Understanding Wastewater Treatment System: THE ADAMSON UNIVERSITY EXPERIENCE

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Earth's Water Resource

The earth's water is about 97.5% saline water with 100 mg salts /L, and of the remaining 2.5% fresh water, 87% of it is trapped in the polar icecaps or lies in deep underground aquifers as groundwater not accessible to human use. This would mean that only 0.4% of all water on earth is accessible freshwater on which all terrestrial living things and ecosystems depend for survival. Freshwater is a very essential natural resource that can continue to be renewable as long as it is well managed.

Rapid industrialization and its concentration in urban centers, however, have placed very high pressures on bodies of freshwater, and rivers, lakes, and coastal waters have been severely affected. Present environmental problems confront technological development and economic growth in complexity and intensity. It is estimated that 785 million people in Asian developing countries have no access to sustainable safe water. The pollution of freshwater bodies with the consequent deterioration in water quality, brought about by the discharge of inadequately treated sewage and industrial wastewaters, can only worsen the situation. Coastal waters are also under pressure as they receive domestic and industrial wastewater discharged directly into them or indirectly from rivers.

The impact of wastewater discharges on the environment and human population can be tragic at times. The Minamata disease which spread among residents in the Yatsushiro Sea and the Agano River basin areas in Japan was attributed to methyl mercury in industrial wastewater (Matsuo, 1999). The Tansui River in Taiwan was discovered to contain pesticides and heavy metals in the sludge (Liu & Kuo, 1988), and the Nam Pong River in Thailand was polluted by the pulp and paper industry (Jindarojana, 1988). Towards the end of 2004, the Huai River in China was reported to have been so seriously polluted by paper-making, tanning and chemical fertilizer factories, and farmers in Shenqiu County had fallen very ill after using the river water (The Strait Times, 2004). In the Philippines, the pollution levels of Pasig River, Meycauyan River, and the Navotas, Malabon and Tulyahan river system have reached alarming stage and the people near these areas are confronted with water- and health- related problems due to the scarcity of clean water and the swelling of untreated waste water released into these rivers.

Although we recognize this fact, we tend to disregard it by polluting our rivers, lakes, and oceans. Subsequently, we are slowly but surely harming our water resource to the point where organisms are dying at a very alarming rate, water-borne diseases spread widely, and our source of safe drinking water has become greatly affected. In order to combat water pollution, we must understand the problems and become active part of the solution.

Sources of Water Pollution

To acknowledge the sources of pollution, it's important to remember the "Law of Conservation of Mass" which was discovered way back in 1785 by a scientist named Antoine Lavoisier. The law in its simplest form states that "matter is neither created nor destroyed." So when you flush waste, it doesn't disappear! Most people don't know or care about what happens once a toilet is flushed, but the waste has to go somewhere.

We, and all living creatures, generate waste products. When a small animal creates waste in the environment, Mother Nature can handle the treatment and disposal. But when human congregate, the waste they generate has to be treated properly and disposed of in an environment-friendly system. We have a choice on how it should be done and where it will be done, but it is essential for us to realize that treatment and proper disposal have to be done as wastes do not disappear.

Domestic sewage and industrial wastes have been identified as the major source of waste pollution. Domestic and industrial wastes contain organic particles, dissolved matter, suphates and nitrogenous compounds, which contaminate natural water sources

Domestic sewage wastes refer mainly to effluents from human activities which are associated with household activities, and are discharged mainly from sanitary conveniences in residential, office, commercial, factories and various institutional properties. It is a complex mixture containing primarily water together with organic and inorganic constituents and contaminants comprised suspended, colloidal and dissolved materials. These arise from the excreta, urine, food wastes, and wastewater from bathing, washing, and laundering, and because of the latter, soaps, detergents, and other cleaning products can be found as well.

Industrial wastewaters are effluents from raw-material processing and manufacturing. These wastewater streams arise from washing, cooking, cooling, heating, extraction, reaction by-products, separation, conveyance, and quality control of manufacturing raw materials and products. Water pollution occurs when potential pollutants in these streams reach certain amounts causing undesired alterations to the quality of the receiving water body.

Why is it Necessary to Treat Domestic and Industrial Wastewater?

Declining quality of fresh water sources mainly due to pollution leads to shortage in the freshwater supply. Freshwater shortages increase the risk of public health problems, reduction in food production, and inhibition of industrial production expansion. All these problems threaten the environment.

Inadequately treated domestic and industrial wastewaters discharged into rivers would not only affect the freshwater in these areas but also the receiving coastal and sea waters. Eventually coastal resources such as the mangrove and reef ecosystems, and thereafter .Fisheries would be affected. The discharge of inadequately treated wastewaters can therefore have far-reaching consequences.

The effects pollutants have on the water environment can be summarized in the following broad categories:

(a) Physical effects — These include impact on clarity of the water and interference to oxygen dissolution in it. Water clarity is affected by turbidity which may be caused by inorganic and/or organic particulates suspended in the water. Turbidity reduces light penetration and this

reduces photosynthesis while the attendant loss in clarity, among other things, would adversely affect the food gathering capacity of aquatic animals because these may not be able to see their prey. Very high particulates may also clog the gill surfaces of fishes and thereby affecting respiration and eventually killing them.

Many industrial wastewaters contain oil and grease (O&G) which can cause interference at the air-water interface and inhibit the transfer of oxygen.

Industrial discharges can have temperatures substantially above ambient temperatures. These raise the temperatures of the receiving water and reduce the solubility of oxygen. Apart from this, rapid changes in temperature may result in thermal shock and this may be lethal to the more sensitive species.

(b) Oxidation and residual dissolved oxygen — Biological or chemical processes induced by the presence of organic or inorganic substances exert an oxygen demand (i.e. as indicated by the BOD or COD), and if the demand exceeded oxidation capacity then the dissolved oxygen (DO) levels would decline. The depletion of free oxygen would affect the survival of aerobic organisms.

(c) Inhibition or toxicity and persistence — These effects may be caused by organic or inorganic substances and can be acute or chronic. Examples of these include the pesticides and heavy metals. Many industrial wastewaters do contain such potentially inhibitory or toxic substances, and those which are resistant to biological degradation. Such persistent compounds can be bio-accumulated in organisms resulting in concentrations in tissues being significantly higher than concentrations in the environment and thereby making these organisms unsuitable as food.. While some organic compounds may be persistent, metals are practically non-degradable in the environment;

(d) Eutrophication—The discharge of nitrogenous and phosphorous compounds into receiving water rbodies may alter their fertility. Enhanced fertility can lead to excessive plant growth. The latter may include algal growth. The subsequent impact of such growth on a water body can include increased turbidity, oxygen depletion, and toxicity issues. Algal growth in unpolluted water bodies is usually limited because the water is nutrient limiting.

(e) Pathogenic effects — Pathogens are disease-causing organisms and an infection occurs when these organisms gain entry into a host (e.g. man or an animal) and multiply therein. These pathogens include bacteria, viruses, protozoa, and helminthes. The concern here would be the presence of such organisms in the wastewater which is discharged into a receiving water body and diseases, if any, are then transmitted through the water.

Wastewater Treatment and Re-Use: The Adamson University Experience

Adamson University is actively engaged in the water conservation efforts since 2002. Its "Sagip Estero" Project created awareness on the importance of conservation of natural water ways and has trained the communities along the Estero de Balete, Manila on environmental conservation. The university, with the cooperation and support of the City government of Manila and the National Housing Authority, had successfully relocated the informal settlers of Estero de Balete to a more safe community in Calauan, Laguna. Estero clean up and rehabilitation programs of were conducted together with other educational institution s like the Sta. Isabel College, Technological University of the Phils., and the Phil. Normal University.

The academic community of Adamson University had also conducted several research projects to study the effective and economical methods for the rehabilitation of the estero water and its sediments. Some of the studies conducted by the Chemical Engineering Department were : a) Determination of the Physico-Chemical Characteristics of Estero de Balete Water and Sediment; (b) Effects of Natural Minerals on the Physico-Chemical Characteristics of Estero Water and Sediment; and (c) Partial Conditioning of Estero de Balete Water by Diffused-type Aerator.

In response to the Phil. Clean Water Act of 2004, Adamson university has carried the responsibility of improving water quality within its territorial jurisdiction by constructing a Wastewater Treatment Plant in 2009.

The WWTP of Adamson University is designed to handle 250.0 m^3/day of wastewater. The main source of the influent is the sewage water coming from the different offices, campus canteen, and restrooms from the teaching buildings. Table 1 describes the parameters used as bases for the design of university's WWTP.

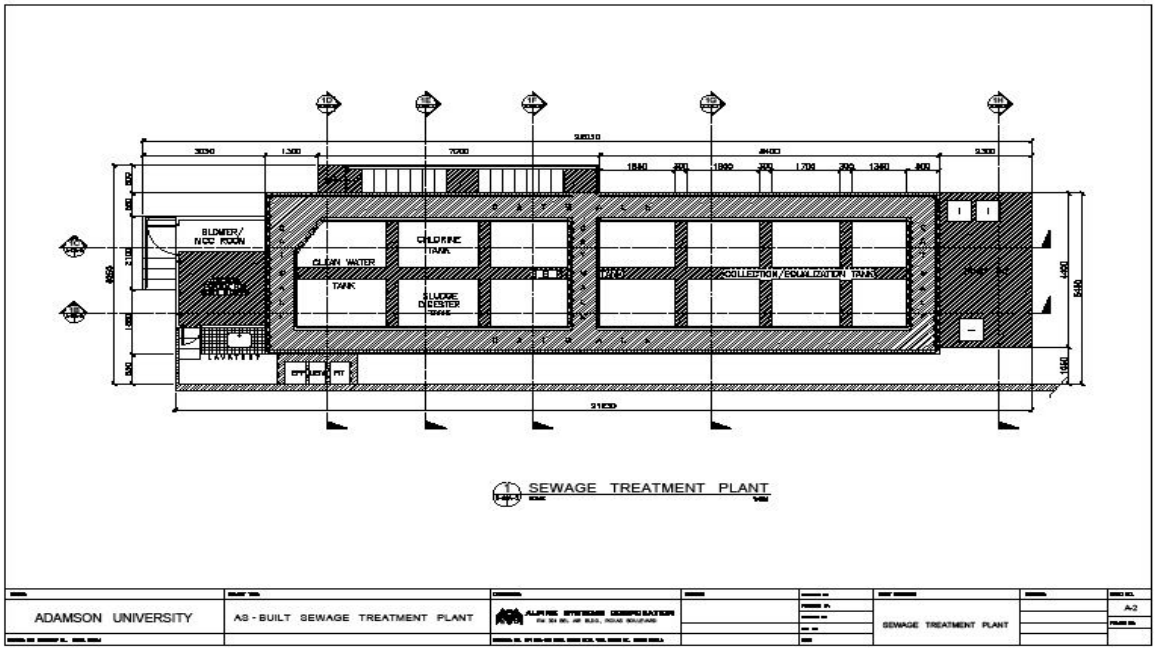
Table1. Comparison Influent Wastewater Characteristics of Adamson University with DENR Standards (DA0 35, Inland Water Class C)

Design Parameter	Influent Load	DENR Standard
BOD_5 (mg/L)	150	50
COD (mg/L)	300	100
TSS (mg/L)	300	70
Oil & Grease (mg/L)	10	10
pH	6-9	6-9

The WWTP is designed to achieve the required effluent standards for Inland Water Class C set forth under the DENR Dept. Administrative Order 35.

Treatment Process

All sewage lines of Adamson University were connected to the WWTP through three (3) collection sump pits located at the St. Vincent de Paul Bldg., Ozanam Bldg. and the Cardinal Santos Bldg. The raw wastewater from the university sewage system flows into the main sump pit at the WWTP site which has a bar screen that separates solid wastes. Solid wastes are collected manually every week and disposed properly as normal solid wastes thorough authorized haulers.



As described in Fig, 1, the **Equalization Tank** receives the influent wastewater and is subjected to pre- aeration for odor removal and to properly homogenize and condition the bacteria to become aerobic from a septic or anaerobic condition. The pH level is also controlled to the average of the total volume of wastewater so when it is transferred to the aeration tank, the receiving body of bacteria will not die and the digestion of pollutant will not slow down due to wide difference in pH. A pH range of 6.5 to 7.5 at the aeration tank will ensure a satisfactory performance of the WWTP.

The Aeration Tank is provided with submersible decanter, air diffusers, and aeration blowers which are installed at the bottom of the tank to maintain air supply uniform throughout the liquid volume of the tank. The treatment is accomplished by the activated sludge process using an aerobic, sequencing batch reaction treatment method. Aeration helps aerobic bacteria digest the organics by mixing the wastewater to a homogeneous stage so the bacteria can a chance to attach to the pollutants. It uses the metabolic reactions of microorganisms to produce a high quality effluent by converting and removing substances that have an oxygen demand. The aeration time normally runs from 2-4 hours depending on the volume and characteristics of the wastewater. The SBR activated sludge process of Adamson University requires a mixed-liquor DO of 2.0 mg/L to insure that the inner portion of the floc particle are aerobic and the same time prevent the prolific growth of certain undesirable filamentous microorganisms. A DO concentration more than 4.0 mg/L normally wastes energy and may result in poor sludge settling characteristics.

The equalization and aeration operations are controlled by a Programmable Logic Control (PLC) system and some float switches located at certain water level.

The aeration is then shut off for the biosludge to settle at the bottom. At this settling stage there should be no flowing of wastewater from the equalization tank and no decanting of

effluent for 45-60 minutes. During settling, there are active bacteria that are still hungry and digest neighboring bacteria cell. This helps minimize the volume of bacteria in the aeration tank, hence disposal of sludge waste is also minimized.

After settling, there would be a layer of clear liquid on the top surface, and this decanted as effluent. The effluent or treated water will then pass through six drum of filters followed by chlorination.

Chlorination is a water treatment that destroys disease-causing bacteria, nuisance bacteria, parasites and other organisms. Chlorination also removes soluble iron, manganese and hydrogen sulfide from water. At the 3 to 5 ppm chlorine level and adequate contact time in the range of 10 to 20 minutes, this final treatment can develop the proper bacterial kill factor, and the treated water is ready for re-use for flushing the water closets.

As described in Table 2, the average characteristics of the effluent of the university's WWTP before the tertiary treatment are compliant with the standards set by DAO 35, and can be recycled back to the restroom for reuse as flush water.

Table2. Comparison Effluent Wastewater Characteristics of Adamson University with DENR Standards (DA0 35, Inland Water Class C)

Design Parameter	Ad U Effluent	DENR Standard
BOD_5 (mg/L)	15 -30	50
COD (mg/L)	50- 79	100
TSS (mg/L)	30-40	70
Oil & Grease (mg/L)	5-7	10
pH	6.5-7.5	6-9

At present, the WWTP is operating at a daily flow rate about 90-150 m^3 (36 – 50% of the full capacity of 250 m^3) and only about 75 % of the treated water (67.5 – 112 m^3) can be recycled back to the rest rooms as the remaining 25% has to be maintained inside the treatment chambers for the proper maintenance of the pumps and aerators, and for the effective settling of sludge.

Power consumption was recorded at nearly 79 Kwh for a 30-day continuous operation.

At current operational conditions, the university can save about 90 m^3 daily by recycling water. This would mean a reduction of nearly PhP18,000.00 in monthly water bill .

CONCLUSION

The future availability and quality of water is one of the key issues today. The UN states that "At the highest political level, there needs to be recognition that water and sanitation are basic needs and rights". As we head into the 21st century, awareness and education will most assuredly continue to be the two most important ways to prevent water pollution. If these measures are not taken and water pollution continues, life on earth will suffer severely as slobal environmental collapse is not inevitable.

We, in the academic institutions, can help ensure that the communities, particularly the poor members of our society, have access to sufficient quantities of clean freshwater resources as this is a significant component of food security and rural livelihoods. We can play a significant role, not only in environmental education, but also in actively preventing water pollution from domestic, industrial, and agro-industrial activities to ensure the sustainability of development with balanced ecosystem.

In order to increase access to water supply the following three elements are especially important: a) development of new water sources; b) Prevention of water resource degradation; and c) improvement in efficiency of water consumption.

Setting up of a wastewater treatment facility and wastewater reuse contributes to all of above three elements. Wastewater reuse can provide alternative source of water and reduce pollution load to water environment by less discharged wastewater to the rivers and lakes. A significant volume of water used in schools need not have the quality as high as that of drinking water. In most cases, secondly treated domestic wastewater followed by sand filtration treatment and disinfections can be used for non-portable purposes such as toilet flushing, garden watering, park or other open space planting, and fire-fighting . Therefore wastewater reuse has a big potential to bring about environmental, economic and financial benefits to the community as a whole.

Currently, there is a growing realization that the human and economic costs of cleaning up after the act is frequently more than preventing the pollution in the first place. But the economics and financial effects of the cost of putting of a wastewater treatment facility can cause uncertainties.

We believe that the more important question is: When are going to act and how?

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