ADDITION OF MICRO-X
ANALYSIS ON ITS EFFECTS FOR TREATING WASTEWATER

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1. INTRODUCTION

In September 2007, the City of St-Adele carried out a test aiming at adding bacteria "Micro-X" in the wastewater treatment plant. The addition of these bacteria, according to the supplier, has a marked effect on the quantity of produced sludge by the treatment.

During the duration of the test, Aquatech, Inc., Society of Wastewater Treatment dealt with the analytical follow-up, the compilation of the results as well as the interpretation of the latter. This report/ratio reveals the conclusions drawn from the test.

2. THEORY

The product Micro-X is mainly made up of a mixture of bacteria Bacillus P. These bacteria are especially developed to activate the biological breakdown of suspended solids in various types of organic substrate. The information descriptive of the product is available in Appendix 1.

These bacteria are available as liquid or solid base. They have the capacity to activate once they come into contact with an organic substrate. All bacterial stocks composing the product Micro-X are included on the list of GRAS products (Generally Recognized as Safe) in the United States and on the DSL (Domestic Substance List) in Canada. These bacteria did not undergo any genetic modification. These bacteria are of aerobic type / anaerobic optional. They can therefore develop in more complex mediums and in the presence of nitrates.

These bacteria have an important enzymatic activity which supports the hydrolysis of composed organic present in wastewater. The process of hydrolysis solubilize the organic compounds, making them more easily assimilable by the flora bacterial naturally present in wastewater.

According to the supplier, these characteristics reduce the odors considerably and decrease the quantity of sludge produced by the biological process.

3. METHODOLOGY

3.1. Protocol of Treatment

The protocol of treatment was worked out by the supplier of the product, Cartier Environmental Services Inc. During the ten (10) first days of the treatment (shock), the product was applied by a representative of C.E.S. at the entrance of the wastewater treatment plant.

It should be noted that during the period of shock treatment, dosage applied was confidential. As from the 11th day of the treatment, dosages applied was Micro-X. The dosing of the product was again applied at the entrance of the wastewater treatment plant.

The supplier established dosing according to measured data of the wastewater treatment plant in 2004 and 2005, available in the annual report of Aquatech, Inc. These data are presented in Table 1.

Since the probation period was originally planned for one 60 day duration from April, we calculated the average of the data available in this table from September to November inclusively. For its part, the supplier has more established dosing for a daily flow of 6 050 m3/ D.

By using a calculated dosage, we indicated, in this same table, data used to calculate the dosage of Micro-X to be injected to the flow at the wastewater treatment plant of Saint Adele.

Table 1: Technical information on the wastewater treatment plant of St-Adele is :

	Volume affluent (m3/d)		BOD5 Affluent (kg/d)		SS Affluent (kg/d)	
	2004	**2005**	**2004**	**2005**	**2004**	**2005**
January	5653	5368	400	406	550	378
February	4997	4848	576	365	378	486
March	6346	5253	612	503	616	637
April	6091	8955	548	292	683	419
May	4555	7159	361	379	492	365
June	5796	6286	381	360	426	464
July	5941	5589	602	393	553	439
August	6039	4928	347	523	418	378
September	6300	5895	259	602	407	579
October	5271	6335	400	454	428	648
November	5612	6285	422	455	358	479
December	5404	5904	361	319	382	321
Average*	5 950		432		483	
Calc. Micro-X	6 050		439		491	

* Average of the calculations for 2004 and 2005 correspond to the same treatment period of Micro-X in 2006.

3.2. Analytical Follow-up

During all the probation period, an analytical follow-up was carried out within various stages of treatment. The guarantee of treatment was conditional upon the follow-up of the protocol of treatment and analysis.

Table 2, presents the analytical and operational follow-up applied on a daily basis for the period of injection of Micro-X. This follow-up was carried out by the personnel of Aquatech, Inc. with the equipment available to the wastewater treatment plant of St-Adele.

Table 2: Analytical and operational follow-up at the time of the injection of Micro-X .

Parameters	Affluent	Effluent	Mixed Liquor	Dehydrated Sludge
Daily Flow	X			
BOD5	X	X		
COD	X	X		
SS	X	X	X	
MVES	X	X	X	
Dissolved Oxygen			X	
Siccité				X

3.3. Data Processing

The purpose of the following report/ratio in principal is to evaluate in an objective way the reduction of sludge generated by the injection of the product Micro-X. With this intention, we compared, on the same basis, data of the years under review to the current year for period corresponding to the injection of Micro-X, of September 25, 2006 to January 31, 2007. It should be noted that a first comparison was made for the period of September 25 to November 19, 2006 to validate the supplier guarantee.

3.3.1. Production of Sludge

In order to calculate the production of sludge for a given period (week, period), we first of all estimated the difference of the total quantity of sludge present the system from the beginning to the end of the calculated period. This quantity of sludge is evaluated starting from Equation 1.

Sludge in the system (kg) = Sludge in mixed liquor (kg) **(Equation 1)**

+

Sludge in the decanter (kg)

Sludge present in mixed liquor are calculated starting from the analysis of suspended solids present in mixed liquor and the total volume of the aeration basins (Equation 2).

Sludge present in the decanter are calculated starting from the height of the sludge levels, surface of the decanters and sludge concentration in decanters (Equation 3). Taking into account the unequal bottom of the decanters and one unequal sludge concentration according to the height, it is very difficult to evaluate with exactitude the quantity of sludge present in the decanter. The total surface of decanters is 201 m2. The dryness of sludge in the decanter was fixed at 2 %.

Sludge in Decanter (kg) = Dryness (%) X Surface (m2) X Height (m) X Density (kg / L) X 1000 **(Equation 3)**

To calculate sludge production for a given period, it is necessary thereafter to evaluate the sludge extracted from the system. This parameter is given from mass dehydrated sludge and dryness of dehydrated sludge (Equation 4).

Extracted sludge (kg) = Dehydrated sludge (Ton) X Dryness (%) X 1000 **(Equation 4)**

While using, for a given period, the value of extracted sludge and the difference of sludge present in the system, it is possible to determine the sludge quantity produced for this period (Equation 5).

Produced sludge (kg) = Extracted sludge (kg) + System Sludge **(Equation 5)**

Since it is very difficult to evaluate the daily quantity of produced sludge, taking into account the error caused by the estimate of the quantity of sludge in decanters, we carried out these calculations for all the period of the treatment for a question of precision.

3.3.2. Removal of Contaminants

The removal of the BOD5 was calculated from the concentrations of the BOD5 in the affluent, the effluent and the daily flow. Equations 6 and 7 allow respectively to calculate the load of the contaminant and the quantity of contaminant treated for a given period.

$$\text{Charge contaminant (kg/d)} = \frac{\text{Concentration contaminant (mg/L) X Flow } (m^3/d)}{1\,000} \quad \textbf{(Equation 6)}$$

Charge treated (kg/d) = Charge Affluent (kg/d) – Charge Effluent (kg/d) **(Equation 7)**

3.3.3. Sludge Production Rate

The sludge production rate is what will enable us to evaluate the performance of product Micro-X. This parameter will enable us to compare the results of the years of references compared to the current year by considering the contaminant load in the affluent, effectiveness of the treatment and differences in flow. This parameter is calculated according to Equation 8.

$$\text{Rate production (kg sludge / contaminant kg)} = \frac{\text{Produced Sludge (kg)}}{\text{Charge Treated (kg)}} \qquad \textbf{(Equation 8)}$$

This parameter is calculated over a given period. The larger the period is, the more precise the data is since the margin of error coming from the evaluation of sludge production is reduced.

4. RESULTS

4.1. Average Charge in the Affluent

In this section, we calculate the load in BOD5 in the affluent at the time of the period of injection of Micro-X in order to make sure that this corresponds to the data used by the supplier for the calculation of the dosage of its product.

We make a comparison of the quality of the affluent between the years 2004, 2005 and the year 2006. The objective of this comparison is to make sure that the conditions of treatment between the two years are equivalent since the calculation of the dosage of Micro-X is based on the data 2004-2005.

For the probation period, the flow in the affluent in 2006-2007 was of 7 060 m3/ D comparatively with 5 950 m3/ D in 2004-2006, which represents an increase of 19 %. The average flow in the affluent in 2006-2007 is thus higher by 17 % than the flow used for the calculation of the dosage of Micro-X, fixed at 6 050 m3/ D. For the probation period, the average charge in BOD5 with the affluent was 832 kg / D in 2006-2007 comparatively to 432 kg / D in 2004-2006, which represents an increase of 92 %. This increase in the load appears not very probable taking into account urban development.

By looking at the results in 2006, it seems that loads increased suddenly in October. We assume a technical problem at the time of sampling could explain this increase. For the need of this study, the load used for the period of injection of the product will correspond to average charge in 2005 raised by 7 % (average increase in the load 2005 vs 2004).

4.2. Sludge Production During the Period of Guarantee

In this section, we describe the stages to be followed in order to evaluate the sludge production rate to determine the performance of the treatment with or without Micro-X. This parameter allows a comparison between the years under review for sludge production by considering the contaminant load in the affluent. This total is calculated for the period of guarantee.

The sludge production rate is calculated by evaluating, for a given period, the quantity of sludge produced compared to the treated contaminant load. Quantity of sludge produced by a wastewater treatment process by performing a mass calculation. This mass calculation includes extracted sludge at the dehydration along with sludge present in the aeration basins and decanters.

The extracted sludge from the process are determined from the dehydrated sludge volume on a daily basis at the wastewater treatment plant and the dryness of these sludge (Equation 5).

Sludge in the process (Equation 1) are evaluated starting from sludge present in the aeration basins and the decanters (Equation 3). The quantity of sludge in the basins is evaluated starting from the suspended solids of mixed liquor and the total volume of the basins (Equation 2).

For a given period, we calculate the difference between the end and the beginning of this period. By doing this, it is possible to evaluate the quantity of produced sludge which would not have been dehydrated or which would have been dehydrated in excess compared to the state of the system at the beginning of the test. A positive data indicates a sludge increase in the decanters or aeration basins compared to previous period while a negative data indicates a sludge reduction in the decanters and aeration basins compared to the previous period.

Starting from the results obtained, it is possible to evaluate the total quantity of sludge produced by the process of water treatment used over a given period. Total quantity of produced sludge is calculated starting from the sludge extracted and differentials of sludge present in the aeration basins and the decanters for a given period (Equation 5).

To leave the contaminant load in the affluent and the effluent of the wastewater treatment plant, it is possible to calculate the contaminant load treated for a given period (Equation 7). The contaminant used for the comparison of the results is the BOD5.

In order to be able to compare the sludge production of various years while considering contaminant load of the affluent, we used the relationship between quantity of produced sludge and the contaminant load treated for a given period. We named this report/ratio "Production Rate of Sludge" (Equation 8).

Table 4 presents the whole of these results of 2004 to 2006 for the period of guarantee. (September 25 at November 19, 2006.)

Table 4 : Data allowing us to calculate Sludge Production (September 25 to November 19, 2006)

	Charge Treated BOD5 (kg)	Sludge Mixed Liquor (kg MS)	Sludge in Decanter (kg MS)	Extracted Sludge (kg MS)	Total Sludge (kg MS)	Total Production (kg MS / kg BOD5 treated)
2004	21 259	2 115	2 277	20 840	25 232	1,19
2005	23 543	0	994	22 536	23 530	1,00
2006*	25 095	819	9 810	9 810	16 708	0,67

* Period of injection of Micro-X

Table 5 presents the percentage of sludge reduction for the period of guarantee between the year of injection and the years under review.

Table 5 : Reduction of sludge over the period 2006-2007 compared to the years of reference (September 21 at November 19, 2006)

Period of Comparison	Sludge Reduction (%)
2006 vs 2004	43,7
2006 vs 2005	33,0
2006 vs 2004-2005 (global)	38,5

For the period of guarantee from September 25 to November 19, 2006, using Micro-X, yielded a sludge reduction of about 38,5 % compared to the whole of data of the years under review.

4.3. Sludge Production for the Period of September 25 to January 31, 2007

This section is identical to the preceding section except that the comparison was made over a more prolonged period of September 25, 2006 to January 31, 2007. Table 6 has these results.

Table 6 : Data allowing us to calculate sludge production (September 25, 2006 to January 31, 2007.)

	Charge Treated BOD5 (kg)	Sludge Mixed Liquor (kg MS)	Sludge in Decanter (kg MS)	Extracted Sludge (kg MS)	Total Sludge (kg MS)	Total Production (kg MS / kg BOD5 treated)
2004-2005	47 303	2 934	9 064	47 230	59 228	1,25
2005-2006	54 042	52	2 373	59 004	61 429	1,14
2006-2007*	57 825	1 089	1 839	43 068	45 996	0,80

* Period of injection of Micro-X

Table 7 : Sludge reduction for the period 2006-2007 in comparision to the years in reference (September 25, 2006 to January 31, 2007.)

Period of Comparison	Sludge Reduction (%)
2006-2007 vs 2004-2005	36,0
2006-2007 vs 2005-2006	29,8
2006-2007 vs 2004-2006 (global)	32,8

For the period of guarantee from September 25, 2006 to January 31, 2007, the injection of Micro-X yielded a sludge reduction of about 29,8 % compared to the preceding year. However, the sludge reduction is actually about 32,8 % per report/ratio with the compilation of the whole data of the years under review.

4.4. Costing

This section makes it possible to evaluate the costs of sludge treatment with or without the addition of Micro-X. Costs for the provision and the transport of sludge of the year 2007 will be used by way of reference.

4 . 4 . 1. Costs of Sludge Treatment

Table 15 presents an estimate of the costs of sludge treatment on an annual basis with or without the addition of Micro-X. The load used for the comparison of costs corresponds to the annual load of the raised year 2005 of 7 %. The dosage of polymer for dehydration is 4,8 kg polymer per metric ton of dry sludge. The annual number of bins was estimated starting from a dryness of 16,0 % and of an average of 10,0 tons metric per bin.

Table 15: Costs of treatment of sludge with or without Micro-X.

Parameter	2004-2005	2006-2007 (Micro-X)
Charge (kg BOD5)	62 148	
Produced Sludge	153 665	
- Total Sludge (kg sludge/kg BOD5)	1,19	0,80
- Quantity (kg dry sludge)	182 861	122 932
Polymer		
- Dosage (kg / MT dry)	4,8	
- Quantity of polymer (kg)	878	590
- Cost of polymer ($ / kg)	5,50	
- Total dosage cost ($)	4 829,00	3 245,00
Transportation and Disposal		
- Number of bins	114	77
- Cost per bin ($/benne)	800,00	
- Total cost ($)	91 200,00	61 600,00
Micro-X	0,00 $	8 030,00 *
Annual Total :	96 029,00	69 630,00

* The price 2007 did not include the transport charges. This amount will be adjusted starting 2008 (± $12 000,00)

Starting from the results obtained during the trial period in 2006-2007, the recorded reduction in sludge and annual cost of the product Micro-X, we have concluded that the utilization of Micro-X produced an annual savings of $26 399,00 to the costs associated with the treatment of sludge.

5. CONCLUSION

In conclusion, per a joint venture effort with the supplier, we worked out a protocol of treatment with the product Micro-X at the wastewater treatment plant in the City of St-Adele for an 8 week duration (September 25 to November 19, 2006.) During this period an exhaustive follow-up of various parameters of water quality was carried out. *Upon conclusion of the data analysis, we determined that the sludge reduction using Micro-X was established overall to be 38,5% compared to preceding years.*

We evaluated this sludge reduction starting from a calculation of the mass at the wastewater treatment plant. This calculation takes into consideration the difference in the contaminated load in the affluent of the wastewater treatment plant along with the accumulcated sludge in the treatment process at the plant.

We also evaluated the performance of the product to include December and January. The sludge reduction, compared to past years, for the period of September 25, 2006 to January 31, 2007, was established at 32,8%. In light of these results, we notice that during the winter period, the product is less effective, probably because of the lower temperatures.

According to the costs of transportation and disposal of sludge in the year 2007, cost of polymer, cost of the product Micro-X and the reduction of sludge production has yielded us an annual savings of about $26,000,00. We thus, recommend the continuance of the application of product Micro-X. Review of the product will be conducted on a monthly basis by the Aquatech team to ensure the profitability of the addition of the product is maintained.

APPENDIX 1 : Identification Sheet for Micro-X

1. Identification of the Substance/Preparation and Company/Undertaking.

NAME **Micro-X {BP}**

Synonyms: Bacterial products.
Common uses: Waste water treatment and drain cleaner.
Supplied by: **Cartier Environmental Services Inc.**
Site 14, Box 10, RR1 Edmonton, AB T6H 4N6
Tel: (780) 955-5520, Fax: (780) 955-0250

2. Composition/Information on Ingredients.

Contains: Bacterial Cultures less than 1% by weight.
Blend of naturally occurring ingredients as a carrier including, corn and wheat bran and kelp 99%.

Hazardous ingredient / impurity	% Conc.	Classification	Exposure	CAS	EINECS
NONE					

3. Hazards Identification.

Classification: Bacterial culture non pathogenic.

4. First Aid Measures.

Immediate medical attention is required in case of exposure by inhalation, contact with skin or eyes, or if swallowed.

Exposure Route	Symptom	Treatment
Inhalation	Same as exposure to dust.	Remove from exposure, rest and keep warm. In severe cases, or if recovery is not rapid or complete seek medical attention.
Skin Contact	Redness and irritation	Drench the skin with plenty of water. Remove contaminated clothing and wash before reuse. If large areas of the skin are damaged or if irritation persists seek medical attention.
Eye Contact	Same as dust	Irrigate thoroughly with water for at least 10 minutes. Obtain medical attention.
Ingestion	Irritation of gastrointestinal tract, nausea, diarrhea	Wash out mouth with water. Do not induce vomiting. If patient is conscious, give water to drink. If patient feels unwell seek medical attention.

Immediate Treatment / Antidote: Symptomatic treatment.

Delayed Effects: Bacterial infection.

5. Fire Fighting Measures.

Suitable Extinguishers: Water

Hazardous Combustion Products: None in normal use. Large dust accumulations can be explosive, similar to a grain dust explosion.

Special Equipment for Fire Fighting: Self contained breathing apparatus

6. Accidental Release Measures.

Personal Precautions: Wear appropriate PPE - See Section 8.

Environmental Precautions: The bacteria and carriers are naturally occurring and should not pose an environmental risk.

Clean up Procedure: Vacuum or sweep up avoiding generation of dust. Place in suitable labeled containers and hold for waste disposal. Wash spill site with water. If bacterial contamination is an issue use chlorine to kill the bacillus spores.

7. Handling & Storage.

Handling

Ventilation: Good general ventilation.

Recommended procedures & equipment: avoid creating dust.

Storage

Temperature range: 0 deg C to 40 deg C for product viability only.

Humidity range: less than 40% for long term exposure of unprotected product for product viability only.

Keep away from: See Section 10.

Suitable storage Media: Original container with closed lid.

Precautions against static discharge: recommended.

8. Exposure Controls/Personal Protection.

Exposure standards:

Component	LTEL (8h TWA)	STEL (15 mins)	Type
None			

Personal Protective Equipment:

Respiratory: Dust mask

Hand: Wash hands after use. Gloves recommended

Eye: Safety glasses or goggles recommended.

Skin: Wash after exposure. Overalls and boots recommended

Environmental Controls: Users should be aware of environmental considerations and their duties under the environmental protection act.

Hygiene Measures: Always wash thoroughly after handling chemicals.

9. Physical & Chemical Properties.

Appearance	Tan colored free flowing powder
Odor	Cereal like pleasant
pH	Neutral 6.0 to 7.0 in water dispersion
Boiling Point/range	Not Applicable
Melting Point/range	Not Applicable
Flash point	Not Applicable
Flammability	Not flammable under normal conditions of storage and handling.
Auto-ignition temperature	Not Applicable
Explosive limits	N/A - except in presence of large dust cloud
Oxidizing Properties	Non
Vapour Pressure	Not Applicable
Relative density	0.6 to 0.8

Solubility in water	Not soluble. Disperses in water.
Solubility in solvent	Not soluble
Partition coefficient	Not Applicable
Viscosity	Not Applicable
Vapour density	Not Applicable
Evaporation rate	Not Applicable
Conductivity	Not Applicable

10. Stability & Reactivity.

Stability: Stable under normal storage and handling conditions.

Conditions to avoid: Accumulations of product in enclosed spaces and generation of dust.

Materials to avoid: Acids and Alkalies may inactivate the bacterial cultures.

Hazardous decomposition products: Oxides of carbon.

11. Toxicological Information.

Toxological effects: Low Acute oral toxicity although ingestion will cause irritation of the gastrointestinal tract and may result in nausea and diarrhea. May cause mild mechanical irritation to eyes, skin and mucous membranes. May cause irritation from allergic reaction, especially to people that have a history of allergic reaction.

LD_{LO}

LD_{50} **oral-rat** **skin-rabbit**

12. Ecological Information.

Environmental Effects: Minimal impact under normal conditions of use and storage. The bacterial cultures are naturally occurring soil type organisms. The carriers are naturally occurring materials.

Mobility: Disperses in water.

Degradability: Contents are biodegradable.

Bio-accumulative potential: Not Known

Aquatic Toxicity: Not Known

13. Disposal Considerations.

Substance: Via an authorized waste disposal contractor to an approved waste disposal site, observing all local and national regulations.

Container: As substance.

14. Transport Information. Not regulated for transport.

UN number **Class**
Primary Hazard **Subsidiary Hazard**
Packing Group **Emergency Action Code**
H.I. Number **Marine Pollutant**
Proper Shipping name Waste water treatment compounds, bacterial culture.

15. Regulatory Information.

Label Name	Micro-X {BP}
Symbols	no risk or safety phrases stipulated
Risk Phrases	no risk or safety phrases stipulated
Safety Phrases	no risk or safety phrases stipulated
E.C. No	n/a
Additional labeling:	

Use of this material may be governed by the following regulations: (users are advised to consult these regulations for further information).

The information contained in this data sheet does not constitute an assessment of workplace risks.

16. Other Information.

This material must not be used for direct contact with food.

Further details may be available upon request from your local Cartier Environmental Services Inc. distribution site.

Other: The product has been shown to be free of Salmonella and Shigella (E. Coli) using the procedures outlined by AOAC and USDA.

17. Legal Disclaimer.

The above information in this MSDS was obtained from sources which we believe are reliable. *HOWEVER, THE INFORMATION IS PROVIDED WITHOUT ANY WARRANTY, EXPRESSED OR IMPLIED, REGARDING ITS CORRECTNESS*. **The conditions or methods of handling, storage, use and disposal of the product are beyond our control and may be beyond our knowledge.** *FOR THIS AND OTHER REASONS, WE DO NOT ASSUME RESPONSIBILITY AND EXPRESSLY DISCLAIM LIABILITY FOR LOSS, DAMAGE OR EXPENSE ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE HANDLING, STORAGE, OR USE OF THIS PRODUCT*.