

Use of EM Technology (EM) in water treatment: Urban sewage water treatment plant, a city slaughter house, and a natural estuary in Guayaquil, Ecuador

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Abstract— The following article describes three case studies where Effective Microorganisms (EM) proved to be successful at recovering natural aquatic ecosystems as well as treating sewage and industrial waste water. The first case was at a water treatment plant that received the sewage water from two populated sectors of about 1'100,000 people within Guayaquil, the largest city in Ecuador. The efficacy of EM treatment was compared to an already established water treatment system using electrical aerators. In both cases, pH was maintained at a neutral range after 8 weeks and hydrogen sulfide, main cause of foul odors, was not detected after 5 weeks. The most significant difference was in the cost and used of energy. The second case consisted of treating the facilities of a slaughterhouse processing 1000 animals a day with the objective of reducing foul odors. EM was sprayed in all areas of the facility including floors, pathways, sewers and surrounding areas. Although no measurable parameters were evaluated, workers were interviewed to determine efficacy in reducing foul odors. After 5 months of treatment, employees and foremen agreed that foul odors were reduced almost completely to the point that employees did not feel the need to use masks. In addition, there was a consensus that the working conditions had significantly improved. The third case was the treatment of a natural estuary being contaminated with sewage water. Water samples and sediments were taken from the area receiving sewage water from the city sewage system. The following parameters were evaluated: Acidity, phosphates, organic matter, hydrogen sulfide, total suspended solids, populations of coliforms and salmonella. The results showed a significant decrease in phosphates, total suspended solids, organic matter and hydrogen sulfide, and a reduction in concentration of coliforms. Additionally, pH was maintained at neutral range allowing the proliferation of native life. These experiences demonstrate the versatility and efficacy of EM to mitigate water contamination due to human activities in populated cities.

Index Terms— Sewage water treatment, waste water treatment, Effective Microorganisms, aquatic ecosystems treatment, estuary

I. SEWAGE WATER TREATMENT PLANT

A. Objective

The main objective was to reduce foul odors from sewage water treatment plant, since such foul odors were negatively impacting the lives of those residing in the vicinity.

The concentration of Hydrogen sulfide (mg H₂S/l) was the main parameter measured to evaluate effectiveness. Measures were taken from sediments at the ponds with aerators (aerated ponds) and the ponds with EM treatment (facultative ponds).

B. Results

H₂S concentration

In both cases Hydrogen sulfide concentrations decreased from the first day of every treatment to the fifth day after which foul odors were not detected (Fig 1). The detection limit of H₂S concentrations was 2×10^{-3} mg/l.

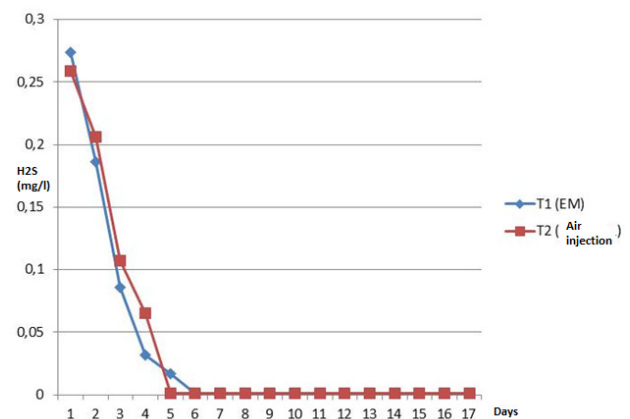


Figure 1. Changes in H₂S concentration over 17 days of application

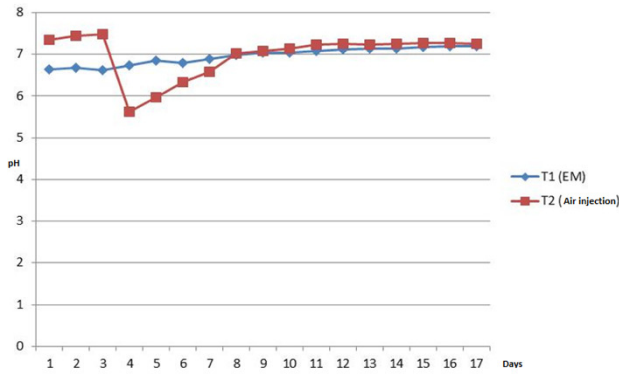


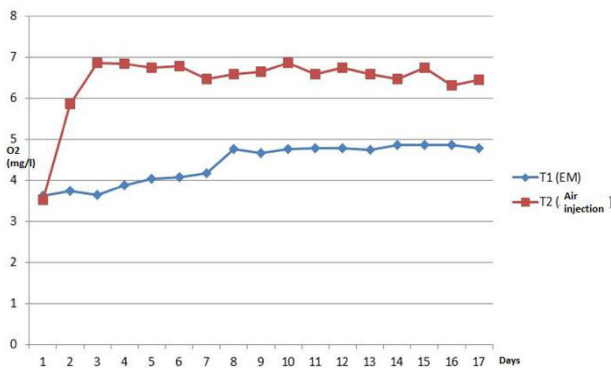
Figure 2. Changes in pH over 17 days of application

pH

Ecuadorian environmental legislation established the limits of water quality parameters that effluents (sewage water after treatment) need to meet before they are released into natural waters (e.g. rivers, lagoons). Within these parameters, acidity levels are acceptable if pH reaches a range between 6 and 9. Regarding this parameter the effectivity of EM treatment was better than aeration treatment because pH was stabilized sooner than the other treatment (Fig 2).

O₂ concentration

Oxygen concentration below 3 ppm are often considered dangerous for most aquatic species. Less than 2 ppm of O₂ is fatal for most fish. After 17 days, aeration treatment (O₂ incorporation to the pond) obtained higher O₂ concentrations (6.4 mg/L) than EM treatment (4.8 mg/L). EM treatment was able to reach an O₂ concentration greater than danger limit, demonstrating the work of microorganisms over organic matter (reducing O₂ consumption in organic matter decomposition).



II. CITY SLAUGHTER HOUSE

A. Objective

The objective was to reduced foul odors that emanate from the facilities of the main slaughter house of Guayaquil, and therefore, improve the work conditions for employees and living conditions from adjacent neighborhoods. The source of the foul odors are manure and urine from animals. This organic waste has been accumulated onto the floor surface over years of operation, making it difficult to remove them by mechanical and chemical means.

B. Methods

Guayaquil slaughterhouse is located at the shore of the Guayas river, the principal river of the city. It is surrounded by houses and commercial venues which makes it impossible to expand. Its relocation is under revision in the medium term.

EM is applied in two ways: spraying through manual and power sprayers and directly in sewage and drainage system during 5 days of every week. Every application is 400 liters of diluted EM (5% of concentration).



Figure 3. Location of city slaughterhouse



Figure 4. EM application in sewage system

C. Results

Workers of slaughterhouse detected that bad odors began to decrease from the fifth day of application. The bad odors were completely controlled after two months of the initiation of EM applications.



Figure 5. Workers wearing necessary equipment before treatment (A), and after 5 days of EM application (B).



Figure 6. Improved work condition is evidenced by workers showing a positive attitude.

III. NATURAL ESTUARY: ESTERO SALADO OF GUAYAQUIL

A. Objective

The objective of the project was to demonstrate the effectiveness of EM as a complementary method to decontaminate the sediments and improve water quality of the “Estero Salado”, a salty estuary of Guayaquil that has a social, environmental and economic importance to the city.

B. Methods

The Estero Salado consists of 600 hectares and it is distributed within the urban perimeter of Guayaquil. For a long time, the Estero Salado received waste water from a variety of industries located on

its vicinities, sewage water, and domestic garbage. That situation generated environmental problems in that ecosystem, including poor water quality.

One of the characteristics of the salty estuary is that the dynamics of the water flow is low. As a result, organic matter accumulates and decays generating foul odors. In addition, there was a high concentration of pollutants such as heavy metals.

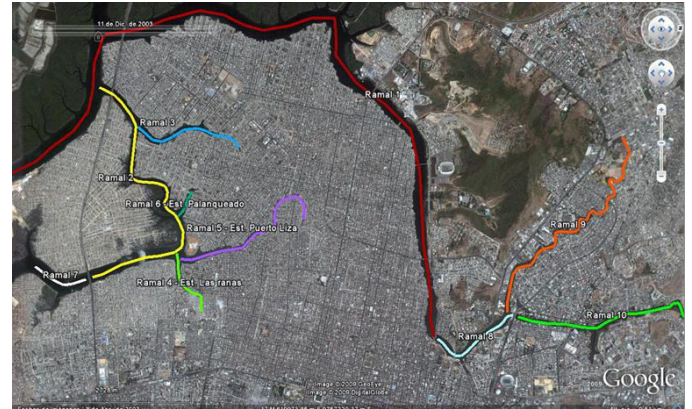


Figure 7. Branches of the Estero Salado that extend through the city of Guayaquil

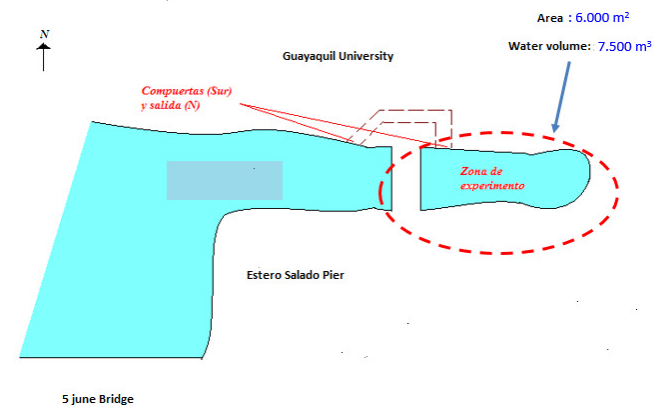


Figure 8. Diagram of the study

C. Results

Table 1. Results obtain from sediment samples.

Parameter	No treatment	EM Treatment		
		Sample 1	Sample 2	Sample 3
pH (wet/dry)	6.5	6.6/7.1	6.8/7.3	6.7/7.2
Phosphate (mg/kg)	20.53	18.69	20.53	6.46
Organic matter (mg/kg)	17.33	16.62	13.95	13.61
Organic carbon (mg/kg)	9.53	9.14	7.67	7.48
Hydrogen sulfide	3.0	3.0	2.8	1.43

(mg/kg)				
Salmonella (CFU/g)	3.0	3.0	2.8	1.43



Figure 9. Sediments before (A) and after (B) EM treatment



Figure 10. Water column before (A) and after (B) EM treatment

Table 1. Results obtain from sediment samples.

Parameter	No treatment	EM Treatment			
		Sample 1	Sample 2	Sample 3	Sample 4
Suspended solids (mg/l)	---	202	30	15	20
Turbidity (FAU/NTU)	---	99	35	25	42
Nitrite (μM)	7.08	2.8	7.0	0.8	0.7
Nitrate (μM)	4.41	3.0	1.2	1	0.77
Sulfate (mg/l)	---	1512.13	200	170	117.01

IV. CONCLUSION

These experiences demonstrate EM is an effective and environmentally friendly technology to solve many problems related to water contamination and foul odors from organic matter decomposition. It is also a significant approach to reduce the environmental impact of human settlements, especially in cities that host a large population.

Furthermore, the implementation of this technology is low cost, without any residual effects or contamination. The use of EM technology has the potential to reduce budgets in environmental sanitation, allowing more resources to be destined to other projects or services that would benefit the communities.

REFERENCES

Consultora Ambiental Ecosambito C. Ltda. EM technology as a complementary method of estero salado descontamination. 2006.

Escuela Superior Politécnica del Litoral (ESPOL). Water quality. Investigation document about oxygen concentration in water. 2007.

Consultora Ambiental Ecosambito C. Ltda. and AGEARTH-Ecuador. EM technology to decrease foul odors from sewage plant treatment of Guayaquil. 2013.

Fabián Castillo experience in EM consulting work.