

# **EM Technology Application in Vietnam and Some Results in Environment Treatment**

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***Abstract :** Since May 1997, EM technology has been applied in different domains. A study at national level entitled “Research, Testing and Application of EM Technology in Agriculture and Environmental Sanitation” has been worked out and implemented since January 1998 by the Hanoi Agricultural College under the guidance and supervision of the Ministry of Science, Technology and Environment. The results of the study will be used for demonstrating the effectiveness of EM technology in crops, animal husbandry and environmental protection, and will be used as a basis for the extension of EM technology in Vietnam.*

*The study has been conducted with 18 experiments related to micro-organisms of EM, effect of EM on different crops such as rice, maize, soybean, vegetables; on domestic animals such as poultry, swine, in plant protection, production of fertilizer, treatment of waste and garbage, and seeking the adverse aspects of EM.*

*The Hanoi Agriculture University while conducting this study has collaborated with the Hanoi National University, the Plant Protection Institute, the Institute for Agricultural Science, the Veterinary Institute (within the Ministry of Agriculture and Rural Development), the Institute for Industrial Chemistry (within the Ministry of Industry), the Vina-Nichi Center for Technology Development (within the Ministry of Science, Technology and Environment). Besides, some provincial Departments of Science, Technology and Environment and other research institutions have also participated in the study.*

*Each participating unit conducts some experiments. The success in 1998 was very satisfactory, especially in the treatment of solid and liquid wastes for environmental protection. Some results of EM application in treating solid and liquid wastes in Vietnam are presented in this report.*

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**Introduction** The Effective Micro-organisms (EM) technology, initiated by Prof. Dr. Teruo Higa working in Ruykyus University in Okinawa, Japan, has been put into application since 1980. Until now, this technology has been applied in a lot of countries and is considered as an effective solution for

developing a sustainable agriculture, increasing the quantity and quality of cropping and animal husbandry products as well as for treating solid and liquid waste and improving environmental sanitation.

Vietnam got access to EM technology since 1994 – 1995, through South Korea and China. But until April 1997, after the visit of Prof. Dr. Teruo Higa to Vietnam and the signing of Memorandum of Understanding between him and Prof. Dr. Chu Hao, Deputy Minister of Science, Technology and Environment, this technology became officially and widely applied in cultivation, animal husbandry and environment treatment.

Since January 1998, the Ministry of Science, Technology and Environment has decided to carry out an independent national scientific study : “Study, test and acceptance of EM technology in agriculture and environmental sanitation”.

Until now, the study has brought about a lot of good results, especially in the treatment of pollution, reduction of pollutants such as municipal solid waste (MSW), waste water from residential quarters and industrial enterprises.

The present report will focus in presenting some initial results of using WM for treating garbage, hospital waste and slaughtering house wastes in Hanoi Capital.

**Materials  
And  
Methods**

**Application of EM Technology in Vietnam**

**Preliminary Stages of Development**

Since May 1997, EM Technology has been applied in Vietnam. The basis for developing EM technology in Vietnam are : -

- The document signed on 28/04/1997 between the Ministry of Science, Technology and Environment of Vietnam represented by Prof. Dr. Chu Hao and Asia Pacific Natural Network (APNAN), EM Research Organization (ERO), Okinawa, Japan, International Nature Farming Research Center (INFRC), ATAMI, Japan organizations represented by Prof. Dr. Teruo Higa.
- The assignment of the Ministry of Science, Technology and Environment for applying EM technology. Application included the following :-
  - The Vina-Nichi Center for Technology Development, within the Ministry of Science, Technology and Environment.

- The Hanoi Agriculture College No. 1, within the Ministry of Education and Training.
- The Applied Microbiology Center, under the Hanoi National University, within the Ministry of Education and Training.
- The Plant Protection Institute, within the Ministry of Agriculture and Rural Development;

The programme of EM technology application in Vietnam was implemented in three years from 1997, with two main orientations, namely, (i) to study, test acceptance of EM Technology and (ii) educate, train, and disseminate EM technology.

During the implementation of the program, since 1997 until now, the Vietnam side has received extremely valuable assistance from APNAN, EMRO and INFRC organizations, including: preparation of EM in Vietnam, creation of conditions for Vietnamese scientists and technicians to practice EM technology in Thailand and participate in international seminars in nature farming and EM technology. Due to this assistance, the Vietnam side has promoted the application of EM technology in different domains of agricultural production and environmental protection.

### **National Project**

The Ministry of Science, Technology and Environment launched a national research project titled “Study, test and acceptance of EM technology in agriculture and environmental sanitation”, with the Hanoi Agriculture College No. 1 as monitor of the project.

Seven institutions have joined together in the implementation of the project namely:

- Hanoi Agriculture College No.1, within the Ministry of Education and Training.
- Hanoi National University, within the Ministry of Education and Training.
- Hanoi Agriculture Science and Technique Institute, within the Ministry of Agriculture and Rural Development.
- Plant Protection Institute, within the Ministry of Agriculture and Rural Development.
- Veterinary Institute, within the Ministry of Agriculture and Rural Development.
- Chemical Industry Institute, within the Ministry of Industry
- Vica-Nichi Center for Technology Development, within the Ministry of Science Technology and Environment.

Researchers have conducted 18 experiments which are classified into the following groups :

1. Studies of main species of micro-organisms available in EM product.

This group has carried out the following experiments :

- Main species of micro-organisms available in EM.
- Conservation and multiplication of micro-organism strains in EM
- Preparation of EM solution mixed useful micro-organisms and micro-organisms of Vietnam
- Studies of EM influence upon useful micro-organisms and micro-organisms available in the root system of crops

These studies have been carried out by :

- Hanoi National University, Ministry of Education and Training
- Hanoi Agricultural Science and Technique Institute, Ministry of Agriculture and Rural Development.

2. Studies of using EM product in environmental protection :

The following two experiments were carried out by the second group :-

- Using EM in treating solid waste : burying and processing garbage into organic compost.
- Treating waste water discharged from hospitals and enterprises.

These studies have been conducted by :

- Vina-Nichi Center for Technology Development, within the Ministry of Science Technology and Environment
- Hanoi Union of Biology Associations
- Chemical Industry Institute, within the Ministry of Industry
- Hanoi City Urban Environment Company
- Hochiminh City Consultation Center for Technology and Environment.

3. Studies of EM efficiency on crops :

The emphasis in these studies was to examine EM efficiency on rice, corn, soybean and some vegetables (cabbage, carrot, tomato, cucumber).

These studies have been carried out by :

- Hanoi Agriculture College No1, Ministry of Education and Training and
- Plant Protection Institute, Ministry of Agriculture and Rural Development.

4. Study of EM impact on pests and diseases:

These studies have been conducted by :

- Plant Protection Institute, Ministry of Agriculture and Rural Development and
- Department of Plant Protection of Vinh Phuc, Da Nang, Ha Nam Ninh and Khanh Hoa province.

5. Studies of EM effect in animal husbandry and veterinary:

These studies have been conducted by :

- Veterinary Institute, Ministry of Agriculture and Rural Development and
- Hanoi Agriculture College No1, Ministry of Education and Training.

Results from these studies have shown that :

- Elements harmful to people and animal were not found in EM.
- EM has positive effects. It can raise the yield of food crops, vegetables and beans. Using EM may reduce the use of chemical fertilizers and insecticides and may shorten the vegetation period of crops.
- The effect of EM in restricting diseases of rice is rather obvious, but it is not so clear in other crops such as vegetables. However, the yield of crops applied with insecticides is equivalent to that applied with insecticides.
- EM has positive effects on domestic animals. It can accelerate the growth of animals, control some diseases and improve hygienic conditions of stables, pigsties and animal husbandry farms.

- EM has an obvious effect in the treatment of urban garbage and transformation of it into organic fertilizer. Odours, putrid smell and flies decrease. The quality of manure produced from garbage is much better.
- EM is very effective in the treatment of waste water, especially waste water discharged from tanning factories, paper plants, sugar refineries and slaughtering houses and hospitals.

## **Education and Training in EM Technology**

### *Overseas training*

With the assistance of Prof. Dr. Teruo Higa, APNAN organization and the Saraburi Training Center for EM technology in Thailand, two groups including 45 Vietnamese scientists and technicians were sent separately in September 1997 and July 1998 to be trained in EM technology in the Saraburi Center.

### *In-country training*

From June 1997 until now, on the average every month a training course on EM technology has been organized for about 20-30 trainees who are engineers, practitioners of this technology in different localities. These trainees subsequently become trainers for other people to understand and apply EM technology. At present, thousands of people have accessed this technology and applied it in different domains of different sizes nationwide.

The EM technology is particularly applied in the treatment of garbage, waste water, stables and pigsties.

## **EM Technology Application for Treating Solid and Liquid Wastes in Vietnam :**

### **Experiment 1 : Application of EM technology in treating garbage treating buried garbage**

EM secondary solution was prepared from 1 liter EM1 + 6kg molasses + 93 liters of water. 1 liter of secondary EM was diluted 500 times to be sprayed on garbage.

EM Bokashi :

Compost produced from garbage fermented by EM

Compost : 780 kg (78 percent)  
Rice bran : 150 kg (15 percent)  
Molasses : 70 kg (7 percent)

If there was no compost, EM Bokashi was produced from :

Sawdust : 60 kg (60 percent)  
Rice bran : 40 kg (40 percent)

Technological procedure of burying garbage :

+ Levelling and pressing garbage with caterpillar bulldozer for achieving a density of 550-700 kg/m<sup>3</sup> spraying EM solution on garbage with a proportion of 5 ml EM1/ton of garbage.

+ After each layer of garbage of 0.8 – 1.0 m thickness, a layer of EM Bokashi was spread with a proportion of 0.1kg/m<sup>2</sup> then garbage was covered by a 10cm thick layer of soil.

Experiment was conducted according to a comparative method, between garbage with treated EM and garbage without EM treatment as the control.

Vietnam's 1995 environment standards 5937 and 5938 were used for comparison.

## Results Experiment 1

The values obtained in the comparative experiment anaerobic fermentation with and without EM treatment are given in Table 1.

**Table 1. Gas Contents in Experimental Garbage Basins (24M3) (Anaerobic Condition)**

Date of Measurement	Method	Gas Contents (mg/m <sup>3</sup> )			
		CO	SO <sub>2</sub>	H <sub>2</sub> S	CH <sub>4</sub>
6/9/1998	Without EM	0.2	3.76	0.36	1.08
	With EM	0.2	3.10	0.26	1.04
15/9/1998	Without EM	0.39	0.20	0.52	0.057
	With EM	0.28	0.20	0.15	0.015
24/9/1998	Without EM	0.10	0.10	0.12	0.02
	With EM	not detected	0.05	not detected	0.007
23/10/1998	Without EM	0.10	0.080	0.20	0.02
	With EM	not detected	not detected	not detected	0.005

There was an obvious reduction of flies and mosquitoes in the dump treated with EM.

- The figures in Tables 1 and 2 show that stinking and harmful gas discharged from garbage treated with EM decreases obviously compared with before the EM treatment, and meet the requirements set by Vietnam's 1995 Environment standards 5937 and 5938.
- Economically, the advantage of EM treatment alone (lime and insecticides are not used) is a saver of 3,150 Vietnam dong (VND) per ton garbage treated in Hanoi.

### **Experiment 2 : Application of EM in Processing Garbage into Compost:**

The flow diagram of processing garbage into compost is given in Fig. 1.

The application of EM was as follows;

- When garbage was collected to the enterprise, diluted solution was sprayed to eliminate odour (a part of the garbage may be fermented in the anaerobic condition). Thus workers can select garbage by hand in hygienic and better conditions. Garbage is kept for one day before the selection.
- After grinding, garbage was mixed with excrement taken out from septic tanks (having been treated with EM), EM solution is sprayed 13 liters for 1 m<sup>3</sup> of garbage, ensuring the moisture of 40 percent keeping thus for 3 days.

### **Results**

The following are figures obtained in the comparative experiment of aerobic fermentation with and without EM treatment.





**Table 2. Analysis of Gas Environment in TAY MO Dump (February 1998)**

Date of Measurement	Site of Measurement	Lot No.	CO <sub>2</sub> (mg/m <sup>3</sup> )	SO <sub>2</sub> (mg/m <sup>3</sup> )	H <sub>2</sub> S (mg/m <sup>3</sup> )	Suspended Dust TSP (mg/m <sup>3</sup> )	CH <sub>4</sub> (mg/m <sup>3</sup> )
18/2/98	Fresh garbage not yet treated with EM	1	2.440	0.2824	0.772	2.886	Not detected
		2	2.397	0.2105	0.757	2.652	-
		3	2.838	0.2176	0.824	2.230	-
		4	2.120	0.2090	0.880	1.858	-
		5	2.956	0.1988	0.536	1.206	Not detected
		Average	2.550	0.2360	0.754	2.166	-
18/2/98	Garbage treated with EM	1	1.137	0.0132	Not detected	0.192	Not detected
		2	1.040	0.0146	-	0.192	-
		3	1.496	0.0120	-	0.190	-
		4	1.180	0.0120	-	0.194	-
		5	1.328	0.0440	-	0.192	-
		Average	1.236	0.0192	-	0.192	-
Vietnam Standards 5937 and 5938 1995	Tolerable concentration in living quarters (mg/m <sup>3</sup> )	Not regulated					
		- Maximum in each time			0.5	0.008	0.3
		- Average day and night			0.3	0.008	0.2
Environment Standards of MOSTE 1993	Tolerable concentration in production areas (mg/m <sup>3</sup> )		1 %	20	10	76	

**Table 3 . Gas Contents in Experimental Garbage Basins (Aerobic Condition)**

Date	Method	Gas Contents (mg/m <sup>3</sup> )				
		CO	CO <sub>2</sub>	NO <sub>x</sub>	SO <sub>2</sub>	H <sub>2</sub> S
6/9/98	Without EM	4.5	121.6	0.14	1.23	0.27
	EM treatment	3.6	503.8	0.08	1.0	0.25
15/9/98	Without EM	0.59	421	0.056	0.45	0.29
	EM treatment	0.23	270.7	0.012	0.23	0.15
24/9/98	Without EM	0.12	199.0	0.029	0.25	0.03
	EM treatment	not detected	177.0	0.010	0.06	0.01

**Table 4. Analysis of Air Environment in the Enterprise (January 1998)**

Measurement Site	Lot No.	CO <sub>2</sub> (mg/m <sup>3</sup> )	SO <sub>2</sub> (mg/m <sup>3</sup> )	H <sub>2</sub> S (mg/m <sup>3</sup> )	Suspended Dust (mg/m <sup>3</sup> )
Garbage Fermentation House	1	2.265	0.1093	2.381	0.612
	2	2.310	0.1071	2.086	0.257
	3	2.243	0.1079	0.726	0.215
	4	2.235	0.1080	2.342	0.359
	5	2.278	0.0997	2.346	0.472
	Average	2.266	0.101	1.976	0.383
Garbage Classification	1	2.291	0.1029	2.378	0.572
	2	2.239	0.1447	0.909	0.567
	3	2.204	0.1269	0.723	0.210
	4	2.175	0.0855	0.726	0.471
	5	1.727	0.1048	2.358	0.485
	Average	2.127	0.1130	1.419	0.461
Other Localities in the Enterprise	1	2.131	0.1388	2.381	0.301
	2	1.906	0.0681	2.086	0.316
	3	1.936	0.0725	2.079	0.324
	4	1.801	0.0647	0.904	-
	5	1.839	0.0789	0.453	-
	Average	1.923	0.0850	1.581	0.314
Environmental Standards MOSTE 1993	Tolerable concentration (Volume) in the production area (mg/m <sup>3</sup> )	1%	20	10	76

**Table 5. H<sub>2</sub>S Content in Tank 1 with and without EM Treatment**

<b>Analyzed</b>	<b>Direct perception</b>	<b>H<sub>2</sub>S Content (mg/1)</b>
Input Waste water before EM application	Stink and putrid smell	4.25
Input Waste water after EM application	Less stink and putrid smell	1.7
Input Waste water before EM application	Without stink and putrid smell	0.255
Input Waste water after EM application	Without stink and putrid smell	0.17

Stinking and harmful gases have been decreased in the factory. The concentration of these gases in the production area is lower than the tolerable environmental standards regulated by the state of Vietnam.

The fermentation period in aerobic condition of garbage basin has reduced from 29 days to 13 days. The compost processed from fermented garbage and treated with EM is supplemented with useful micro-organisms.

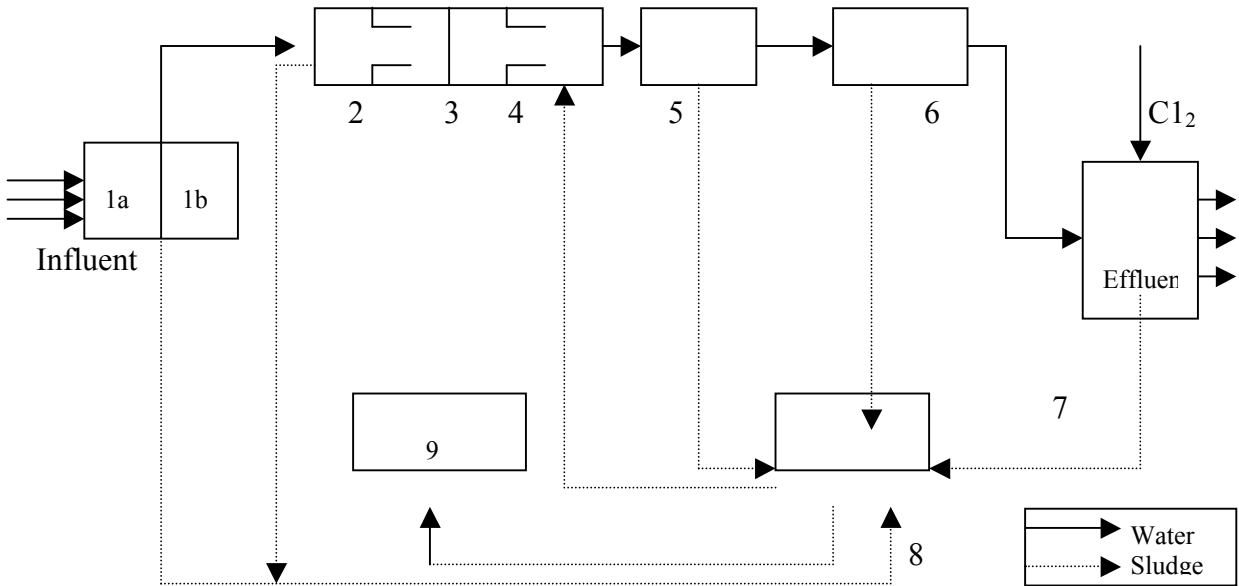
Economically, the using of EM has reduced the total expenses for producing 1 ton compost by 46,875 VND.

### **Experiment 3 : Treatment of Hospital Waste Water**

We have conducted the tests of EM for treating liquid waste discharged from Bach Mai hospital. This is a unique hospital in Hanoi where a system for treating waste water has been built. It is shown diagrammatically in Fig. 2.

This waste water treatment system functions following the activated-sludge method. However, there exist some weak points :

- Much stink and putrid smell exhale from the first tank
- In tank 7, Cl<sub>2</sub> is used. When Cl<sub>2</sub> is put in, HClO is formed and the oxidation of important organic matters will cease the vitality of cells, at the same time produce trihalogen methane which is very toxic for people. On the average every day 400 cubic meters of waste water of Bach Mai hospital flow into tank 1. EM secondary (5 percent EM1: 5 percent molasses: 90 percent water) is put into the second compartment of tank 1 with the proportion of 1/1000.



**Fig. 2. Diagram of Bach Mai Hospital's Waste Water Treatment System**

1. Waste water collection tank (composed of 2 compartments with a primary treatment process).
2. Water tank for containing water pumped from the first tank
3. Trough system
4. Treatment tank (with 2 big aerators)
5. Settlement tank
6. Filtering tank
7.  $Cl_2$  aeration tank
8. Sludge pumping station
9. Sludge tank

## Results

After one day of putting EM into waste water, almost all stink and putrid smell disappeared from tank 1 (analytic data of H<sub>2</sub>S are showed in Table 5).

After 5 days since putting of EM into tank 1, samples of the last tank were analyzed. Data before and after EM treatment, with and without EM treatment are showed in table 6.

The results have shown obvious effect of EM, especially in the reduction of indexes of micro-organisms, coliform and fecal coliform compared with the absence of EM treatment.

Other pathogenic micro-organisms were not found in waste water after being treated with EM. Especially the *Pseudomonas aeruginosa* which exist in output waste water without EM treatment was not found in waste water after treating with EM.

Other indexes such as BOD<sub>5</sub>, COD, NH<sub>4</sub><sup>+</sup>... are remarkably reduced compared with waste without EM treatment.

**Table 6. Analytic Data of Input and Output Waste Water with and without Application**

Analyzed items	Unit	Waste Water in Tank 1	Output Waste Water from Tank 7 without EM Application	Output Waste Water from Tank 7 with EM Application	Vietnam Standard 5945-1995 column B
pH		6.5	6.5	6.0	5-8
Turbidity	NTU	39	18	16	-
SS	Mg/1	240	61	60	100
DO	Mg/1	4.6	5.9	6.1	-
BOD <sub>5</sub>	Mg/1	185	67	51	50
COD	Mg/1	316	153	104	100
Nh <sub>4</sub> <sup>+</sup>	Mg/1	25.75	22.5	18.25	-
N0 <sub>2</sub> <sup>-</sup>	Mg/1	0.073	0.177	0.225	-
PO <sub>4</sub> <sup>3-</sup>	Mg/1	7.75	5.45	5.5	-
Total coliform	MNP/100ml	11,000x10 <sup>3</sup>	4.3 x 10 <sup>3</sup>	1.2 x 10 <sup>3</sup>	10 x 10 <sup>3</sup>
Fecal coliform	CFU/100ml	6,400	110	43	-
Salmonella	(±)	-	-	-	-
Shifella	(±)	+	-	-	-
Pseudomonas	(±)	-	+	-	-
Aeruginosa					
Vibro cholerae	(±)	-	-	-	-

Sources: Applied Biology Center, Hanoi National University and Military Institute for Hygienics and Prophylaxies, December 1998.

#### **Experiment 4 : EM Application for Treating Waste Water Discharged from Slaughtering Houses in Hanoi**

Waste water discharged from slaughtering houses which are located in residential quarters of Hanoi Capital constitutes a source of very serious pollution, chemically and biologically. Therefore, there will be serious consequences for environment and for the community's health if this waste is collected into a concentration station of the city.

The test of using EM for treating this kind of waste water is conducted as follow.

Materials were

- Secondary EM solution was prepared as follows;
  - + EM 1 : molasses: water (5% : 5%: 90%) (symbol:EM 5%).
  - + EM 1 : molasses: water (5% : 5%: 90%) (symbol:EM 5%).
- 3 vases of 10 liter capacity each for collecting and testing waste water.

The methods were :

- Waste water samples are collected in 3 vases. A vase without EM is used as control; Two other vases are added with EM 1 percent and EM5 percent separately, at the rate of 1/1.000; it means each vase is added with 10 ml of secondary EM solution of 1% or 5%.
- Measurement and observations were made on indexes of BOD, COD, SS, total coliform at different periods of time, after 1 day, 7 days, 14 days and 20 days. The changes after 20 days are shown in Table 7.
- After the last analysis, observations can be made on the decomposition of organic matter in waste water and effect of micro-organisms available in waste water.

**Table 7. Indexes of Waste Water before and after EM Treatment**

Items	Unit	Before Treatment	20 days after EM Treatment		Vietnam Standard 5945/1995 Column B
			EM 1%	EM 5 %	
PH	-	7.2	6		5.5 – 9
Odor	-	Slight stink	Odorless		-
Suspended solids (SS)	mg/l	180	16	11	100
DO	mg/l	7.6			
BOD <sub>5</sub>	mg/l	320	110	45	50
COD	mg/l	550	190	80	100
Coliforms	MPN/100ml	18.10 <sup>5</sup>	12.10 <sup>4</sup>	8.10 <sup>4</sup>	1.10 <sup>4</sup>

The test of EM treatment of waste water discharged from slaughtering houses has shown that micro-organisms of EM have reduced noticeably the contents of organic matter in waste water, increased the treatment effect upon BOD and COD, and after a certain period waste water may reach tolerable environmental standards and may be used for irrigation.

The test is only carried out in anaerobic conditions if combined with other treatment methods, the results will certainly be better.

**Conclusion** Through experiments and the application of EM technology in treating garbage and waste water in Vietnam, the following conclusions may be drawn:

- The spraying of secondary EM solution over garbage may reduce the decomposition of decayed organic matter and reduce bad smelling, toxic and harmful gas. Hence the reduction of air pollution and fly population, and the environmental improvement for dumps and enterprises producing organic fertilizers from garbages.
- The process of decomposition of garbage into organic fertilizer may be accelerated. The use of organic humus fermented by EM to produce EM Bokashi has a good effect for treating garbage.
- EM is very effective in treating waste water discharged from hospitals and slaughtering houses, reducing stink, putrid smell and BOD, COD, SS and coliform indexes and other pathogenic micro-organisms
- EM is easy and convenient for use, safe, unharmed, low cost and economically effective.