# Ray Optics and Heat Transfer Analysis of a Curved Fresnel Lens Heater for a Desalination System

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**INTRODUCTION**: Fresnel lens have wide applications. The goal of this work is to simulate an efficient solar seawater desalination portable system to obtain drinking water, using a Fresnel lens. The design is simulated using COMSOL Multiphysics®, with a 120 cm diameter curved Fresnel lens, which concentrates the heat flux from the sunlight into one small focal area, significantly elevating the temperature. This surface transmits and distributes the energy along the heating chamber, evaporating seawater setting the salt aside, converting it into freshwater.

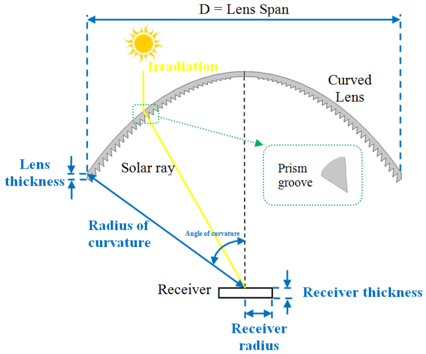


**Figure 1**. Fresnel curved lens design

**COMPUTATIONAL METHODS**:

1. Heat Transfer in Solids:

Simulates only the heat (temperature) propagation and distribution in the heating chamber using a Gaussian Pulse to simulate the sunrays energy (heat flux) applied to the receiver. The Gaussian function parameters were calculate running an algorithmic method using MATLAB[1]. This provides an idealized result.

2. Ray Heating (Ray Optics):

Simulates the chamber and lens heat propagation and distribution due to sunrays, real sunrays energy (heat flux) applied on the receiver and ray trajectories. This simulation provides results that resemble real behavior.

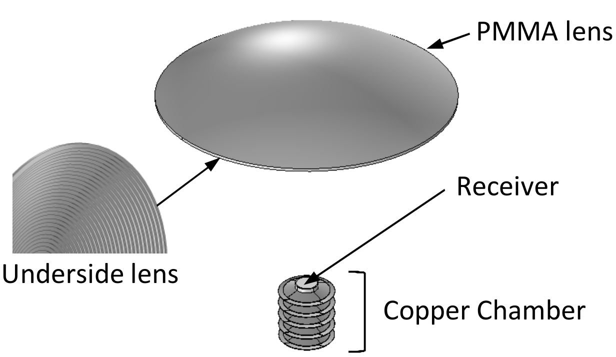


**Figure 2**. Curved Fresnel lens and chamber geometry

**RESULTS**: The Heat Transfer and Ray Heating simulation are for temperature and heat flux distributions, for 4 h time study. In both simulations, the temperatures and flux were concentric on the receiver. The temperature was uniform distributed along the chamber. Using Ray Heating, the maximum temperature (reached after 56.4 minutes), and heat flux at the receiver have higher peaks than using Heat Transfer. Peaks of heat flux using Gaussian Function are similar on 2D and 3D receiver surface.

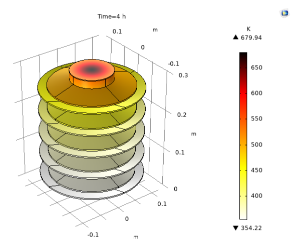

**Figure 3**. 3D Temperature Distribution using Heat Transfer

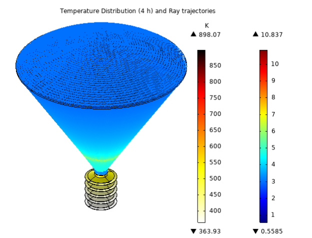

**Figure 4**. 3D Temperature Distribution and Ray Trajectory using Ray Heating

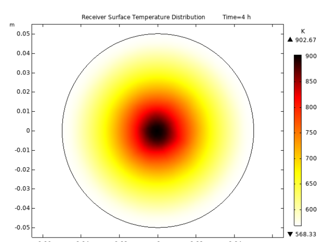

**Figure 5**. 2D Receiver Surface Temperature Distribution using Ray Heating

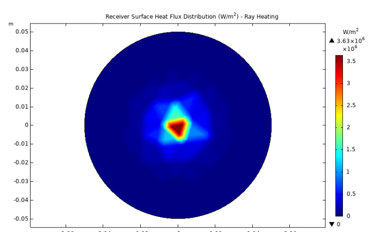

**Figure 6**. 2D Receiver Surface Heat Flux Distribution using Ray Heating

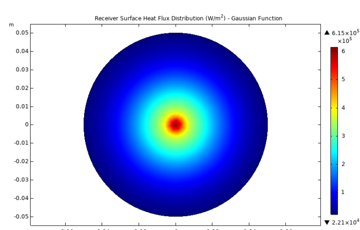

**Figure 7**. 2D Receiver Surface Heat Flux Distribution using Gaussian Function

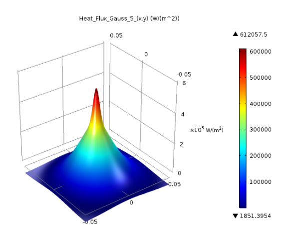

**Figure 8**. 3D Receiver Surface Inward Heat Flux Distribution using Gaussian Function

**CONCLUSIONS**:

- The objective of this work is primary to predict temperature and heat flux values on the receiver surface. The design of the water evaporating chamber depends on the freshwater output requirements.
- The results of this work will be used in the generation of a prototype.
- Results of temperature and heat flux values on the receiver surface can be taken as reference to apply in other applications.

**REFERENCES**

1. H. Qandil, W. Zhao, Design and Evaluation of the Fresnel-Lens Based Solar Concentrator System through a Statistical-Algorithmic Approach, Proceedings of IMECE 2018, 87023, (2018)