POLICY AND REPORT ON THE USE OF FINE BUBBLE AERATION TUBING IN MUNICIPAL AERATED LAGOONS IN ALBERTA

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ALBERTA ENVIRONMENT
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POLICY ON THE USE OF FINE BUBBLE AERATION TUBING IN MUNICIPAL AERATED LAGOONS IN ALBERTA

INTRODUCTION:

The attached report was commissioned by Alberta Environment for the purpose of obtaining an independent assessment of a fine bubble aeration technology called "ADS" and the aerated lagoon design concepts/criteria being used in the application of this technology in aerated wastewater treatment lagoons. The report along with data and studies by the Municipal Branch were used to prepare the following policy with respect to the use of this technology in municipal wastewater treatment applications in Alberta.

POLICY:

"ADS" technology for municipal wastewater aerated lagoon systems will be considered capable of meeting Alberta Environment's secondary treatment performance standard provided that

i) a minimum energy input of .5 W/m^3 is provided throughout all aerated cells; and

ii) a Ke value of $0.08d^{-1}$ and design soluble effluent BOD of 15 mg/L is used to size the aerated lagoon system for winter operation; and

iii) sound design practices are followed in the spacing of aeration tubing and in the estimation of oxygen transfer efficiencies and associated blower sizings.

Also in order that all the potential costs associated with this type of system are used when comparing it to other treatment alternatives, the present worth cost of the "ADS" system shall include replacement of all tubing after 10 years of service and HCl cleaning of all tubing on a monthly basis.

Provided the above criteria and approaches are followed, an "ADS" aerated facultative lagoon system will be considered an acceptable method of providing secondary treatment to municipal wastewaters in Alberta.

General and technical background information outlining the basis of this policy is appended.

APPENDIX TO POLICY ON "ADS" TECHNOLOGY

BACKGROUND:

Aerated lagoons evolved originally from overloaded conventional industrial lagoon systems that required artificial aeration to effect aerobic biological treatment. The use of aerated lagoons to treat municipal wastewaters is reported to have started in the early 1960s and is now a commonly employed method of treating municipal wastewaters. In Alberta there were twenty municipal aerated lagoon systems in operation in 1990.

A number of different design approaches and equations for sizing and configuring aerated lagoons and associated aeration equipment have been developed. Two common aerated lagoon design approaches are the "aerated-facultative" and the "complete-partial mix". The design approach used and type of aeration technology employed in aerated lagoons can have significant implications in terms of capital, and operating and maintenance, costs and can also impact performance efficiencies.

In the 1970 and early 1980s a number of aerated lagoon systems were constructed in Alberta using the "aerated-facultative" design concept and employing a perforated tubing diffuser aeration technology called the Air Aqua System. While these systems initially worked well, performance and maintenance problems related to the aeration technology (and also possibly to the kinetic design) eventually occurred with all systems. Therefore, in the mid 1980s, the Municipal Branch of Alberta Environment adopted the position that aerated-facultative lagoons using the Air Aqua System could not be considered reliable systems for municipal wastewater treatment and as such could not be approved for use in Alberta.

In the late 1980s Air Diffusion Systems and a local supplier advised that past problems with the Air Aqua System were due to poor manufacturing practices and that a similar but better perforated aeration tubing had been developed. It was claimed that this new tubing should eliminate many/all of the performance and maintenance problems previously experienced. Reservations still existed regarding this technology since the new aeration tubing was in many ways similar to the old tubing and the general system design concepts were the same. It was therefore decided to get an independent evaluation of both the new perforated tubing diffusers which are called "ADS"and the general "aerated-facultative" design associated with

the "ADS" technology. The report summarizing the results of this evaluation was finalized in November of 1992. Based on this report it was concluded that:

i) the new perforated tubing diffusers ("ADS") and physical system design are superior to the Air Aqua System tubing and should therefore perform better;

ii) the design life of the "ADS" tubing is still questionable; and

iii) the "ADS aerated-facultative" design approach can be used to design a system meeting Alberta Environment's performance/effluent requirements provided that proper design parameters/kinetics are used and provided sufficient mixing is provided.

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On the basis of these conclusions it was decided that an "ADS" aerated lagoon system in municipal wastewater treatment applications would be considered acceptable provided that certain design criteria and approaches are followed.

CRITICAL DESIGN FACTORS:

The critical design factors/approaches that are considered necessary to ensure that an "ADS" system can meet performance/effluent requirements and that a reasonable estimate of the total costs (both capital and O & M) of the system are used when comparing this treatment alternative to others, are as follows:

i) projected design life of the tubing and frequency of cleaning;

ii) the minimum total retention time necessary to ensure that performance/effluent requirements can be met.

iii) the minimum energy input required to ensure oxygen dispersion (fluid mixing); and

Tubing Life and Maintenance - Frequent cleaning and the ultimate need to replace tubing was a major problem with the Air Aqua System. The "ADS" system is too new to draw any conclusions regarding long term maintenance and replacement requirements. When developing cost estimates for this technology it is considered reasonable to assume that once

per month HCl cleaning of the tubes may be required/appropriate and that the tubing has a design life of 10 years after which it will require replacement. These assumptions should ensure that municipalities are aware of all the possible costs associated with the use of this technology over its entire design life. It should be noted that if tubing maintenance and/or replacement is not required as frequently as projected then this is a "bonus" to the municipality.

Total Aerated Lagoon Detention Time - The total amount of detention time required to achieve a certain effluent quality is a function of the strength and nature of the wastewater being treated, temperature and lagoon configuration and mixing. The approach used to design "ADS" systems is considered sound and the major issue or question is the applicability of the design reaction rates used to predict biochemical oxygen demand (BOD) removal efficiencies. Reaction rate (Ke) values in the range of 0.1 to 0.15/day are generally used for aerated-facultative lagoons operating at low temperature and it is reported in the evaluation report that the "ADS" uses a conservative Ke value of $0.10d^{-1}$ for winter operation. Using this Ke value and an influent BOD of 220 mg/L, predicts that 3-10 day cells in series should produce an effluent with a BOD of 25 mg/L which is Alberta Environment's effluent standard for these systems. Thirty days retention in a minimum of two cells is Alberta Environment's minimum size requirement for aerated lagoons. An extensive evaluation by Alberta Environment of an Air Aqua Systems aerated lagoon at Lac La Biche, however, indicates that Ke values during the winter for these types of aerated facultative lagoons may be lower i.e. Ke values for January, February and March (4 data sets) ranged from $0.055d^{-1}$ to $0.08d^{-1}$ based on total BOD in and out and from .07 to $.12d^{-1}$ for total BOD in and soluble BOD out. Based on this data, and the fact that some BOD associated with suspended solids can be expected in the effluent, it is considered appropriate to use a Ke value of $0.08d^{-1}$ for winter operation and design for a soluble BOD in the effluent of 15 mg/L. For an influent BOD of 200 mg/L these design criteria translate to a requirement for 3-17 day aerated cells in series. Should actual operating experience indicate that this design is overly conservative then the design capacity/life of the system will be greater than expected.

Minimum Energy Input - For aerated-facultative lagoons the amount of aeration or energy input is based on factors such as oxygen demand, oxygen transfer efficiency and rates, and mixing considerations. To ensure oxygen dispersion throughout the entire volume of the aerated lagoon a certain minimum energy input is required. Adequate oxygen dispersion is necessary to ensure that the entire volume of the aerated lagoons can provide treatment. While the amount of mixing provided per unit of energy input will be a function of the type

of aeration system, a general design rule is 1 to 1.5 watts of energy input per cubic meter of lagoon volume (W/m^3). The "ADS" system recommends sufficient aeration to provide a fluid turnover time of 15 minutes. This translates to a power input of approximately .35 W/m^3. The "ADS" design approach, however, uses total air input and total aerated lagoon volume to determine whether or not sufficient aeration for mixing is provided. Since the aeration tubing is not equally spaced throughout the aerated cells this approach is not considered appropriate. Therefore, to ensure that sufficient energy is provided for fluid mixing and oxygen dispersion, a minimum of .5 W/m^3 of energy input is considered the minimum that should be provided throughout all aerated cells. It should be calculated by taking the air flow to a section of the aerated lagoon, converting that air flow into the blower horsepower (wattage) required to generate that air flow, and dividing this by the volume of the aerated lagoon receiving that air flow.

CONCLUSION:

The above assessments were the basis for the policy on the use of "ADS" technology in Alberta. It is recognized that these assessments are based on limited data and that as operating data for, and experienced with, "ADS" technology is obtained there will be a need to reevaluate and update the policy.

A REPORT ON FINE BUBBLE AERATION TUBING

Prepared for Municipal Branch, Alberta Environment by

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TABLE OF CONTENTS

SUMMARY AND CONCLUSIONS

SCOPE OF REPORT

This report describes fine bubble aeration tubing, reviews operating experience with it in Western Canada and at selected locations in the United States, and discusses its applicability to Alberta circumstances for use in the aerated lagoon treatment of municipal wastewaters.

BACKGROUND

The history and development of fine bubble aeration tubing in North America is discussed in the report. Currently there are two fine bubble aeration tubing systems being marketed in Canada:

- The Air Aqua aeration tubing system, a modification of the system originally developed by J. Nelson Hinde of Hinde Engineering Co. in the U.S.A., is being marketed by Aer-O-Flo Environmental Inc. of Burlington, Ontario. The Hinde Engineering Co. is no longer in business.

- The newer ADS aeration tubing is being promoted by Air Diffusion Systems - A John Hinde Company, of Lake Bluff, Illinois as a considerably improved version of the original Air Aqua tubing. John Hinde is the son of J. Nelson Hinde. The ADS system is being marketed in Western Canada by Fresh Water Treatment Systems Ltd. of Beaverlodge, Alberta.

Aer-O-Flo Envirnomental Inc. and Air Diffusion Systems - A John Hinde Company are independent of one another.

MANUFACTURER'S TECHNICAL INFORMATION

Manufacturer's technical information supplied by Air Diffusion Systems is reviewed and the following comments are made:

- The recommended design procedure follows a rational approach;

- Technical information on transfer efficiencies measured in a full-scale test aeration tank showed standard oxygen transfer efficiencies increasing from about 15% to 38.5% with increasing depth in the range from 1.5 m to 4.3 m

deep. Extrapolation of these and other data reported for oxygen transfer efficiencies to significantly greater depths, as was presented in manufacturer's data, should not be done.

- The recommended Alpha values in the manufacturer's technical literature used for estimating mass transfer rates in wastewaters are substantially higher than those commonly measured in other fine bubble aeration systems. This could lead to an overestimate of the aeration ability of the fine bubble aeration tubing system.

OPERATING EXPERIENCE

Discussions with the operators of two fine bubble aeration tubing systems in British Columbia, four in Alberta, two in Saskatchewan, and four in the United States have elicited the following comments on their experience:

- A fine bubble aeration tubing system requires much less aerator blower capacity than an equivalent coarse bubble static tube aeration system treating the same amount of wastewater.

- However a fine bubble aeration tubing system requires considerably more attention and maintenance to keep it operational than does a coarse bubble static tube aeration system.

- Early versions of the fine bubble aeration tubing marketed in Canada had skin adhesion problems and were susceptible to deterioration due to ultraviolet radiation from sunlight if stored unprotected outdoors for lengthy periods.

- The fine bubble aeration tubing system has been susceptible to waterlogging which causes decreased air throughput and uneven aeration patterns. Waterlogging occurs during power outages when water can seep into the aeration tubing through the aeration tubing slits that may not properly seal themselves or may be distorted by the coupling joining two butt-end sections of aeration tubing (a new coupling design is available from ADS which minimizes this problem).

- The roller-flexing operation for de-clogging the slits and for squeezing water out of the fine bubble aeration tubing is generally effective in cleaning and de-waterlogging the system but is a very onerous and labour-intensive task.

- Blowing water out the fine bubble aeration tubing by isolating a line, disconnecting one end from a dual header system and pressurizing the tubing from the other header is less onerous and labour intensive. The out-of-water header system developed by ADS provides a convenient means of performing this exercise. While more convenient for the operator, however, the out-of-water header system is susceptible to vandalism.

- Hydrogen chloride (HCl) gas cleaning of the fine bubble aeration tubing is a required maintenance procedure for unclogging of aeration tubing openings. The cleaning frequency will be dictated by experience but it should be done as a preventative rather than a corrective measure. ADS suggests that HCl gas cleanings ever three months should be sufficient. If the tubing openings become extensively clogged, operating and maintenance experience indicates that HCl gassing of the system likely will open up only those slits that are clogged in the length of tubing nearest the header. Once this part of the tubing opens up, the air (and HCl gas) flow passes through it because it is the path of least resistance. Thus it is difficult to free the entire length of an extensively clogged tubing lateral by HCl gassing.

- Concern was expressed over the occupational health and safety aspects of HCl gas cleaning. In addition, operating experience has been that it is very difficult, if not impossible, to perform HCl gas cleaning of the lines during the cold winter months due to the difficult working conditions and freezing of the HCl gas in the gas bottle. Operator training and appropriate personnel protection measures are required.

- Systems in which some form of preliminary treatment was provided seemed to be less prone to fine bubble aeration tube clogging than systems in which no such treatment was provided. Pretreatment measures should include screening and grit removal as a minimum.

- Care must be taken during handling and installation of fine bubble aeration tubing to ensure that the tubing is not "kinked" or this may cause the aeration slits to obstruct and not seal properly after installation.

- The City of Regina's experience has been that the deeper (6.1 m deep) more intensively aerated coarse bubble static tube aeration system is less prone to the development of algae than in the shallower (3.0 m deep) fine bubble aeration tubing system.

RECENT CANADIAN EXPERIENCE WITH ADS TUBING

In June, 1991 a new ADS system was installed in aerated lagoon system in the Town of Caroline, Alberta. To date, the system has performed satisfactorily and has met treated effluent requirements despite the fact that the tubing has been HCl gas cleaned only about once every four months.

In the fall of 1991, the City of Regina in Saskatchewan installed 4,500 m of new ADS tubing in one of several large aerated lagoons in the City's wastewater treatment system. Operating experience to date has been positive and the City is planning to install more ADS tubing this year.

The Town of Chase, British Columbia conducted a preliminary a parallel full-scale trial of new ADS fine bubble aeration tubing and a porous plate fine bubble system. Because of the preliminary nature of the test and the equipment configuration used, the results of the test were inconclusive. The Town's engineer suspects that the tubing delivered for the test was not of the same quality as the small sample length he inspected prior to placing the order.

On the basis of the three recent examples reported above, it is concluded that the new ADS tubing seems to be improved over the older Hinde Engineering Company/Air Aqua technology but that a longer period of operating experience is required before conclusions on its long term viability in terms of materials integrity and susceptibility to clogging and waterlogging can be made. Nevertheless, recent innovations by ADS such as butt welding and the out-of-water header system are definite improvements.

ABILITY TO MEET ALBERTA ENVIRONMENT'S REQUIREMENTS

The Alberta Environment design standards for aerated lagoon design require a minimum of three cells in series as follows:

- A minimum of two aerated cells in series with a combined total retention time of at least 30 days;
- A polishing cell in series with the above with a minimum retention time of 5 days.

In addition, Alberta Environment has established a treated effluent carbonaceous BOD_5 performance standard of not more than 25 mg/L for design populations less than 20,000 and not more than 20 mg/L for design populations greater than 20,000.

In Section 5.0 of the report, a simple first order kinetic mathematical model given in the ADS technical literature is used to predict aerated lagoon treated effluent BOD_5 concentrations using the minimum base case lagoon configuration specified in the Alberta design standards. For winter conditions, the model calculations indicate that the ADS model predicts a treated effluent BOD_5 concentration that is uncomfortably close to the Alberta performance standard of 20/25 mg/L for systems serving a population of more than/less than 20,000. For summer conditions, the ADS model predicts that treated effluent BOD_5 values will be well within the Alberta Environment requirements. A prudent design practice using the ADS model to ensure that treated effluent requirements are satisfied throughout the year would be to determine the aerated lagoon retention time required to produce a treated effluent BOD_5 of say 15 mg/L in order to ensure that lagoon effluent quality is consistently within the required limits year-round. In this case, a total lagoon retention time somewhat larger than the minimum base case configuration specified in the Alberta design standards would be required.

On the basis of two out of three of recent ADS tubing installations in Western Canada, the short-term experience appears to be promising while time will tell for the longer term materials integrity and performance of the system. A fine bubble aeration tubing system requires additional maintenance than does a coarse bubble static tube system to achieve the higher oxygen transfer efficiencies and correspondingly less energy input claimed by the manufacturer. The additional maintenance involves periodic gassing of the system with hydrochloric acid gas and dewatering of the tubing whenever it becomes waterlogged.

SECTION 1.0

INTRODUCTION

1.1 BACKGROUND

Fine bubble aeration tubing system (FBAT) has been employed in aerated lagoons as a means of supplying oxygen for biological treatment. It has also found application in water reservoirs as a means of providing oxygen and mixing to discourage stratification. The system is a "fine bubble" aeration system with claims of economical capital cost, high oxygen transfer efficiencies and corresponding low aeration power requirements relative to other aeration devices used in similar applications.

Over the last decade in Alberta, there has been a decrease in the confidence in the ability of the FBAT system to consistently meet required effluent BOD limits when applied to aerated lagoon treatment of municipal wastewaters. As well, there is concern over the higher than expected level of maintenance required to keep the system operating properly. This increased skepticism has led Alberta engineering consultants to shy away from using these systems in aerated lagoons and at present only one community (Caroline) utilizes a FBAT system for wastewater treatment in Alberta. The community of Bon Accord has fine bubble aeration in their lagoon; however, it is incorporated for odour control only and not specifically considered part of the treatment process.

1.2 PURPOSE OF REPORT

The purpose of this report is to assess the suitability of the FBAT system for treating municipal wastewater in the Province of Alberta. The scope of the report includes:

- A description of the FBAT system as marketed in Canada and the United States;
- A review of selected wastewater treatment systems in Canada and the United States where the FBAT system is in operation;

- A discussion of the ability of the FBAT system to meet current Alberta Environment standards for aerated lagoon facilities. [Reference (3)].

The report has been prepared following a review of technical and promotional information supplied by Freshwater Treatment Systems Ltd. of Beaverlodge, Alberta and Air Diffusion Systems - A John Hinde Co. of Lake Bluff, Illinois. During preparation of the report, discussions were held with the manufactures of the two FBAT systems that have been marketed in Canada - Air Diffusion Systems - A John Hinde Co. (Re; ADS tubing) and Aer-O-Flo Environmental Inc. of Burlington, Ontario (Re; Air Aqua tubing). Contacts also were established with the operators of several FBAT systems in Canada and the United States to solicit comments on their operating experience.

SECTION 2.0

FINE BUBBLE AERATION TUBING DESCRIPTION

2.1 PREAMBLE

A brief history of the fine bubble aeration tubing (FBAT) system, originally developed by J. Nelson Hinde is presented in this section of the report. Also described is the evolution into the two manufacturing companies, "Hinde Manufacturing Ltd." in Canada and "Air Diffusion Systems - A John Hinde Co." in the United States. The differences between the Canadian (Air Aqua) and American (ADS) systems are described.

2.2 HISTORY

The original FBAT system was developed in the 1960's by J. Nelson Hinde who formed the Hinde Engineering Co. in Highland Park, Illinois. J. Nelson Hinde owned the patent (pending prior to 1965 and issued on December 27, 1966). The original system was manufactured as "Air Aqua" and early problems included clogging due to the roughness of the slits (also referred to as check valves and air releases). It is reported that slits were cut using a punch that left a rough burr on the tubing and subsequently entrapped solids. The green polyethylene tubing used originally was not UV resistant and deteriorated if left exposed to the sun.

In 1974, die cuts replaced the original punch. The dies were more like a surgical cut and left no burring so solids were prevented from collecting on the outside of tubing. Thus it was claimed that the die cut technique resulted in a product that was less prone to clogging.

In 1978, J. Nelson Hinde sold the Canadian rights to a group who formed Hinde Manufacturing Ltd. in Hamilton and a trade agreement was established. Hinde Manufacturing Ltd. purchased the dies, used the same tubing and adopted the same technology to manufacture the systems. The tubing was tested in Ontario for oxygen transfer

efficiencies and training was provided by J. Nelson Hinde and his son, John Hinde.

In 1982, the trade agreement expired and J. Nelson Hinde of Illinois no longer had any connection with Hinde Manufacturing Ltd. in Hamilton.

Presently Aer-O-Flo Environmental Inc. of Burlington, Ontario, which amalgamated with the original Hinde Manufacturing Ltd., manufactures and distributes Air Aqua lagoon aeration systems in Canada. Air Diffusion Systems (ADS) was formed by John Hinde in the USA in the mid 1980's as a separate company. For simplicity in this report, the Canadian System will be referred to as Air Aqua and the U.S.A. system as Air Diffusion Systems or ADS.

Air Diffusion Systems (U.S.A.)

ADS evolved from the original Hinde Engineering Co. and is owned and operated by John Hinde and his wife near Chicago in Lake Bluff, Illinois. The recent claims for improvements to the technology and options available with the ADS system include the following:

- Triple cut tube available which consists of slits along the top and both sides of tube at 38 mm (1.5 inch) spacing between slits. More air per unit length of tubing results in less tubing required for the same oxygen transfer. Tubing is still available with the original single cuts along the top at either 38 mm or 75 mm spacing.

- Improvements to the dies for making better quality surgical slits.

- Carbon black LDPE tubing as a standard (UV resistant).

- Development of an "out-of-water header" system for ease of access to service the air diffuser laterals using HDPE butt fused pipe and saddles.

- Optional factory-assembled modular units that can be pre-fabricated to any rectangular configuration with up to 8 aeration lines and 730 m of tubing. Claims that this installation can be made without

INFORMATION PROVIDED BY AIR

EXHIBIT 2.1 - PRODUCT INFORMATION PROVIDED BY AIR DIFFUSION SYSTEMS.

ADS

AIR DIFFUSION SYSTEMS
A JOHN HINDE CO.

28846-C NAGEL COURT • P.O. BOX 38 • LAKE BLUFF, ILLINOIS 60044

"ADS" PRODUCT AND APPLICATION BULLETIN

ADS AERATION TUBING WITH SUPERIOR FACTORY PROCESSED AIR RELEASES:

- The air releases prevent fine silt and foreign material from entry into tubing when air pressure is reduced. As the tubing lies on the bottom in sludge it could allow material to enter the tubing and form into solid particles which can plug the air releases from the inside of the tubing.
- Air releases are designed so that internal pressure is required to open the air releases. Internal pressure is advantageous in that it promotes an even air discharge pattern in uneven lagoon bottoms. Unlike a drilled-hole orifice, ADS die cuts require a slight pressure drop of 0.75 PSI or 1.7 feet of water.
- Factory processed air releases squeeze the air into small bubbles. These almost invisible openings rely on internal air pressure to overcome external water pressure. Polyethylene has a terrific "memory" giving the air releases a very high duty cycle.
- A spacing of 1½ inches between air releases creates a curtain of air which gently rises through the sewage and divides the lagoon into a number of treatment cells. Other systems utilizing point source discharges emit larger bubbles thus decreasing oxygen transfer and tend to lift bottom sediment.

The ADS tubing has transformed from a 0.013" hole to a self closing manufactured air release. After years of experience, it was found that the original 0.013" hole would quickly deteriorate, for the following reasons:

- The open holes allowed silt and sludge to enter the tubing when the system was off. Then as the blowers were re-started, the water was driven out but the dry solids collected on the inside of the tubing. Chunks broken loose by water/air pulsations often completely or partially clogged the holes.
- Holes do not create internal pressure required to make an even discharge of air over the length of the tubing. The tubing was also very susceptible to uneven lagoon bottoms. It was noticed that if a slight internal pressure could be maintained, these problems could be minimized.
- Through the years, research and development with various shaped holes has proven large bubbles yield inferior oxygen transfer rates which double and quadruple power cost to the end user.

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dewatering the lagoon. Improvements to the pipe welding of feeder lines to headers, i.e. fused polyethylene joints, etc., have improved quality. This system is available in a float/sink model.

- Optional assembly available in disk modules which is the same tubing coiled and mounted onto compact square base plates. Claims of easier installation and retrieval for circumstances where dewatering is not allowed or where locations must be changed periodically. These are to compete with static aerators and porous plates.
- Optional use of ozone cleaning system.

Samples of the ADS tubing and connection fittings can be made available upon request.

Air Aqua Systems (Canada)

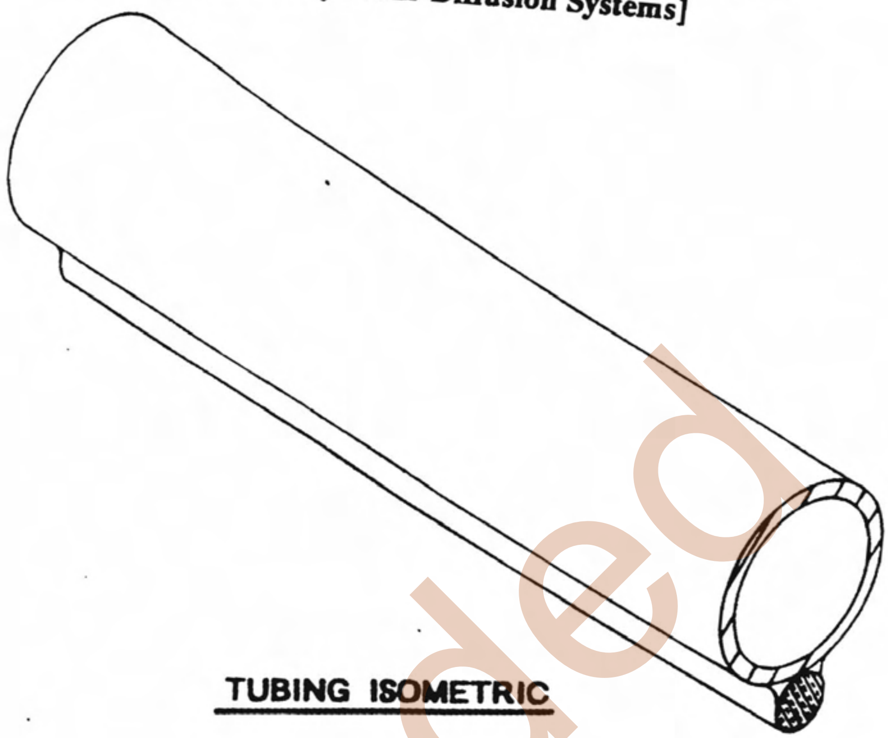
The Air Aqua system is currently manufactured and distributed by Aer-O-Flo Environmental Inc., of Burlington, Ontario which amalgamated with the original Hinde Manufacturing Ltd. (Hamilton). The product has not been developed since it was first produced by Hinde Manufacturing Ltd. and does not presently have any of the above-described improvements and features that ADS has, with the exception that the tubing is available in carbon black.

2.3 ADS AERATION SYSTEM DESCRIPTION

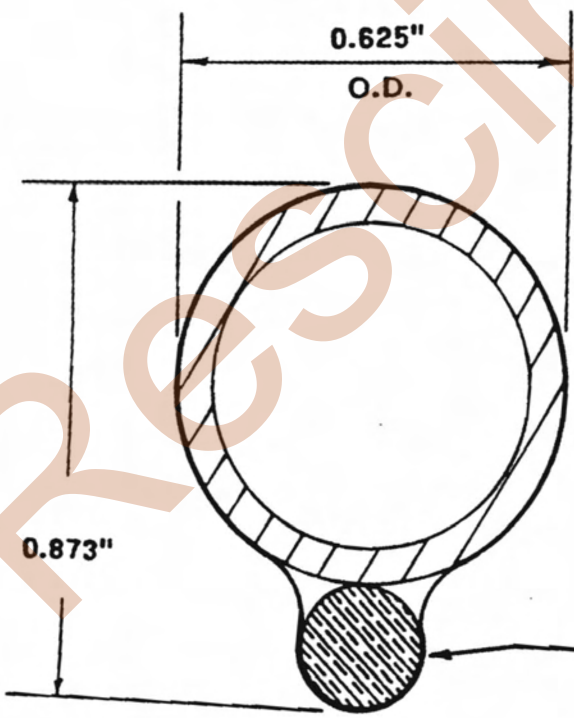
The ADS aeration system consists of a parallel series of lead-ballasted hollow polyethylene tubes 13 mm (1/2 inch) in diameter placed on the bottom of the aerated lagoon and connected by means of a larger diameter header pipe to an air compressor. Die cut slits 9.5 mm (3/8 inch) long and approximately 0.0254 mm (0.001 inch) wide are cut at 38 mm (1.5 inch) spacings parallel to the longitudinal axis of the tubing. The slits provide openings through which the compressed air passes from the tubing to the bulk liquid medium being aerated. The slits are

AIR DIFFUSION WEIGHTED TUBING SPECIFICATION

[Courtesy of Air Diffusion Systems]



TUBING ISOMETRIC



MATERIAL

LOW DENSITY POLYETHYLENE COPOLYM
COMPOUND WITH 2% CARBON BLACK F
ULTRAVIOLET SYABILIZATION

MEETS OR EXCEEDS

FEDERAL SPECIFICATION L-P-3906

REA PE-200

ASTM D1248

SDR 11

0.195" TO 0.198" DIAMETER LEAD KEEI
ENCAPSULATED WITH POLYETHYLENE

CROSS SECTION

AIR DIFFUSION SYSTEMS

A JOHN HINDE CO.

28846-C NAGEL COURT P.O. BOX 38 LAKE BLUFF, ILLINOIS 60044

SECTION 4.0

REVIEW OF EXPERIENCE ON SELECTED FULL-SCALE SYSTEMS

4.1 PREAMBLE

This section of the report reviews the experiences of several owners/operators of full-scale fine bubble aeration tubing (FBAT) systems in Western Canada and at selected installations in the United States. The distinction between installations using the earlier versions of the tubing and the more recent ADS/John Hinde tubing are noted in the text.

4.2 BRITISH COLUMBIA SYSTEMS

Two lagoon systems with Air Aqua fine bubble aeration equipment were investigated in B.C., one in the Town of Chase and the other in the Town of Smithers.

Town of Chase, British Columbia

The wastewater treatment plant in the Town of Chase consists of a two cell aerated (Air Aqua) lagoon system with no pretreatment and effluent discharge to an infiltration chamber. The lagoon treats mainly domestic sewage from the Town, which has a population of 2000 and average flows of 0.8 to 0.9 ML/day.

The Town has experienced operational problems with their 10 year old Air Aqua system and are currently looking at alternatives for retrofitting the system to reduce the amount of maintenance they are experiencing. The main problem has been waterlogging of sections of tubing, which occurs gradually over a period of time when the system is running or more quickly during a power outage. Because of inadequate air flow and pressure to the sections of the waterlogged tubing, the water cannot be purged by the blowers and this has forced the operator to periodically drain the lagoon to expose the headers and physically clean the slits in

the tubing and squeeze the water out of the tubing by roller-flexing. This has deteriorated the 10 year old green tubing to the point where it now has to be replaced.

During initial start-up, there were problems with the aeration system and Air Aqua installed bigger blower motors to produce enough pressure (approximately 75 kPa) to operate the system. The original design pressure (48 kPa) was not adequate to overcome the increased pressure resistance due to water in the tubing and it is now thought that poor quality tubing was the real problem from the beginning (i.e. either the inability of the check valves or slits to seal themselves properly or a skin adhesion problem which would eventually trap solids between the outer skin and the tube).

The weekly gas cleaning costs ($800/month for HCl gas), the labour intensive physical cleaning exercise and the lack of energy savings that were supposed to be realized with the Air Aqua system led the Town to consider other options. Accordingly, the Town conducted a preliminary trial evaluation in the lagoon of the new ADS triple cut tubing operating alongside a porous plate fine bubble aeration system supplied by Environmental Dynamics Inc. While the Chase System was not fitted with out-of-water headers to facilitate dewatering and the scope of the evaluation was limited in nature, it was observed that the ADS tubing under test did not perform much differently than older tubing with respect to its ability to be purged of water after becoming waterlogged. The Town's engineer has indicated that, while the slits cut into the short sample of triple cut ADS tubing provided beforehand were almost invisible, the much larger quantity of tubing that arrived on site for installation in the trial evaluation had slits that were quite visible. As waterlogging continues to be a problem with this new ADS tubing that is installed, it may be that the new tubing is not properly sealing due to defective manufacture or damage since shipment from the factory.

Air Diffusion Systems has since commented on the waterlogging problem as follows:

> "Waterlogging is a term in which water resides inside the tubing mainly due to power failure/system shut-down. Entry of water into the tubing while operating does not occur provided:
>
> a. The equipment was installed as specified.
>
> b. The fine bubble aeration tubing was manufactured and tested to a tolerance of: A minimum air release pressure drop of 0.50 PSI and ± 20% air release uniformity.
>
> c. Lagoon bottoms are level to within ± 3", for earlier Air-Aqua systems and ± 6" for new 0.75 PSI tubing.
>
> d. A grinder and bar screen are installed prior to inlet dumping.
>
> e. The tubing is not buried in sludge, especially at the inlet.
>
> f. No leaks are present and pipes are level and have the proper diameter.
>
> Should one or more of the above items not comply, water could remain inside the tubing. Any system with continual aeration distribution problems must be inspected and retrofitted by a qualified factory service man."

Town of Smithers, British Columbia

The wastewater treatment system in Smithers serves a population of 5000 and consists of a bar screen and grit chamber, an aerated (Air Aqua) primary cell, a final settling cell and final discharge to the Bulkley River. The system was completed in 1983. From about 1988 to 1991, they have been experiencing clogging problems with their Air Aqua tubing which has coincided with effluent BOD limits being exceeded in the warmer summer months. The visible loss of air pattern during this time required the operator to increase the frequency of HCl gas cleaning from an average of once per month to once per week. Very little, if any, improvement in the air distribution pattern in the aerated lagoon was observed. The centrifugal blowers, which are reportedly serviced