

# Performance of Combination of PreOzonation and Membrane Biological Reactor on Greywater Characteristics

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## Abstract

an ozone-biological aerated filter process was operated for ten months to evaluate its feasibility in polishing Greywater as primary treatment. The reduction efficiency of BOD<sub>5</sub>, COD, and TSS were 44%, 27%, and 41.1% respectively. The average ranged effluent of PH, NH<sup>3</sup>-N, T-N, Total Phosphorous were (6.5-8.5), (19-61)mg/l, (9.1-34.7)mg/l, and (2.8-18.2)mg/l respectively.

Main operational parameters were: Ozone rate 2 gm/hr for 6 hr from April to July and 8 hr from October to March. All results showed excellent performance of the ozone-biological aerated filter process. Experiences proved that the operation parameters such as dosage of ozone should be changed with the influent quality to acquire the best quality of the effluent.

## 1-Introduction:

Grey water consists of diluted domestic wastewater streams coming from the shower, laundry facilities and/or the washbasins, whereas in some studies grey water also includes the kitchen wastewater (Nolde, 1999; Jefferson et al., 1999, 2000, 2004; Eriksson et al., 2002; Elmitwalli and Otterpohl, 2007). Biological treatment is a prerequisite for storing and/or reusing grey water (Nolde, 1999; Jefferson et al., 2004; Abu Ghunmi et al., 2008). A distinguishing important feature of biological treatment is that it stabilizes in a controlled manner the organic matter that otherwise causes problems; such as malodor, mosquito breeding, water and soil pollution, and clogging in the distribution systems, e.g. used for irrigation and toilet flushing (Christova-Boal et al., 1995; Diaper et al., 2001; Eriksson et al., 2002). Clogging occurs due to accumulation of solids and microorganisms growth (Christova-Boal et al., 1995).

Tested technologies for treating grey water aiming at the maximum stabilization of the wastewater, in principle apply either long HRTs such as constructed wetlands with HRTs of 2–14 days (Fittschen and Niemczynowicz, 1997; Winward et al., 2008) or membrane/ultra-filtration bio-reactors, which apply long SRT, with an HRT of less than 1.5 day (Jefferson et al., 1999, 2001; Winward et al., 2008). The first mentioned system has the disadvantage that large areas are needed, e.g., 1.4–3.25 m<sup>2</sup> Cap<sup>-1</sup> (Nolde and Dott, 1992; Hegemann, 1993; Li et al., 2003). Moreover, evapotranspiration in summer especially in the dry area is a crucial issue (Fittschen and Niemczynowicz, 1997). The second systems, the membrane/ultra-filtration bio-reactors, demand high energy and maintenance requirements (Jefferson et al., 1999, 2000), and are therefore not suited for on-site situations in the developing countries. Use of treated grey water for irrigation in countries with low precipitation is an attractive option, as grey water is low in salts (Abu Ghunmi et al., 2008) and not polluted with toilet (waste)-water. Applying on-site treatment and use of grey water, providing that black water is treated on-site as well, minimizes transporting cost; i.e., distinctively reducing investments for installing and maintenance of sewerages system (van Riper and Geselbracht, 1998; Lettinga et al., 2001).

Many other oxidation agents are often used in combination with ozone to provide increased efficacy. Agents such as peroxides, UV, and conditions of high pH assist ozone in the oxidation process.

Ozone Chemistry is composed of a single bond and one double bond. The single bonds are weak and this leads to easy formation of free radicals. The double bond is as strong as the double bond of oxygen and so unreactive. Two resonance structures of ozone exist and they are interconvertible.

The location of ozone use in WWWT will determine the goal of treatment. A simple way to explain a classical WWWT will be broken up into the process into:

- 1) Preliminary treatment consisting of process such as screening
- 2) Primary treatment including sedimentation
- 3) Secondary treatment including activated sludge treatment and secondary sedimentation
- 4) Tertiary treatment including discoloration, disinfection, COD reduction etc.

Ozone finds use in each of these stages of WWWT. Ozone during preliminary stage is used for detoxification, and at secondary stage is used for sludge reduction, while ozone during the tertiary stage is more common and used for disinfection, micro pollutant removal, COD reduction and declaration. The location of ozone is dependent on the goal of ozonation, and in each of these cases the use of ozone has been found to be very productive.

## 2-Experimental Equipment and Method:

Experiments batch process as been conducted in a pilot plant installed in Al- Mustansiriya University at Environmental Hydraulic lab. Equipment consists of a reaction tank, an ozone generator, and a pump. The

reaction cylindrical tank was diameter of 1m and 1m length of a capacity of 1000 L. Ozone was generated from dry air and pumped into the base of reaction tank at a constant flow rate. Graywater to be treated was pumped into the tank. Influent and effluent gray water characteristics include BOD<sub>5</sub>, COD, pH, TSS, T-N, Ammonia nitrogen as N, Total phosphor, and fecal coli form.

Ozone was used to rise the dissolved oxygen level ,Ozone rate 2 gm/hr for 6 hr from April to July and 8 hr. from October to March

### 3-Results:

#### 3-1BiologicalOxygen Demand (BOD<sub>5</sub>)

The measurements of **BOD<sub>5</sub>** indicate the relative oxygen-depletion effect of waste contaminants, Which measures the oxygen demand of biodegradable pollutants. **BOD<sub>5</sub>** tests were carried out for the raw graywater, and after preozonation as shown in figure (1)The range of BOD<sub>5</sub>measure of rawgraywaterwas (122- 296 mg/l), and after preozonation (65-211 mg/l) with mean values of 186 mg/l, and110 mg/l, for raw Greywater, and after preozonation respectively. The removal efficiency's during the tests period was shown in figure (2), which the average removal efficiency after preozonation was **44%**.

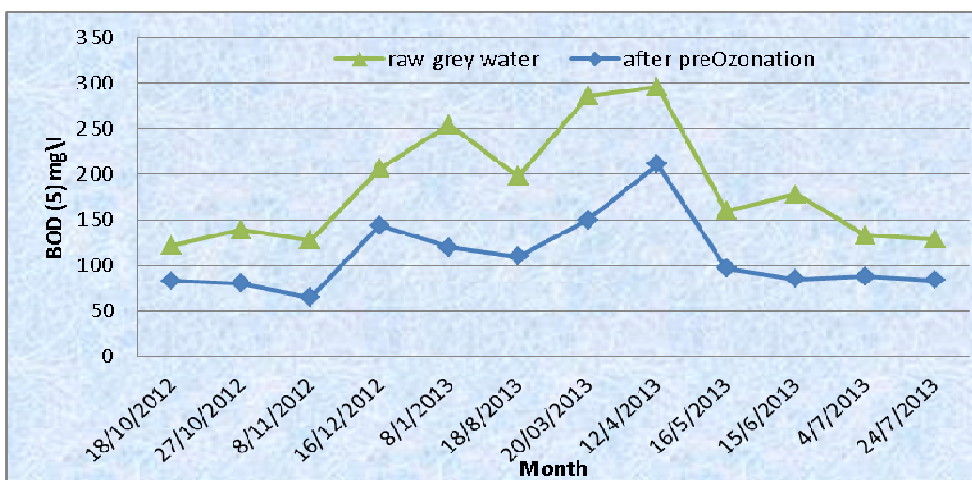


Figure 1: Biological Oxygen demand (BOD<sub>5</sub>) after preozonation at different time.

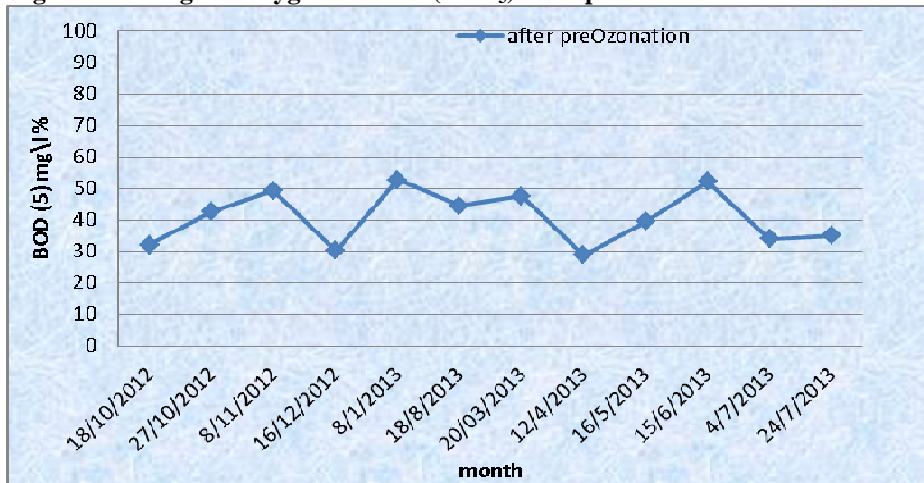


Figure 2: BOD<sub>5</sub> removal efficiency after preozonation at different time.

#### 3-2ChemicalOxygenDemand(COD)

**COD** tests measure the relative oxygen-depletion effect of a waste contaminant. which, these tests measures the oxygen demand for biodegradable pollutants plus the oxygen demand of non-biodegradable oxidize able pollutants. The values of influent **COD**, the resulting effluent **COD** after the preozonation and the removal efficiency for the entire test period was approach in figure (3,4). The mean values for raw grey water, and after preozonation were 278mg/L (range: 198-465 mg/L), and202mg/l (range: 147-330mg/l) respectively.

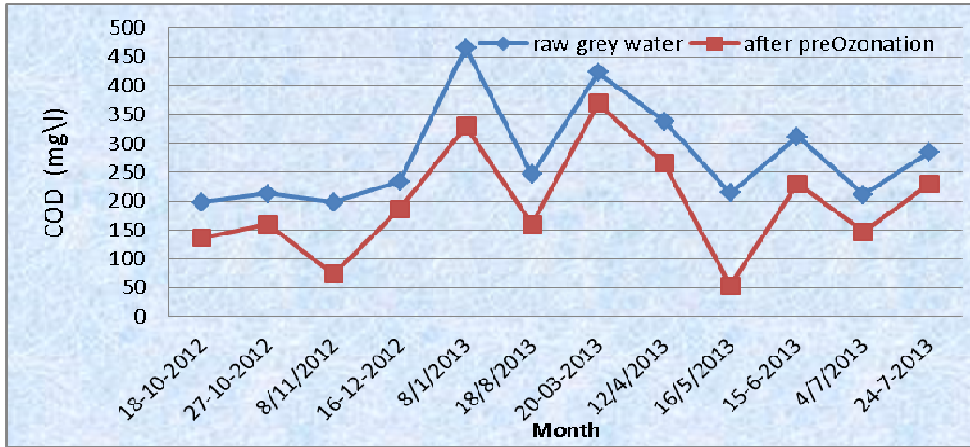


Figure 3: Chemical oxygen demand COD after preozonation at different time.

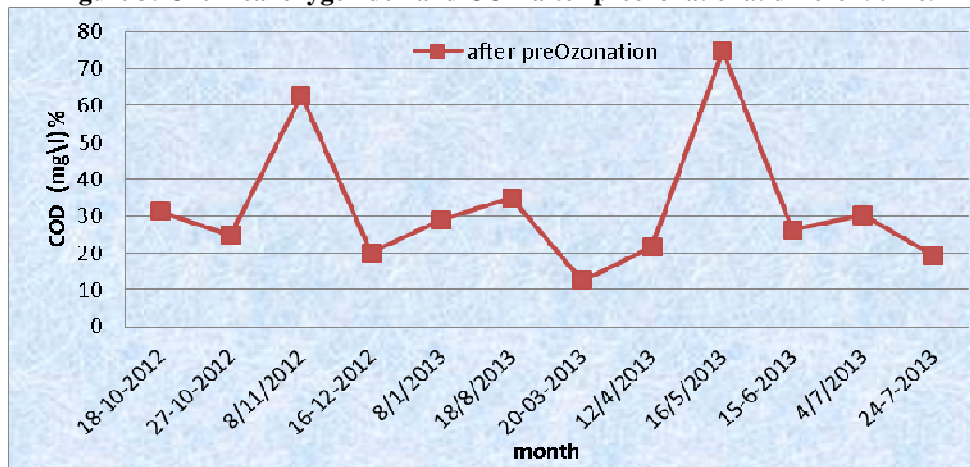


Figure 4: COD removal efficiency after preozonation at different time.

The average removal efficiency after preozonation was 27%.

### 3-3 Total Suspended Solids (TSS) (mg/l)

Monitoring of water quality during 9 months has been carried to characterize the water quality to evaluate the pretreatment performance fluctuation of total suspended solids (TSS) values for treated water follows the influent concentrations which shown in figure(5). The mean TSS values for raw graywater was 125 mg/l (range: 24-245mg/l), and after preozonation was 77 mg/l (ranged: 16-219 mg/l). Removal efficiency after preozonation were 41.1%, as shown in figure(6).

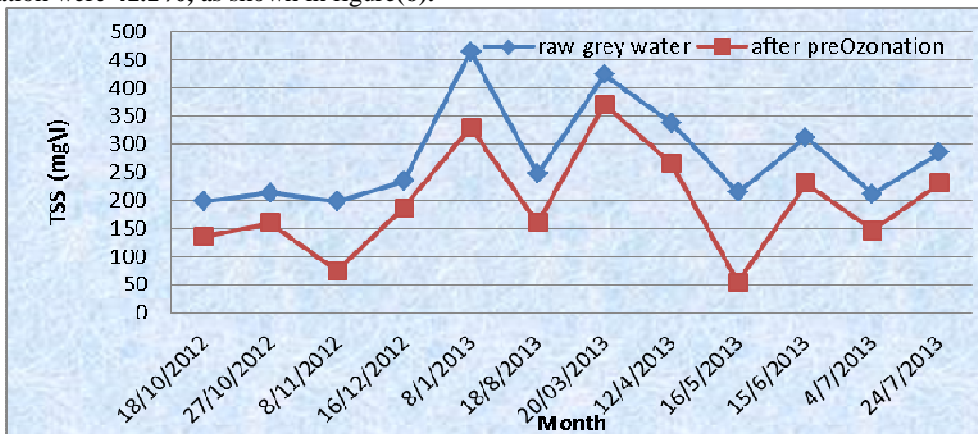


Figure 5: influent and effluent Total suspended solid TSS (mg/l) at different time.



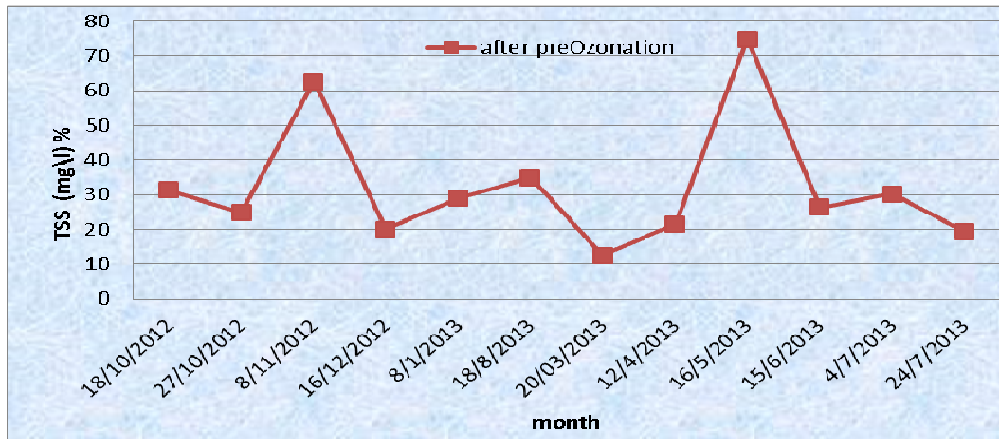


Figure 6: TSS removal efficiency after preozonation at different times.

### 3-4 pH test of the preozonation process:

A set of experiments have been achieved to make the pH of ranged (6.5- 8) in the aerobic treatment because of its acidity results by adding (CaCO<sub>3</sub>). The average of five samples was depended on the recording the pH values of influent and effluent during and after preozonation which is shown in figure(7).

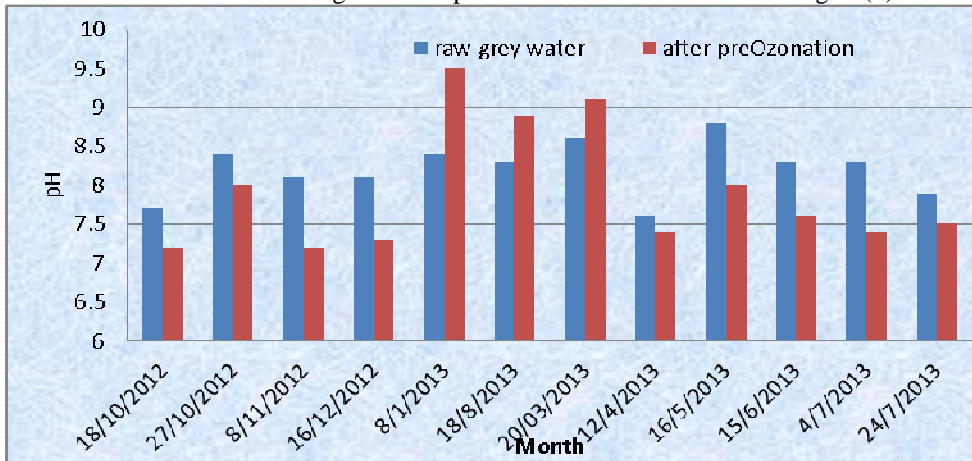


Figure (7) Influent and effluent pH at different times at different stages.

### 3-5 Ammonia Nitrogen as N and total Nitrogen as T.N:

Ammonia Nitrogen as N and total nitrogen as N (T-N) have been tested for raw grey water and after the preozonation because they have an effect on plant and soil. The average result was 23.4, and 17.8 mg/l respectively for Ammonia Nitrogen as shown in figure (8), and were 31.9 mg/l (range: 19- 61.1 mg/l), and 21.5 mg/l (range: 9.1- 34.7 mg/l) respectively. As shown in figure(9).

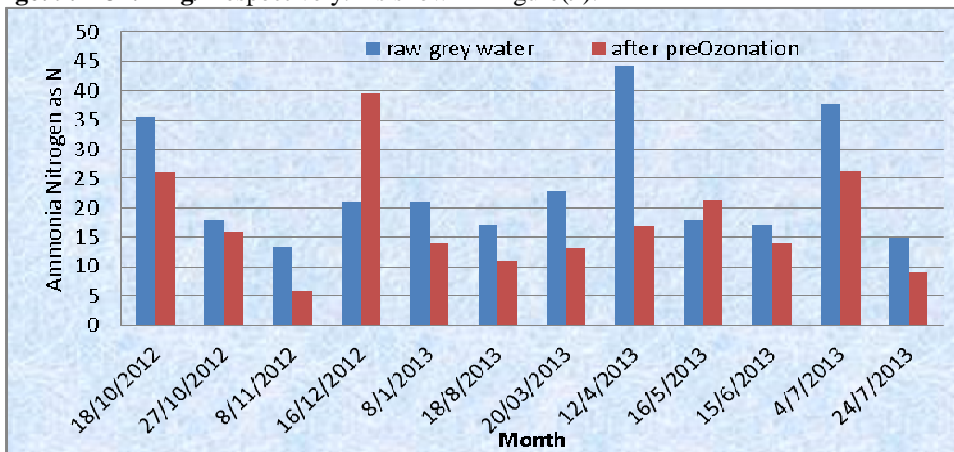


Figure 8: Ammonia Nitrogen as N at different times.

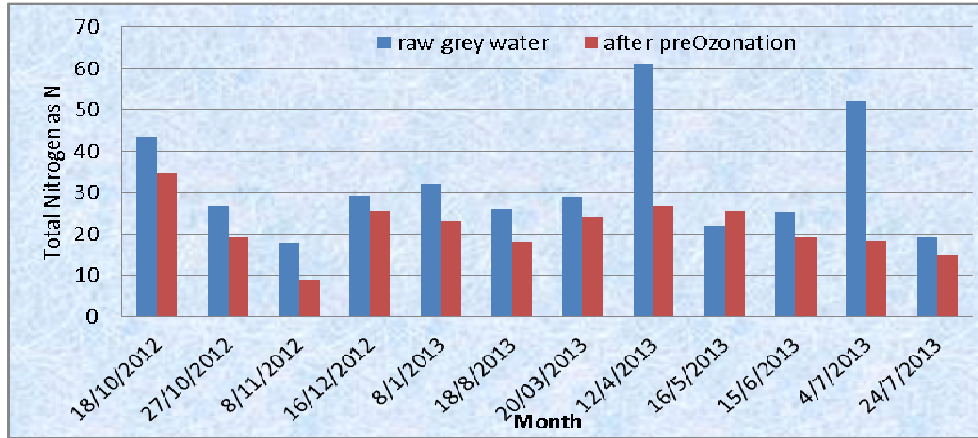


Figure 9: Total Nitrogen as N test results at different time.

**3-6 Total Phosphorous tests results:**

Due to the effects of total phosphorous on the plants and soil and its importance. Figure(10) shows the concentrations of total phosphorous for raw graywater and after preozonation and the average result was 16.6 , and 10.6 mg/l respectively.

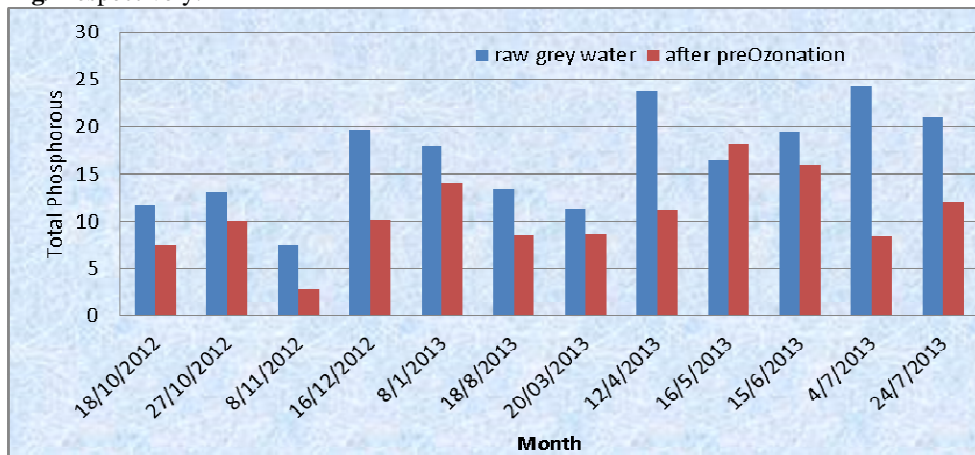


Figure 10: Total Nitrogen as N at different times.

**3-7 Total fecal coli form removal efficiency.**

In order to study bacteriological quality of the wastewater at different stages of Pilot plant, a set of bacterial tests were carried out. These tests included total fecal coli forms at the inflow and after the preozonation. From figure (11), it seems that the preozonation reduce the number of Coli form bacteria but still it cannot be used without filters and disinfection processes, because the dosage used in the preozonation was low and increasing the dosage of ozone will result for killing microorganisms in addition to the high cost, compare to use low dose with filtration and disinfection unit.

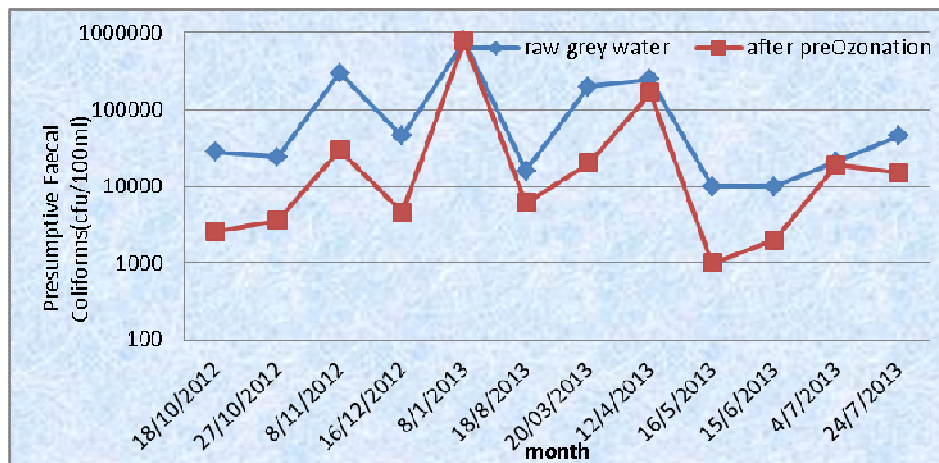


Figure 11: Total fecal coliforms test result.

#### 4- Conclusion

Ozone is extremely effective as an agent for the decomposition of persistent organic compounds. The method is most effective if pH is adjusted for each substance. Organic compounds that are not suited to biological treatment can be converted to biologically degradable compounds without generating hazardous byproducts. Ozone treatment is thus applicable to more organic compounds and a greater range of concentrations. The technology is effective in minimizing both the environmental burden and treatment costs. It is a very versatile method for decomposing organic compounds. Future application of this technology should result in low-cost treatment and recycling of water.

preozonation shows reduction of 44% of BOD<sub>5</sub>, 27.5% COD and 41.1% TSS, and shows a good improvement for other parameter (pH, Ammonia Nitrogen as N and total nitrogen as N (T-N), Total Phosphorous, and Total fecal coli forms).

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