Dugout Aeration System Operation

Prepared by Reynold Woelcke, (403) 624-3386
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Line Pressure

The pressure that the aeration system operates at is the summation of various contributing factors.

(1) The depth of water. For every 2.31 feet of water the line pressure increases 1 psi. This does not change with different air flow rates.
(2) Pressure increases due to air friction in the system. This increases the pressure as air flow rate increases. Components that contribute to this type of air pressure are, (a) check valve, (b) air transmission pipe from compressor to the diffuser, (c) diffuser. Components such as check valves and diffusers may also have a constant pressure component.
(3) Pressure increase due to frozen moisture build up in pipes in winter.
(4) Pressure increase over time in the diffuser. Certain fine and medium size bubble diffusers develop mineral and/or organic deposits over time on the air release holes. These diffusers are airstones and linear diffusers. Pressure increases in the order of 5 psi or more over a year are not uncommon. Rubber membrane diffusers do not seem to develop these pressure increases.

Example:		
	Dugout water depth 15 ft	6.5 psi
	Koenders Check Valve	0.25 psi
	400 feet ½ diameter pipe	0.16 psi
	Self made linear diffuser (new)	0 .50 psi
	System Pressure (Total)	7.41 psi

Winter Pipe Blockage

A common aeration problem that occurs in winter is the air transmission pipe between the compressor and the diffuser becomes completely blocked with ice. This occurs because some of the moisture in the air moving through the pipe condenses inside the pipe as frost. This is aggravated by short periods of warmer weather in winter when the frost in the pipe thaws to liquid water and collects at low dips in the pipe. When the weather becomes cold again the water freezes and blocks off the pipe completely. There are several solutions.

The best solution is to bury a ½ inch diameter air transmission pipe with the water transmission pipe below the frost line when the dugout is newly constructed. The compressor is then housed with the water pump, which is also the best location for the compressor; as it is usually a cool, dry place such as a house basement.

For exiting dugouts where the aeration is installed after the water transmission pipe has already been installed, separately burring the aeration line deep underground is not very cost effective.
Several things can be done to minimize the problem of winter pipe blockage.

(1) Draw air into the compressor from outside the compressor house so that the coldest air is used. The colder the intake air is, the less moisture it contains. Also, the cold air intake should be elevated at least 5 feet above the ground to minimize the effect of morning dew, and the opening should face down to minimize precipitation and dust entering the intake pipe.

(2) After the compressor, have the air pass through a metal tank. This will slow the air down and allow it to cool in the tank and thereby condense some of its moisture in the tank and not in the transmission

pipe to the dugout. A possible source of a metal tank is a tank removed from an old small hot water heater with any leaks located and repaired. Fiberglass and resin works well for the leak repair.

(3) Using an air transmission pipe larger the normal size such as 1 inch diameter instead of a ½ inch diameter pipe to the dugout. This increases the cross-sectional area of the pipe 4 times, and makes it less likely to freeze off.

(4) If possible have the pipe to the dugout slope continuously down to the dugout. This will allow any liquid water in the pipe during warm periods to flow harmlessly to the dugout.

(5) Koenders sells a device ($50) to minimize the pipe ice blockage problem. It consists of a plastic tank that is partially filled with a antifreeze such as ethanol (ideal), or isopropyl alcohol, RV and home plumbing antifreeze (30% propylene glycol - $6 per 4 liter). If isopropyl alcohol or propylene glycol is used, use as little as possible as it has some toxicity. Do not use methyl hydrate, it is 8 times more toxic than isopropyl alcohol; or ethylene glycol (automotive antifreeze) which is also quite toxic. Winter pipe blockages are more common at very low temperatures so saturated salt water, likely would not be very effective as an antifreeze since it freezes at -18 deg. Celsius. Commercial grade denatured ethanol is also difficult to find in stores but is the only antifreeze recommended. The tank has a pressure sensitive valve which opens when the pressure in the pipe reaches 10 psi to 12 psi. This then allows the antifreeze to flow into the pipe and thaw the partial moisture blockage before it gets worse and hopefully flush the moisture harmlessly to the dugout. One complication with this device is that the system operating pressure may increase over time due to the air diffuser in the dugout. Both airstones and linear diffusers can increase in line pressure 5 psi or more if regular diffuser maintenance is not done. This will also trigger the pressure sensitive valve.

Need for Check Valve, Pressure Release Valve and Pressure Gauge

Check Valve

For aeration systems where the air transmission pipe enters the dugout from the surface a check valve is needed so that in the event of a power outage or other disruption in the compressor's operation, water is not allowed to move up the pipe, where in winter at ice level it would freeze and block off the pipe. If water freezes in the pipe at the dugout surface, then it is hard to fix other then putting in a new pipe through the ice.

A check valve can be placed in the aeration system in ether of two locations; (1) on the compressor side next to the air transmission pipe ,or (2) at the bottom of the dugout between the diffuser and the air transmission pipe, (3) both places to be safer.

Where the check valve is on the compressor side of the air transmission pipe, it can more easily be tested for proper operation and repaired or replaced if faulty. However in this location the air transmission pipe should be one pipe (not several clamped together pipe segments) to minimize the chance for air leakage and the check valve must be tightly attached next to the pipe. Any air or water leakage between the check valve and the diffuser will make the check valve useless. Use pipe Teflon tape on all threaded joints to make them air tight and clamp the pipe securely. Water with dish soap can be used to check for air leakage at joints with the aeration system pressurized to 25 psi or more. The check valve in this location needs to be air tight in the reverse direction of normal air flow.

Where the check valve is in the dugout between the pipe and the diffuser the check valve is less accessible. Here the check valve does not need to be air tight but it does need to be water tight in the reverse direction of air flow.

If there is concern of the reliability of any one check valve, two can be installed at one time but this will increase the operating pressure a little.

For air transmission pipes buried 8 feet under ground a check valve is needed because the compressor (often in a house basement) is often below the dugout water level. The check valve here is needed to prevent water from

the dugout flooding the basement if the compressor is not operating.

Pressure Release Valve

A pressure release valve (PRV) set between 10 psi to 15 psi should be installed so that in the event of any sort of blockage in the aeration system that the air has an alternate release point. This will prevent the compressor from being damaged in such an event. The pressure release valve should be installed as close to the compressor as possible. Most PRVs are somewhat adjustable. Princess Auto sells a PRV for $3 set at 14 psi which is well suited for a dugout aeration system. Its part # is 0430926; some are set at 8 psi (they are stamped with A 559B-2M-8), others are set at 14 psi (they have stamped on them CSC C 532B-2M-14 JS6). It is the -8 or -14 portion of the stamp that indicates the valves relief pressure. The 14 psi PRV should be selected for the aeration system.

Air Pressure Gauge

An air pressure gauge is **important** to monitor the operation of the aeration system. When aeration is first installed, record the operating pressure and the water level and use it as a reference for future pressure checks. Pressure rising over time indicates that the diffuser needs maintenance and/or in winter, frost is building in the pipe. If the air pressure is near zero then either a break in the air line has occurred or the compressor is not operating properly. Air exiting the pressure release valve indicates that there is either a blockage in the system or the diffuser needs maintenance.

Compressors with two diaphrams need two additional valves and an extra pressure release valve so that operating pressure of each diaphram can be measured, isolated from the other diaphram. Otherwise, if one diaphram is damaged and the other diaphram is undamaged the pressure gauge would give no indication of that.

A gauge connected close to the compressor or connected where it is exposed to the environment should have a shut off valve between it and the aeration system. The pressure gauge is a sensitive device and soon (within a year) becomes damaged if continually exposed to the vibration and pressure pulsation created by the compressor or moisture of the environment. So after a system pressure has been read and recorded, close the valve between it and the aeration system, remove the gauge and store it close by until the next time the pressure is to be read.

The pressure gauge should range from 0 - 15 psi or 0 - 30 psi. Gauges with larger ranges such as 0 psi to 120 psi (often use in water pressure systems) have too little resolution in the general operation range of an aeration system. Glycerine filled gauges dampen pressure pulsation, making them easier to read when installed close to a diaphram type compressor but is still susceptible to its damaging effect. They are also a little more expensive then non glycerine filled pressure gauges. Four inch diameter gauges are also easier to read than 2.5 inch diameter gauges. A gauge installed on or after a tank will also not pulsate.

Larger pumping wholesale stores generally sell this type of gauge. As a reference Western Supply in Edmonton (1-403-454-9551) sell the following pressure gauges (cash account):

Brand	Model	Part #	Range	Face Diameter	Face Fill	Accuracy	Cost
Winters	Economy	E212	0-30 psi	2.5 inch	air	+/- 3%	$8.90
Winters	Economy	E221	0-30 psi	4.5 inch	air	+/- 3%	$17.11
Winters		P802	0-30 psi	2.5 inch	glycerine	+/- 1.6%	$18.45

They also sell the same brand gauges from 0-15 psi at the same cost.

Weights in the Dugout

The portion of the air transmission pipe that is in the dugout and some diffusers such as a self-made linear diffusers need to have weights attached or they will not submerge. Attaching weights much heavier than needed such as one or two very heavy large masonry bricks makes moving the diffuser in and out of the dugout for maintenance very difficult. For a ½ inch diameter air transmission pipe attaching multiple smaller weights such as 500 ml plastic soda pop bottles filled with sand every 6 ft or, or a 1 inch diameter polyethylene plastic pipe filled with sand makes a better counter buoyancy weight. This is because the later weight system attached to the air pipe is only a little heavier than the water it displaces and is therefore easier to move . If the 1 inch

diameter polyethylene pipe filled with sand is used, it best made on a hot summer day so that the plastic is supple enough to stay uncoiled.

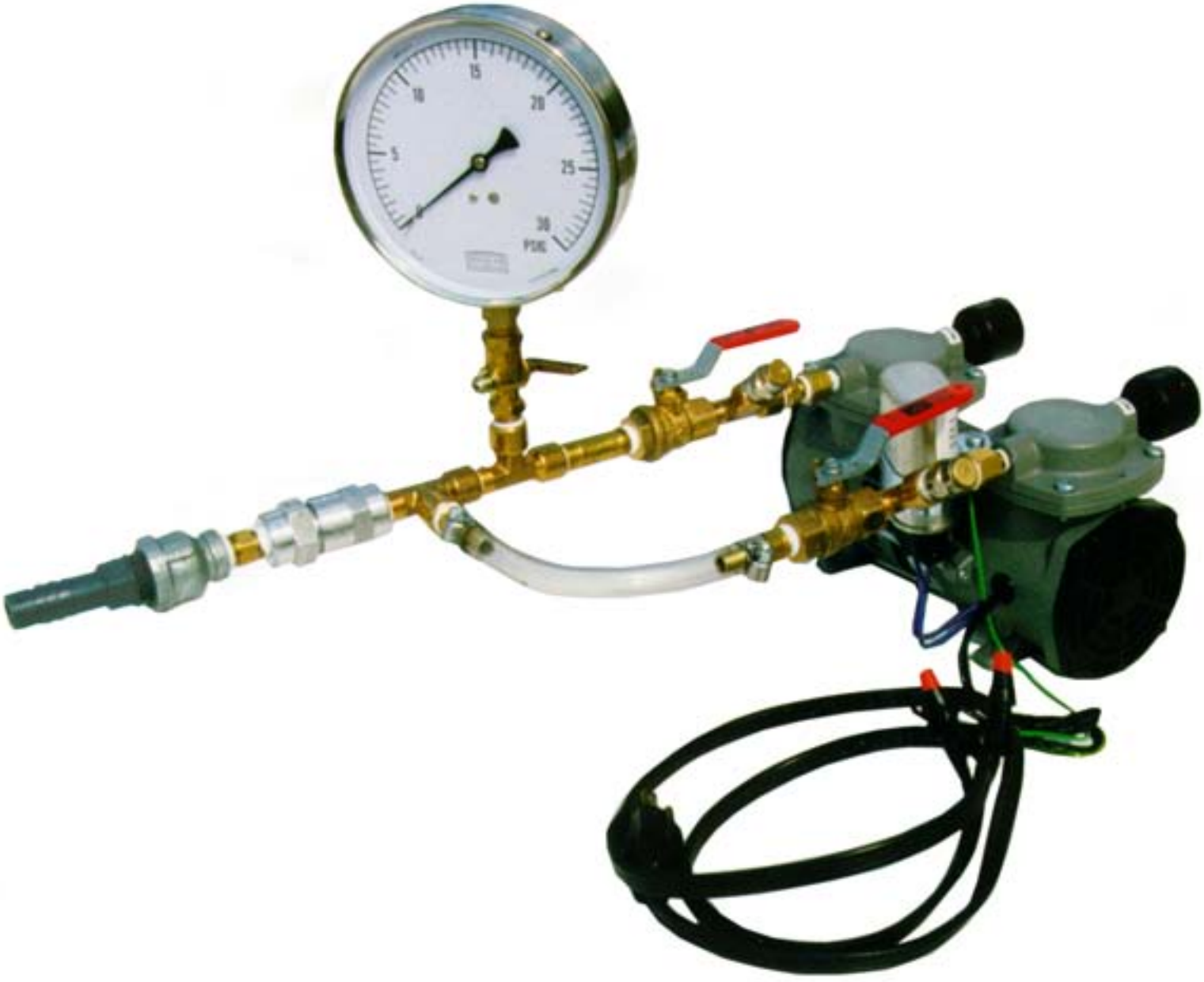
Power Outages

Electrical power outages are a problem with dugout aeration systems. Most compressors suited for dugout aeration will not start when the compressor exhaust port pressure is greater than 2 psi as for the Gast DOA compressor and 4 psi as for the Thomas CEF2107 . The exception to this is the Koenders compressor which because of the Capacitor Start Capacitor Run motor that it contains has sufficient starting torque to start when exhaust port pressures even exceed 15 psi. Since compressor aeration systems generally operate at a pressure above 6 psi, after a power interruption when the power is back on the compressor electric motor will try to turn but will not be able to and will instead overheat to the point where an automatic overheating switch in newer compressor motors disconnects the power. Once the motor cools down sufficiently the automatic switch reconnects the power and if the pressure in the aeration system is still not low enough the cycle will be repeated. Although the overheating switch gives some protection to the electric motor from the heating, each time it is used shortens the life of the electric motor and the switch itself. If the switch where to fail then the compressor motor would become damaged beyond economical repair.

Dugout aeration systems are run unattended for long periods, and farmers may not always realize if a power outage had occurred or think of inspecting an aeration system after a known power outage. There are several possible solutions to automatically remove the pressure at the compressor exhaust port after a power interruption.

The least expensive solution is to put in a T pipe fitting and a bleed valve between the compressor and the check valve (a check valve should be on the compressor end of the air transmission pipe). Adjust the bleed valve to vent a small amount of air to the atmosphere while the compressor is operating. To make this bleed valve adjustment, operate the compressor until the pressure reaches 10 psi then shut it off; adjust the bleed valve so that the exhaust port pressure goes from pressure of 10 psi to 2 psi in approximately 1 second. At this bleed valve air flow rate the operational compressor efficiency is only reduced 1% to 2%. Higher air bleed rates reduce the aeration system efficiency without significantly increasing the protection for the compressor motor.

Another solution, though having a greater initial, and long term energy cost is to replace the bleed valve with a normally closed solenoid valve. The advantage of this method is that there is no bleed valve to adjust. The disadvantage is that the solenoid valve cost $80 to $100 to purchase and an additional $5 dollars each year it is in energy. This increased energy usage equates to approximately a 5% to 10% aeration system energy efficiency reduction.



ITEM	COST
1 Compressor	$360
1 Check valve	$16
2 Pressure relief valves	$6
1 Pressure gauge	$20
2 Shut off ball valves	$17
1 Shut off valve	$6
Pipe fittings	$25
Total Cost	$450