# Use of Lenses in Sewage Treatment Plant for Waste Water Purification

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**Abstract: The rising demand for clean water necessitates exploring sustainable wastewater treatment options. While effluent from Sewage Treatment Plants (STPs) offers a potential source for non-potable purposes, ensuring its microbiological safety is paramount. Conventional disinfection methods using chlorine or UV lamps raise concerns about environmental impact or operational costs. This study investigates the application of "spot fresnel lens" and solar irradiation for wastewater disinfection. The concentrated sunlight channeled by these lenses delivers a high dose of UV radiation to the effluent stream, disrupting the microorganisms' DNA and rendering them inactive. The project will comprehensively evaluate the efficacy of this method for various wastewater qualities typically encountered in different STP configurations. Factors like flow rate, channel depth, and sunlight intensity will be analyzed to optimize the disinfection process. Furthermore, a techno-economic assessment will compare the long-term sustainability and cost-effectiveness of this solar-powered system against conventional methods. Finally, a life cycle assessment will be conducted to evaluate the environmental impact of the proposed technology. The project will evaluate the disinfection efficacy for various wastewater qualities, analyses operational parameters, and develop a design model for a solar disinfection system using spot Fresnel lenses. The focus will be on maximizing efficiency, sustainability, and cost-effectiveness compared to traditional methods. This novel approach holds promise for a paradigm shift in wastewater treatment, promoting environmental responsibility and water resource conservation.**

***Keywords —STP, Spot Fresnel Lens, Waste Water Treatment, Solar Disinfection, Efficiency, UV Radiation***

## I. INTRODUCTION

In this project the main purpose of application of the Fresnel lens treatment is to observe significant changes in the measured parameters of the wastewater samples.

Fresnel lenses, ingenious tools that concentrate sunlight on sewage water offering a sustainable and potentially cost-effective solution for disinfection of sewage water in both rural and urban areas. Here's how they disinfect with the power of the sun: Solar Disinfection (SODIS): Imagine simple plastic bottles filled with water transformed into mini purification units. Fresnel lenses concentrate sunlight onto these bottles, generating enough heat and UV radiation to kill harmful bacteria and viruses. This lowcost, easy-to-implement method empowers individuals and communities to take charge of their water safety. Beyond individual households, Fresnel lenses can be integrated into larger systems for community-level water treatment. Think tanks or basins strategically positioned under the lenses can disinfect larger volumes of water, serving entire villages or schools. The primary function of the Spot Fresnel lens disinfection is to eliminate harmful microorganisms from the wastewater effluent. The core chemical and physical properties of the

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water itself remain largely unchanged. UV disinfection plays a crucial role in eliminating harmful microorganisms, but conventional methods like screening, grit chamber, sedimentation, oxidation, nitrification and denitrification, activated sludge process will effectively address other contaminants, making them a complementary approach for wastewater treatment.

## II. FRESNEL LENSE

A Fresnel lens is a type of optical lens with a specially designed surface to achieve focusing or light manipulation. Unlike traditional lenses with a smooth, curved surface, Fresnel lenses achieve similar effects using a series of concentric ridges or steps on a flat or near-flat surface. These ridges offer several advantages, including Significantly thinner profile compared to conventional lenses, making them ideal for weight and size-sensitive applications.

Less material is required to manufacture a Fresnel lens of similar focal length compared to a traditional lens. Simpler design and reduced material usage often translate to lower manufacturing costs.

It can be designed in various shapes and sizes for diverse applications.

## III. SPOT FRESNEL LENSE

This lens is made of acrylic, also called as Perspex. Conventional lenses have a smooth, curved surface that refracts light rays to a focal point. Fresnel lenses, on the other hand, achieve the same focusing effect with a series of concentric grooves or ridges etched on a flat or near-flat surface.

Each groove acts like a mini-lens, bending light rays towards a common focal point. By strategically arranging these grooves, the lens can be designed to focus light in a specific way. The unique design allows for a significantly thinner profile compared to traditional lenses, making them ideal for applications where weight and size are critical.

Less material is required to create a Fresnel lens compared to a conventional lens of similar focal length. The simpler design and reduced material usage often translate to lower manufacturing costs. Fresnel lenses can be designed in various shapes and sizes to suit a wide range of applications. Similar to traditional lenses, Fresnel lenses have a focal length which determines the distance at which parallel light rays converge to a point.

## II. NECESSITY OF FRESNEL LENSE IN WASTE WATER TREATMENT

1 Conventional wastewater treatment plants (WWTPs) typically rely on chemical or mechanical processes to purify water. Grooved Fresnel lenses, while not currently a mainstream technology in this field, offer a potential sustainable and cost-effective approach for disinfecting the treated wastewater effluent. Here's why they might be a valuable addition:

2 Grooved Fresnel lenses act like magnifying glasses, concentrating sunlight onto a designated area within a channel containing the effluent from the WWTP. This concentrated sunlight delivers a high dose of UV radiation.

3 The UV radiation disrupts the DNA and reproductive processes of microorganisms like bacteria, viruses, and protozoa present in the effluent, rendering them inactive and significantly reducing their population. This achieves effective disinfection.

4. This approach utilizes natural sunlight, a renewable energy source, reducing dependence on chemicals (like chlorine) or energy-intensive UV lamps.

## III. PROPERTIES OF TREATED WATER USING FRESNEL LENS

1 Grooved Fresnel lens disinfection, being a method focused on eliminating microorganisms, shouldn't inherently change the core chemical and physical properties of the treated water itself. However, there might be some indirect effects to consider:

The core chemical composition of the water, including dissolved minerals and other solutes, should not be significantly altered by the Fresnel lens disinfection process.

The pH level of the water likely remains unchanged as the disinfection process relies on UV radiation and doesn't involve chemical reactions that would impact acidity or

alkalinity

.Similar to pH, the electrical conductivity of the water which reflects the presence of dissolved ions, should not be affected by the disinfection method.

The study employed an experimental research design to evaluate the effectiveness of Fresnel lenses in treating wastewater effluent from sewage treatment plants (STPs). This design involved subjecting wastewater samples to concentrated sunlight using Fresnel lenses and measuring various parameters before and after treatment to assess the impact of the treatment process.

## IV METHOD

The main purpose of application of the Fresnel lens treatment is to observe significant changes in the measured parameters of the wastewater samples.

**4.1 Data Collection Process:**

**Initial Data Collection:**

Untreated wastewater samples were collected from the effluent of the STP.

Parameters such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, and Mixed Liquor Suspended Solids (MLSS) were measured initially.

Dissolved Oxygen: 2 mg/L

Biochemical Oxygen Demand (BOD): 70-75 mg/L

Chemical Oxygen Demand (COD): 200 mg/L

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pH: 6.7

Mixed Liquor Suspended Solids (MLSS): 70 mg/L

| Parameter | Initial Value |
|---|---|
| Dissolved Oxygen (DO) | 2 mg/L |
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| Chemical Oxygen Demand (COD) | 200 mg/L |
| pH | 6.7 |
| Mixed Liquor Suspended Solids (MLSS) | 70 mg/L |

**4.2 Treatment Process:**

Wastewater samples were exposed to concentrated sunlight using the Fresnel lens system for a 45 minutes of duration.

**Post-Treatment Data Collection:**

After treatment, wastewater samples were collected again for analysis.

The same parameters measured initially (DO, BOD, COD, pH, MLSS) were reassessed post-treatment to evaluate any changes resulting from the Fresnel lens treatment.

**4.3 Analytical Approach:**

**Comparison Analysis:**

Pre-treatment and post-treatment values for each parameter were compared to assess the effectiveness of the Fresnel lens treatment.

**4.4 Results Analysis:**

The given values of parameters (Dissolved Oxygen, BOD, COD, pH, MLSS) remained unchanged after treatment with the Fresnel lens.

Statistical analysis was conducted to confirm the consistency of the results.

**4.5 Results Summary:**

The application of the Fresnel lens treatment did not result in significant changes in the measured parameters of the wastewater samples.

The values of Dissolved Oxygen, BOD, COD, pH, and MLSS remained consistent before and after treatment, indicating that the Fresnel lens treatment did not alter the characteristics of the wastewater.

## V. APPLICATION OF TREATED WATER USING FRESNEL LENS

Water treated using a grooved Fresnel lens disinfection The treated water can be used for irrigation of non-edible crops like ornamental plants, trees, or certain industrial crops. This can significantly reduce the reliance on freshwater resources for agricultural purposes.

1 Parks, golf courses, and other landscaped areas can utilize the treated water for watering purposes.

Many industrial processes require non-potable water for tasks like cooling, cleaning, or dust control. Fresnel lenstreated water could be a suitable option for such applications.

In areas facing water scarcity, treated wastewater can be used for toilet flushing, reducing the demand for potable water for this non-consumptive use.

Projects often require water for dust suppression, concrete mixing (with certain limitations), and equipment washing. Fresnel lens-treated water can be a viable alternative to using freshwater for these purposes.

## VI. ENVIRONMENTAL BENEFITS OF UTILIZING TREATED WASTEWATER:

By reusing treated wastewater for non-potable purposes, we can significantly reduce the pressure on freshwater resources, especially in drought-prone areas.

Treating wastewater with Fresnel lenses promotes a sustainable approach, minimizing reliance on chemicals and lowering energy consumption compared to some traditional methods.

Utilizing treated wastewater can be a more cost-effective option compared to using freshwater for certain applications.

## VII. ADVANTAGES:

Using Fresnel lenses in wastewater treatment offers several advantages:

1 Solar disinfection can effectively kill bacteria, viruses, and other pathogens present in the wastewater, reducing the risk of waterborne diseases.

2 Fresnel lenses are relatively inexpensive to manufacture compared to traditional optical lenses.

3 The process is environmentally friendly and sustainable, contributing to energy conservation efforts.

4 Fresnel lenses can be modular in design, allowing for easy integration into existing wastewater treatment infrastructure

5 Solar disinfection using Fresnel lenses eliminates or reduces the need for chemical disinfectants, such as chlorine or ozone.

## VIII. LIMITATIONS

1 Grooved Fresnel lens disinfection for wastewater treatment is still under development.

2 Further research and optimization are needed for widespread adoption.

3 Efficiency can be affected by factors like cloud cover, sunlight intensity, and flow rate of the effluent.

4 Designing large-scale disinfection systems using Fresnel lenses can be challenging.

5 The initial cost of installing a Fresnel lens disinfection system is higher than traditional methods. Application & Management publishes original research

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## Conclusion

The values of Dissolved Oxygen, BOD, COD, pH, and MLSS remained consistent before and after treatment with the Fresnel lens. This consistency indicates that the Fresnel lens treatment did not alter the characteristics of the wastewater.

Challenges include the need for further research in, need of Fresnel lens to kill fecal & coliform bacteria

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