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APPLICATION OF EFFECTIVE MICROORGANISMS IN TREATMENT OF WASTEWATER OF BEET SUGAR FACTORY AT BILQAS, DAKAHLIA GOVERNORATE, EGYPT

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ABSTRACT

Effective microorganisms (EM) have shown great promise in wastewater treatment. Application of EM technology has been attempted for treatment of industrial wastewater resulted from the Factory of Beet Sugar at Bilqas, Dakahliya Governorate. The results of the present study indicate that Effective microorganisms improve water quality by decreasing; chemical oxygen demand (COD), biological oxygen demand (BOD), nitrates and phosphates, and increasing the total dissolved solids (TDS) with odor control. This improvement has a great environmental and economic impacts. Furthermore, the treated wastewater can be drained in the agricultural drainage system and/or reused in irrigation without any environmental problems.

Keywords: *Wastewater treatment, Effective microorganisms (EM), Beet sugar, Agricultural industries.*

INTRODUCTION

Recently, effective wastewater utilization and management are vital demands. Effluents from the domestic and industrial operations pollute the available fresh water resources. Moreover, the unsanitary drainage of wastewater represents a source to many diseases such as typhoid, cholera and dysentery and hepatitis, and polio, among others. There are many vital treatment methods. Later, biological technologies have emerged for effluent treatment. One of these technologies is the use of effective microorganisms "EM" that is steadily growing in the world. It is a more eco-friendly biological treatment method. The cost effectiveness also plays an important role in deciding for adoption of appropriate technology for effluent treatment.

Effective Microorganism technology is used for sustainable environmental management (Sangakkara, 2002). It uses about 80 strains selected species of beneficial and effective microorganisms such as predominant populations of lactic acid bacteria, yeast, photosynthetic bacteria, smaller quantities of actinomycetes, fermenting fungi and other types of microorganisms. All of these are mutually compatible with one another and coexist in liquid culture (Higa, 1995). EM technology does not involve any chemicals unlike in the conventional effluent treatment system and therefore ecofriendly. These microbes live in the sludge of treatment plants and holding tanks. They digest the solids and breakdown various compounds. Effective microorganisms are economical compared to other chemical and biological treatment (Gopinathan, et al., 2006).

Application of EM to wastewater reduced its toxic effects (Okuda and Higa, 1997). Effective microorganisms (EM) are successfully helping to reduce odors, decrease sludge and improve effluent water quality (Wood, et al., 2001 and Szymanski & Patterson, 2003). Effective microorganisms (EM) play a vital role in digesting the organic matter present in the wastewater (Venkatachalapathy, et al, 2007). EM contain various organic acids due to the existence of microorganisms such as lactic acid bacteria that secrete organic acids, enzymes, and antioxidants (Higa and Chinen, 1998).

There are several major projects that stimulate EM technology in the world, including: EMRO (Effective Microorganisms Research Organization), APNAN (Asia-Pacific Natural Agriculture Network) and INFRC (International Nature Farming Research Center).

Egyptian Ministry of State for Environmental Affairs began to use effective microorganisms in the treatment and purification of wastewater. EM techniques are used in the treatment of sewage in Sadat City (EMRO, 1998), in agriculture and fish farms (Eco Pure, 2003), as well as in the biological treatment of wastewater in the rural sector, Suez Governorate (Ahmed, 2004). Also, the "EM" technique was applied in the east of the Nile Delta as a fruit of cooperation between the Egyptian Environmental Affairs Agency "EEAA" and the Japanese Effective Microorganisms Research Organization "EMRO" (EEAA, 2006 and El-Shahawy, et al., 2009).

The present study deals with the application of EM for the treatment of wastewater of Beet Sugar Factory at Bilqas. It is hoped that such treatment may improve water quality (COD, BOD, TSS, nitrogen and phosphorus reduction) and lead to odor removing and sludge reduction, in addition to environmental and economic factors.

Effluent treatment plant at Bilqas Sugar Factory:

The wastewater treatment plant of Bilqas Sugar Factory is divided into two main phases. The first mechanical phase, which is conducted in settling pond and separator where clear water is reused for washing new Beet and mud and undesirable materials are removed from the wastewater. The second phase is conducted in aeration tank using chemicals (urea and phosphoric acid) by the activated sludge process. It is necessary that microorganisms are supplied with nutrients (Nitrogen-Phosphorus) in a ratio of BOD:N:P = 100:5:1. A urea solution is used as nitrogen source. Phosphoric acid is used as phosphorous source. These chemicals are expensive.

Effluents from the Beet washing circuit, which contain high amount of suspended solids 15:20 g/l in addition to the organic load, are collected in circular clarifier (capacity 800m^3). To remove mud and other solid wastes a grid removal screen is provided where the solid waste removal is done. After sedimentation, clear water from the upper part of the circular clarifier is pumped to washing new Beet. Stagnant water and mud "sludge" are collected in the primary sludge thickener. The sludge consists of 65% water. The sludge removal reduces simultaneously the BOD load of the effluent. Then, the effluents are pumped to the first activated sludge cascade (1800 m^3) that use three mammoth rotors and inoculated with EM solution. Then, they are pumped to another two activated sludge basins (2500 m3), which contain four mammoth rotors in each that use for aeration and mixing, where dissolve atmospheric oxygen into the effluent. After aeration, the EM treated effluent is allowed to settle in a secondary clarifier (3200 m^3) to remove the suspended solids. After settling, clear treated water is drained into El-Aman agricultural drain. The settled sludge is removed periodically by mechanical pump.

The productivity of Beet Sugar will be doubled in the next two years. So, there is too much wastewater for the treatment facility to clean it very well before the water is discharged into El-Aman agricultural drain that drained in the Mediterranean Sea..

MATERIALS AND METHODS

EM application began in March, 2006. Two wastewater samples are collected from the secondary clarifier and four samples from the outlet of the wastewater treatment plant of the Bilqas Sugar Factory before and after addition of EM. Each sample was analyzed in the Lab of the Egyptian Environmental Affairs Agency "EEAA", Mansoura Branch, using standard procedures, described by APHA (1998), for the following; the pH value, biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS) and total nitrogen and phosphate concentrations (Table 1).

Table (1): Chemical properties of wastewater samples at Bilqas Sugar Factory, Dakahliya Governorate, Egypt, compared with the maximum limits for discharge of industrial pollutants in the agricultural drains (AIDMO, 2001).

Ser. No.	Date	Sampling site	EM treatment	The pH value	Pollution indicators (mg/l)					
					COD	BOD	TSS	TDS	NO_3	PO_4
1	First preliminary process on 27/3/2006	Secondary Clarifier	Before	6.68	1703.7	1166.5	11106.6	1600.1	3.88	19.32
2			After	6.54	1622.6	805.9	22379.3	1963.7	0.60	17.96
3		Outlet of wastewater treatment plant	Before	8.35	146.9	99.0	91.8	1430.3	8.70	2.12
4			After	7.70	129.8	88.1	150.4	1460.0	0.33	0.88
5	Secondary process on 3/5/2006		Before	7.10	202.8	125.8	12774.7	1101.6	51.91	10.91
6			After	8.50	122.4	78.9	85.1	1671.6	33.42	1.86
Maximum limits for discharge of industrial pollutants in the water environment "agricultural drains" (AIDMO, 2001).				***6.00-9.00***	***100.0***	***60.0***	***60.0***	***2000.0***	***40.00***	***10.00***

RESULTS AND DISCUSSIONS

Before EM application, the wastewater in the treatment plant was not clear enough and had a very bad odor. However, during EM application, turbidity decreased and the odor nearly disappeared. The amount of chemicals needed when applying EM is significantly reduced.

The results are preliminary because the process has just begun. Based on these preliminary data, there was not any significant change in pH value throughout the course of the treatment process (Table 1). Several days after initial treatment, significant reduction in odor was achieved (Mahmod Nor El-Din, 2009 pers. comm.). An improvement in transparency as a result of reduction of total suspended solids (TSS) content during the secondary process, also a drop in the levels of chemical oxygen demand (COD) and biological oxygen demand (BOD) is recorded. It is also concluded that EM techniques are successfully helping to decrease nitrates and phosphates concentrations with an slightly increase in total dissolved solids (TDS) at the wastewater treatment plant of the Bilqas Sugar Factory (Fig. 1, 2 & 3). Although this improvement, the effluents of the factory into El-Aman agricultural drain is higher than the maximum limits for discharge of industrial pollutants in the water environment "agricultural drains" (AIDMO, 2001).

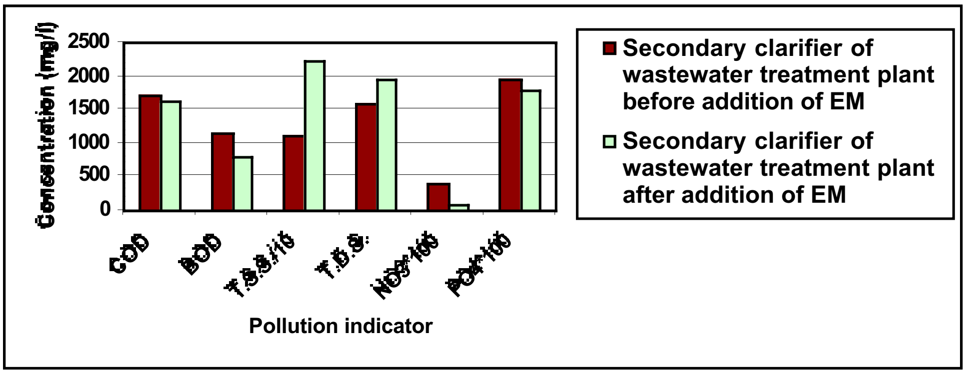

Fig. (1): The results of analyses for samples from the secondary clarifier of the wastewater treatment plant of Bilqas Sugar Factory before and after addition of EM, on 27/3/2006.

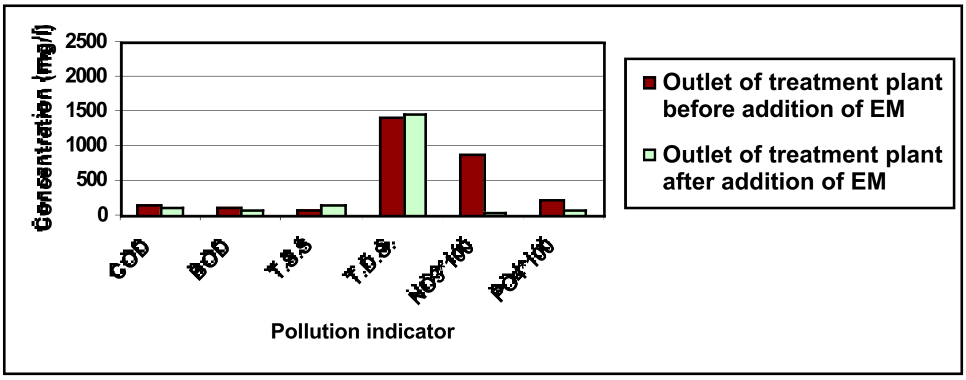

Fig. (2): The results of analyses for samples from the outlet of the wastewater treatment plant of Bilqas Sugar Factory before and after addition of EM, on 27/3/2006.

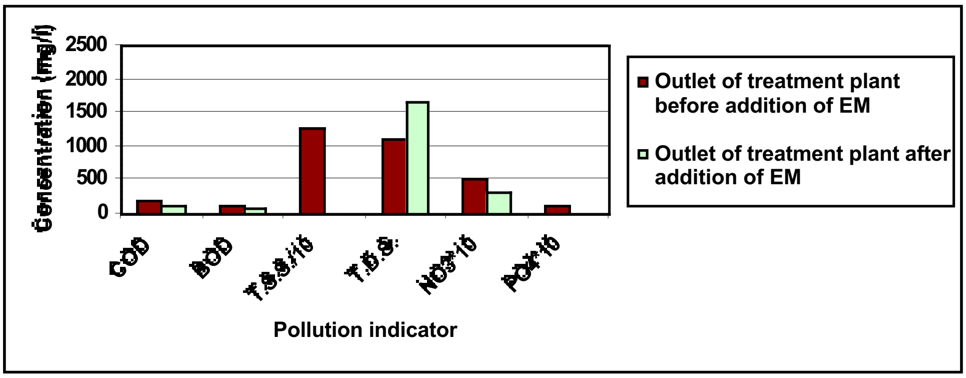

Fig. (3): The results of analyses for samples from the outlet of the wastewater treatment plant of Bilqas Sugar Factory before and after addition of EM, on 3/5/2006.

EM technology is a more efficient method to reclaim the wastewater of the Bilqas Sugar Factory. It solves problems of odor and water quality (BOD, COD, TSS, "Mahmod Nor El-Din, 2009 pers. comm.", nitrates and phosphates) by managing the microbial ecology of the wastewater. After EM application, worms growth phenomena disappeared at the end of work season, in addition to a considerable improve in sludge properties (Moahamd Saad, 2009 pers. comm.). Moreover aeration time can be reduced compared to the previous treatment process. This improvement has environmental and economic significances.

CONCLUSION

In Beet Sugar Industry, implementation of EM technology can improve wastewater quality, due to physical, chemical and biological improvement of effluent water quality, and decrease the cost of purification. Further studies using EM should be conducted with purpose of achieving more ecofriendly and economically wastewater purification process.

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الملخص العربى

استخدام الكائنات الدقيقة النافعة فى معالجة مياه صرف مصنع سكر البنجر فى بلقاس محافظة الدقهلية، مصر

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أظهرت تكنولوچيا الكائنات الدقيقة النافعة ("Effective Microorganisms "EM) تقدماً كبيراً فى معالجة مياه الصرف، وقد تم تطبيق تكنولوچيا "EM" كمحاولة لمعالجة مياه الصرف الصناعى الناتجة عن مصنع سكر البنجر ببلقاس، شمال محافظة الدقهلية، وتشير نتائج الدراسة الحالية إلى تحسن نوعية المياه نتيجة لاستخدام تقنية الكائنات الدقيقة النافعة (EM)، عن طريق خفض نسبة الأكسجين الكيميائى المستهلك (COD) والأكسجين الحيوى الممتص (BOD) وخفض العكارة والمواد الصلبة العالقة (TSS) خاصة فى المرحلة الثانية من التجربة، وكذلك خفض النترات والفوسفات، وزيادة طفيفة للمواد الصلبة الذائبة (TDS) مع إختفاء الرائحة، هذا التحسن فى مؤشرات التلوث له آثار بيئية واقتصادية كبيرة، علاوة على ذلك، فإن المياه المعالجة يمكن صرفها على نظام الصرف الزراعى أو إعادة استخدامها فى الرى دون أى مشاكل بيئية.

الكلمات الرئيسية : معالجة مياه الصرف، الكائنات الدقيقة النافعة، سكر البنجر، الصناعات الزراعية.

JOESE 5

APPLICATION OF EFFECTIVE MICROORGANISMS IN TREATMENT OF WASTEWATER OF BEET SUGAR FACTORY AT BILQAS, DAKAHLIA GOVERNORATE, EGYPT

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