Characterization of the Eurotrough PTC and development of a methodology

to determine torsion using high-precision inclinometers

Graduate

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Initial Situation: Concentrating solar power is an established technology for renewable electricity generation and makes a significant contribution to international commitments to reduce the increase in greenhouse gases and their contribution to climate change. Current research still aims at improving this technology and making it more efficient in order to increase the useful energy (electricity or process heat) generated by these collectors.

This bachelor thesis was carried out at Plataforma Solar de Almería, the largest solar thermal concentrating research, development, and test center in Europe. The work focuses on the development of a methodology to characterize misalignment in the focal line due to torsion in a solar thermal concentrating parabolic trough collector. This deviation in the alignment of the central axis of the receiver tube is an important factor which reduces the performance of the collector. A method should be determined to characterize the alignment for new prototypes to be installed in the near future.

Approach / Technology: To measure this misalignment, seven high precise inclination sensors capable of detecting small variations of hundreths of a degree are used and installed in the construction, parallel to the focus axis of the collector. Before these sensors could be used in the field, they were calibrated in a laboratory to improve their measurement accuracy and repeatability (shown in Figure 2).
Several measurements were performed on the Eurotrough semi-collector to determine the torsion that caused the focal line not to coincide with its reference position. For this purpose, the collector was rotated into different positions and also set to sun tracking mode. A simplified simulation was also carried out using ray tracing software to see at what point of misalignment the performance of the PTC drops dramatically. With these methods, the often-used collector type Eurotrough is operated as in reality in commercial solar power plants. It is possible to detect the difference in alignment, also the stiffness and overall behavior of this collector can be characterized.

Conclusion: The experiments by using these inclinometer sensors have shown the behavior and inclination position of the various elements of the collector could be measured very precisely. They are suitable to detect very small deviations which is very important in this area of the focus line's orientation. A maximal torsion or misalignment in the focus axis of 0.35-0.4° with minimal measurment uncertainity during the rotation positions or tracking modus could be measured. It has been shown that the direction of rotation of the collector has a small influence on the torsion value. With a ray tracing simulation, an initial estimate can be made of the power that still reaches the receiver tube at various levels of misalignment. Using the measured torsion from the experiments, it can be said that the geometrical intercept factor decreases by 2 percent due to the misalignment in the focus axis with regard to the incident flux analysis in the simulation (shown in Diagram). It also became apparent that with higher misalignment the losses would increase drastically.

Figure 1: Eurotrough collector at the Plataforma Solar de Almería
Own presentment

Figure 2: Setup for sensor calibration
Own presentment

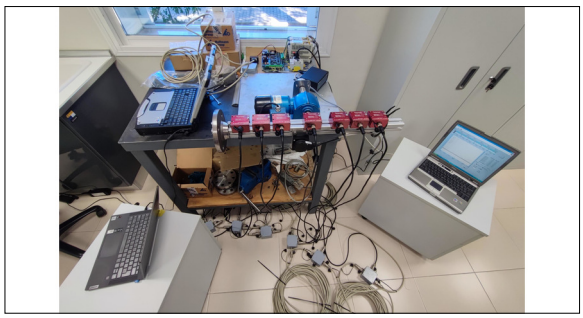
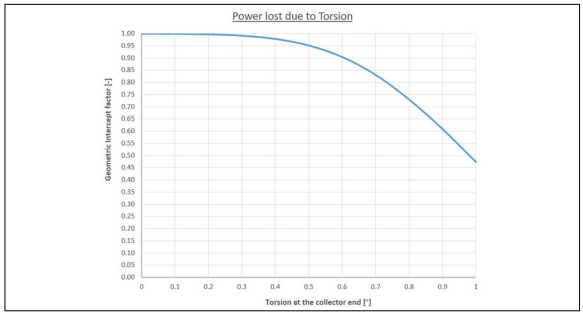


Diagram: Simulated effect of losses due to torsion
Own presentment



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Subject Area
Solar thermal technology