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A new Variable Curvature concept for Linear Fresnel Reflectors Solar Concentrating Systems.

Jose M. Sojo-Gordillo, Antonio Carrillo-Andrés, Samuel Guarino-Molina, Eduardo A. Rodríguez-García

University of Málaga, Industrial Engineering School, Energy Research Group. C/ Arquitecto Peñalosa s/n. 29071. Spain, Phone: 34-951-952-401, e-mail: jmanuelsojo94@gmail.com, acarrillo@uma.es

1. Introduction

In a Linear Fresnel Reflector (LFR) solar concentrating system [1] a series of single axis linear reflectors target the sunrays to a longitudinal facedown receiver on top of a fixed structure. The LFR technology offers simplicity and reduced costs when compared with the standard Parabolic Trough technology, but it also suffers from reduced optical performance, especially with large incidence angles. The present preliminary study explores the possibilities of a variable curvature geometrical concept for a LFR that would achieve a more focused solar print over the receptor than in a traditional fixed geometry system.

2. Variable curvature concept

In order to achieve a better optical performance at any time of the day, the conceptual technique relies in lines of reflectors which not only can roll over their axis but change their curvature as well. To do so, the system must adapt the reflector curvature in order to convert the surface in part of a bigger imaginary parabola which is focused to the receiver. This way sunrays must be parallel to the parabola axis (focus-vertex line). Figure 1 illustrates the idea.

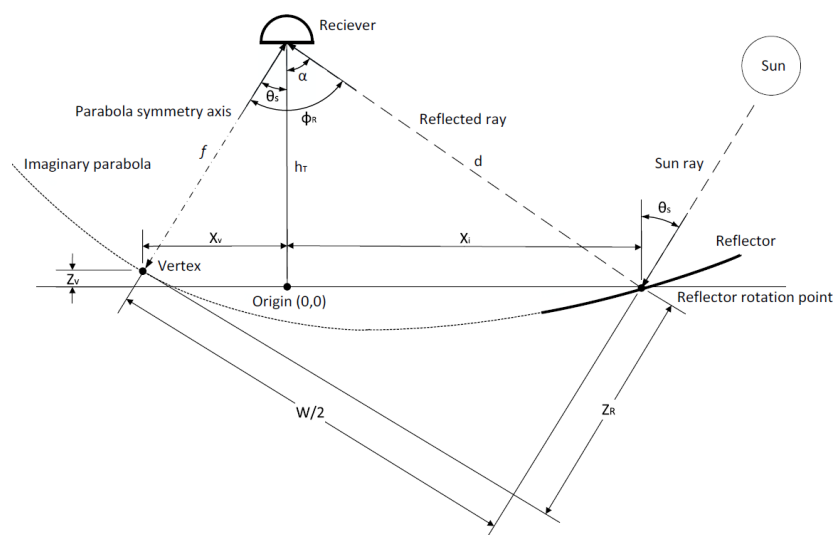


Figure 1. Scheme of the geometrical concept.

3. Results analysis

The Monte-Carlo ray tracing software Soltrace [2] is used for the analysis. Taking the geometry of the standard model Novatec NOVA-1 [3] as a reference, a large difference in solar print is found between the standard and the new proposed design. With the sun in the zenithal position, the wide of the print can be reduced about 60% (see Figure 2). Moreover, in case of large

longitudinal incidence angles, the new concept is able to keep the print totally inside the receiver thanks to the fact that the new curvature adopted can correct the blur of the print.

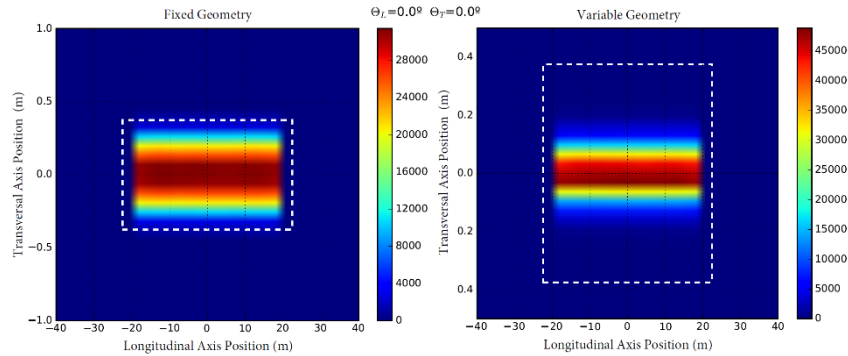


Figure 2. Comparison of solar print between the NOVA-1 system and the concept with the sun at zenith.

4. Technical viability

The mirrors flexion needed to fulfil the requirements of the proposed concept are of the order of less than one centimeter per 1 meter wide reflector as shown in Figure 3. Obviously, the technology of flexible reflective materials for this application is not a deeply explored field, but several ideas to perform the change in curvature are proposed:

- Mechanical flexion of reflector plates using hydraulic or pneumatic pistons.
- Inverse piezoelectric effect applying voltage to plates made of this materials.
- Bimetallic plates controlled by temperature using part of the thermal energy collected to heat up the plates as much as needed.

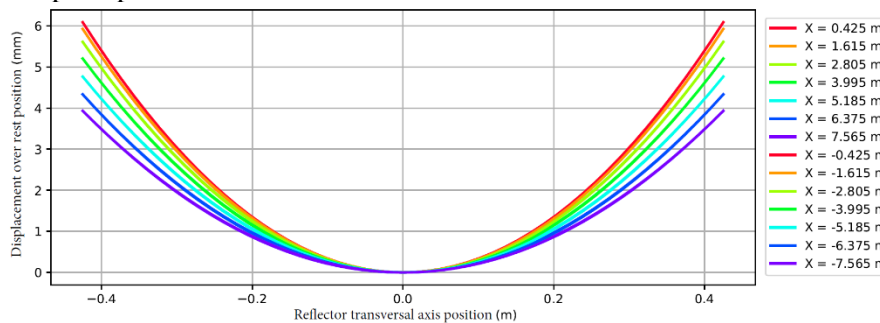


Figure 3. Flexion profile of each reflector line according to its position in the field (X).

5. Conclusions

This preliminary analysis shows promising results for this new LFR concept. Optical efficiencies can be kept high during more hours along the day yielding largely improved daily and seasonal optical efficiencies. This will allow to reduce thermal losses of the system by means of reducing receiver wide (since the print has been reduced). On the other hand, it is possible to improve the energy collected with the same receiver by widening the reflector field.

6. References

- [1] K. Lovegrove, W. Stein, Concentrating Solar Power Technology: Principles, Developments and Applications, Elsevier Science, 2012.
- [2] NREL-National Renewable Energy Laboratory, Soltrace Optical Modeling Software, (2012). <http://www.nrel.gov/csp/soltrace/download.html>.