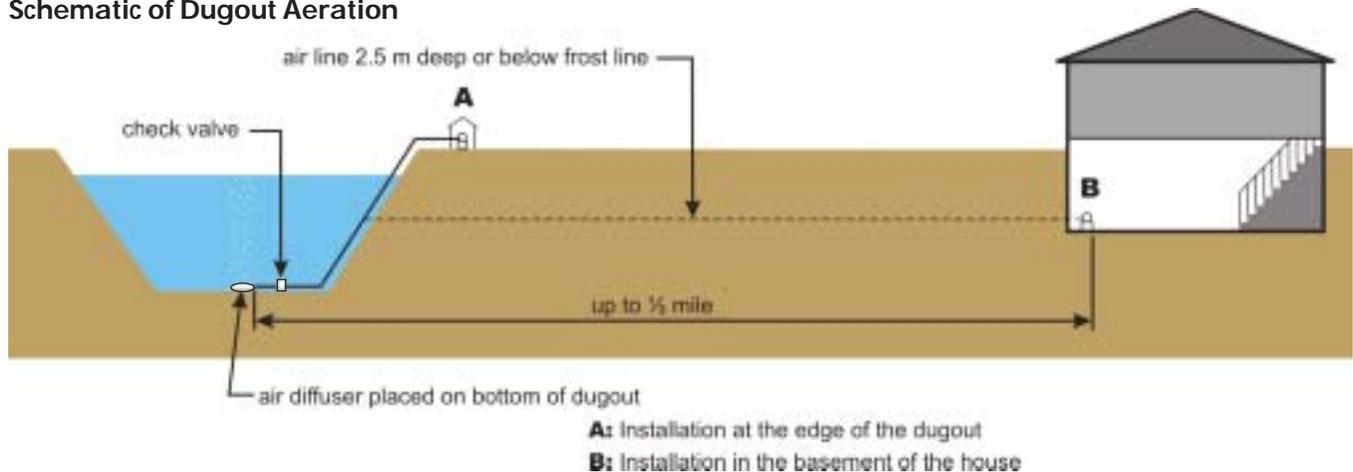
INSTALLING AN AERATION SYSTEM

LOCATING THE COMPRESSOR

The air compressor can be located near the dugout or far away. If power is not available at or near the dugout the compressor can be located up to 1/2 mile from the dugout and the air carried to the dugout through 1/2" plastic pipe. It can also be in the basement of the house if an air line was installed along with the water line. If the compressor is in a heated building, then some precautions should be taken to avoid condensation in the air line during the winter. Air pressure in the line will increase as condensation occurs and eventually the air line can be blocked by ice. This problem can be avoided by having a condensation tank outside the heated building. Condensation tanks for aeration systems are available commercially. Condensation is not a problem if the compressor is in the house and the air line is buried below the frost line. The air line should have at least one check valve because basements are often at or below the water level in the dugout.

If power is available, the compressor can be located in a box or an unheated building on the edge of the dugout. Some protection from the weather and dust should be provided if the compressor is outdoors.

Schematic of Dugout Aeration



The compressor should have a pressure release valve with a release pressure of around 15 psi to bleed off air and prevent damage to the compressor in case the air line becomes blocked. A pressure gauge should also be located on the outlet line to monitor pressure. It should be isolated from the air line with a valve so that it will not wear out rapidly because of fluctuating pressure near the pump. A check valve should be installed on the aeration tubing, preferably near the diffuser, to prevent water from flowing back up the tubing.

INSTALLING THE AIR LINE AND CHECK VALVE

The most common form of air line used for dugout aeration is 1/2" black plastic pipe. It is readily available and inexpensive but it is thin-walled and easily damaged. Bury it so that it is not accidentally damaged. If it is to remain on the surface, it is best to use a line that is not easily damaged, such as rubber line used on shop air compressors.

Install a spring-loaded check valve with an opening pressure of 2 psi or less on the air line near the diffuser. This prevents water from coming up the line and freezing if the compressor stops in winter. If, for reasons of safety, you install two check valves (e.g., one near the diffuser and one near the compressor), then you should be aware that the opening pressures are additive (i.e., two valves with an opening pressure of 2 psi would add 4 psi to the back pressure on the compressor). This would significantly increase operating cost and also wear on the compressor.

LOCATING THE DIFFUSER

The diffuser should be located on the bottom in the deepest part of the dugout. Aeration will occur only to the depth at which the diffuser is located. In order to aerate the whole dugout the diffuser must be on the bottom in the deepest spot.

COST CONSIDERATIONS

CAPITAL COSTS

Suitable air compressors cost around \$500. They should operate continuously for several years without requiring servicing. Eventually the diaphragm and reed valves may require replacement but the established brands have kits available for this purpose. You can also have the compressor serviced by a dealer. Some compressors have been reported to operate continuously for more than 10 years without requiring servicing.

The various fittings (pressure release valve, pressure gauge, check valve, clamps, etc.) will cost another \$25 to \$50.

Air line costs depend on the length of air line required. Black plastic pipe costs about 15¢ to 20¢/ft.

The cost of diffusers is variable. Air stones manufactured specifically for dugouts cost around \$25. A linear diffuser sells for about \$2 - \$5/ft depending on type and membrane diffusers cost around \$100. Neither the linear nor the membrane diffusers are readily available in Western Canada.

OPERATION AND MAINTENANCE

Aeration systems for dugouts should be operated continuously throughout the year. Turning the compressors on and off daily or more often will cause significantly more wear to the diaphragm and other moving parts than letting it run continuously. This is particularly important if the compressor is operated outside in the winter. The main areas requiring maintenance are the diaphragm and reed valves which may have to be replaced after a few years. The bearings or bushings on the compressor may have to be replaced after several years of use.

Diffusers should be inspected and cleaned in the spring and fall. Mineral deposits, algae and other organisms build up on some of the diffusers. The frequency of maintenance varies with the type of diffuser installed. PFRA research indicates that linear diffusers should be cleaned every spring and fall for optimum performance. Air stones and membrane diffusers should be checked and cleaned annually.

The best indication of the performance of an aeration system is the operating pressure. Check and record the operating pressure when you install the diffuser. Aeration systems should operate at between 5 and 12 psi in most dugouts. After installation, monitor the pressure regularly. When pressure increases 2-5 psi or goes above 15 psi, check for problems.

The most common problems are a plugged diffuser or, in winter, ice blocking the air line. If ice is the problem, put ethyl alcohol in the air line where it connects to the compressor. This will dissolve the ice in the air line.

Disconnect the pressure gauge with a shut-off valve when you are not using it. At a minimum, you should check and record pressure at least twice a year.

OPERATING AND MAINTENANCE COSTS

Annual operating costs depend on the compressor used and the back pressure, but typically a system can be

operated continuously year round for \$40-\$100 for power at 5.5¢/kilowatt. The only other regular cost would be replacement of the diffuser when it plugs.

THE BIG PICTURE

Dugouts represent an important water source on the Prairies. They are used to provide water for drinking, household uses, livestock watering, crop spraying and aquaculture. Each of these uses is affected by water quality. Therefore, it is important to maintain the best possible quality of water in your dugout.

Aeration is one of the many tools available to improve dugout water quality. Other techniques include appropriate management of the land surrounding the dugout and controlling inflows to the dugout. Regardless of what tools might be used, dugout water is not safe for human consumption without additional treatment and disinfection. Aeration can, however, reduce the cost of these treatment processes and make them more effective.

For more information on dugout aeration see the following **Water Quality Matters** publications: "Why Aerate Your Dugout" and "Myths About Dugout Aeration". For more information about dugout aeration equipment contact your local PFRA Office.

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

- read the other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA Website at www.agr.gc.ca/pfra
- get a copy of "Rural Prairie Water Quality: Searching for Solutions for On-Farm Users" available from PFRA;
- read Prairie Water News available from PFRA, or on the Internet at www.quantumlynx.com/water; or
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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