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WHITE PAPER

Windmill Aeration Systems for Commercial & Recreational Pond and Municipal Sewage Lagoons

Executive Summary

Windmill Aeration Systems are a long accepted method of adding oxygen into standing water facilities. Traditional users are farmers who need clean aerated water for livestock watering and crop irrigation. Commercial fish farmers also use aeration windmills to provide them with aerated water in an economical way. Newer users include rural municipalities who use aeration windmill to oxygenate their sewage lagoons thereby accelerating the degradation process.

As energy costs continue to rise and environmental issues become more critical in the decision making process, the windmill aeration system becomes an increasingly more attractive proposition.

Windmill Aeration Systems

The Practical use of wind

The American Wind Energy Association stated that wind provided 2.3% of American electricity in 2010. Between 2007 and 2010 wind generation capacity has doubled and during that period was responsible for 35% of the new generating capacity.

This expansion is very visual and has made the general public more aware of/receptive to using the wind for practical purposes. The aeration windmill market is sharing in the interest which the turbine windmills have generated.



Koenders Windmills –Regina, SK, Canada

The main functions of an aeration windmill are:

- Inject oxygen into the pond
- Encourage vertical mixing of the water
- Vent off unwanted gases
- Prevent stagnant water

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Problems experienced by the Farmer.

The increasing use of fertilizers ultimately results in the farm pond becoming nutrient enriched, which encourages the rapid growth of algae. The water cannot then be used for irrigation as it blocks the water jets, likewise the farmer is reluctant to let his cattle drink this water.

The traditional remedy for the algae bloom is a treatment of copper sulphate (bluestone), this algaecide rapidly kills the algae and renders the water usable, but the treatment has several unwanted but avoidable side effects:

- The dying algae releases ammonia into the water, making it deadly for fish stocks and unpalatable for livestock
- The decaying algae consumes oxygen from the water and if insufficient oxygen remains in the water then it becomes anoxic.
- The organic matter will sink to the bottom of the pond and reduce its depth. Rehabilitation work done on dugouts has shown that from 1% to 10% of water volume can be lost in a single year (source: Agriculture & Agri-Food Canada 2002)
- Fluctuating oxygen levels between day and night resulting in fish kills

Problems experienced by the Fish Farmer.

They share many of the same problems as the farmer but with the extra complication of additional nutrients in the water due to consumed/unconsumed fish food.

Aeration is an essential component of the business model and represents an ever increasing business cost.

In many communities the unpredictable nature of the electricity supply is a problem and diesel generators are not always a practical alternative.

Windmill Aeration Systems

Problems experienced by the Sewage Lagoon Operator

The typical facultative sewage lagoon operator uses a system of primary and secondary cells. Adequate oxygenation is an essential part of the degradation process. As more people are attracted back to the country by the cottage/acreage lifestyle this places an additional burden on the rural sewage lagoon. New lagoon installations are extremely expensive and communities are very receptive to any method which make their lagoons more efficient



Koenders Windmills – Assiniboia Sewage Lagoon, SK, Canada

Problems experienced by the recreational user

They share the previously mentioned problems but with special emphasis on the use of the water for swimming and fishing. These two activities either preclude or limit the use of chemical, so more nature friendly alternatives are needed in order to maintain and improve the quality of the water.



Windmill Aeration Systems

The Basic Solution

The objective in all cases is to have a water supply which is sufficiently oxygenated for the demand placed upon it, and for that water not to be static:

$$\text{Oxygenation} + \text{agitation} = \text{water quality}$$

Nature will play its part in this equation by providing movement and surface aeration from wave action and rain.

Vertical mixing can also occur naturally and this is called 'pond turnover'. As the surface layer cools down, it becomes heavier and sinks to the bottom. In warmer climates this turnover is quite gentle and leaves the bottom sediment undisturbed. In harsher climates this turnover is vigorous and redistributes the sediment throughout the pond.

Both these scenarios cause water quality problems. In the former, the layer of sediment remains on the bottom and degrades anaerobically (rotten egg smell) and in the latter the sediment decays more rapidly by using the oxygen in the water

$$\text{Mechanical oxygenation} + \text{natural inputs} = \text{water improvement}$$

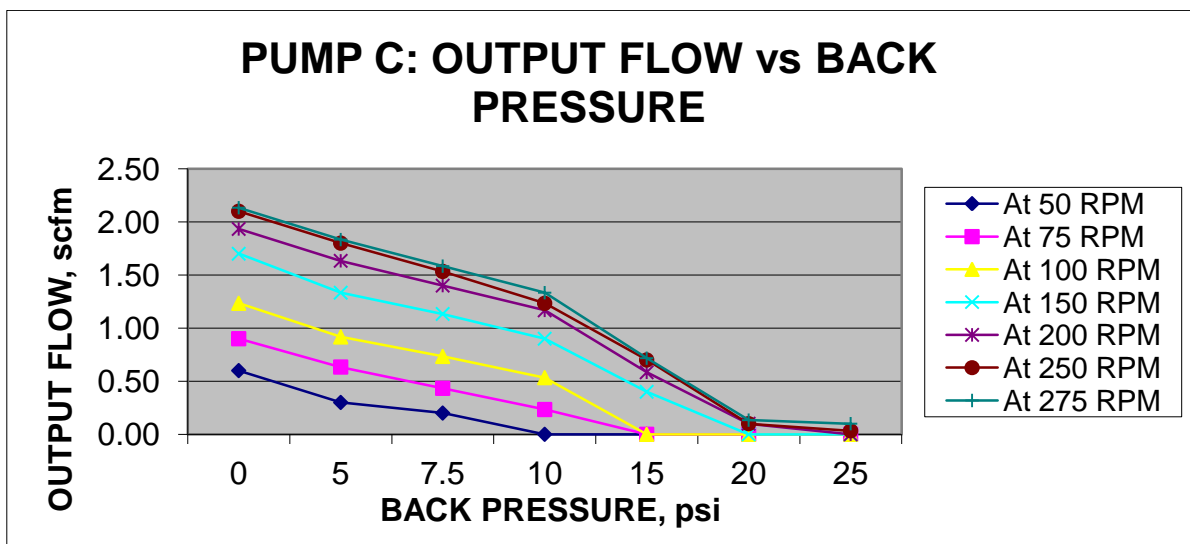
Converting Wind into Compressed Air

Aeration windmills are generally 'self assembled' which precludes the use of taller towers as in wind turbines. Better use therefore has to be made of the lighter winds nearer ground level. It therefore follows that lighter/ smaller volume compressors which are more receptive to lighter winds offer more functionality than their larger competitors.

Windmill Compressor features

Most brands use direct driveshaft + offset cams with a diaphragm pump, some with single stroke compressors and one with a dual stroke compressor.

All compressors are factory rated for maximum CF/Minute (cubic feet per minute), this rating is normally a bench test rating and gives no indication of how that unit will function under real wind conditions and at water depth, both of which will affect the CF/M.



The above graph shows how bench test CFM will diminish rapidly when subject to reduced wind speeds and back pressure caused by water depth.

Windmill Aeration Systems

Competitor Comparisons

A recent study was conducted by a leading Research establishment in Canada and an eminent academic in the field of environmental sciences.

Below is an extract from the report produced by Prof. Gillies. This analysis couples laboratory compressor measurements with actual wind speed patterns purchased from the NOAA, and shows quite clearly that the Koenders Double diaphragm compressor outperforms all others in all wind conditions.

“The Koenders compressors were the most efficient due to their ability to aerate at lower windspeeds than their competitors” Prof. J.A. Gillies B.E. M.SC.(Sask) P.Eng (ret.) FEC.

Compressor model	Average output based on 3 Least Windy States (Cubic feet per month)	percentage of the month windmill aerating
Koenders Double diaphragm	20,913	81%
Koenders Single diaphragm	9,938	81%
OWS Balcam	5,594	15%
American Eagle	357	3%

	Monthly Average windspeed (mph)	% of month with windspeeds 10mph or less
Ashville NC	14.0	51%
Nashville TN	10.0	59%
Huntingdon WV	7.4	71%

Compressor model	Average output based on 4 Windiest States (Cubic feet per month)	Percentage of the month windmill aerating
Koenders Double diaphragm	39,541	93%
OWS Balcam	23,073	43%
Koenders Single diaphragm	19,705	93%
American Eagle	3,683	16%

	Monthly Average windspeed (mph)	% of month with windspeeds 10mph or less
Dodge KS	19.7	20%
Billings MT	16.7	37%
Jamestown ND	17.2	28%
Aberdeen SD	20.2	24%

Windmill Aeration Systems

Conclusions

Aeration windmills have always been valuable tools to help the farmer fight the problems of nutrient rich ponds. A major Canadian retailer to the farm market estimates that only 1 in 10 farmers are currently using windmill aeration.

That appeal has broadened over recent years and the market is continuing to expand in North America.

Increasing interest is being shown by developing Nations as the problems of standing water quality are becoming more pronounced. Escalating fuel costs and availability are making the use of aeration windmills an obvious choice in the fight against deteriorating water quality.

Aeration windmills is a growing segment and provides benefits for businesses, utilities and communities.

About Koenders Windmills.

Koenders Windmills have been manufacturing and selling aeration windmills and water pumps since 1988, with over 50,000 units in operation.

They have an extensive dealership network in USA and Canada and via their websites have sold windmills throughout Europe and the Far East.

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