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COMPARISON BETWEEN SOLAR TRACKING SYSTEMS DEVELOPED FROM MATHEMATICAL MODELS OF SOLAR GEOMETRY AND LDR SENSORS

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Abstract. *Stationary flat plate and tube collectors that do not require solar tracking system have been used more every day for various applications. An alternative to these conventional collectors is the use of the V-trough and parabolics collectors. They concentrate the received radiation in its focus. If it is combined to solar tracking systems, provides greater solar radiation absorption than flat plates collectors. In this study algorithms are implemented in order to enable the timed command of the solar or radiation sensors tracking systems viability. The tracking system was simulated and implemented following the methodology used by Duffie (1991) and Beckman (2006). In other simulation, light sensors were used for a tracking system. The obtained results from the two models were compared. The results obtained from the LDR sensors blur the collector due to the interference from other light sources. The adjustment with solar geometry equations depends heavily on a clock coupled to the integrated circuit. Besides the sunlight, tests with the set LDR sensors in the focus will be performed.*

Keywords: *Mathematical model, LDR sensors and solar tracking.*

1. INTRODUCTION

The parabolic collector is an example of concentrating collector, it has a concentrating surface in parabolic shape, which reflects the solar radiation to a determined focus, this energy can be absorbed by a heated fluid and transformed into electrical energy. Solar tracking systems are interesting alternatives to be used with the collectors because with the opening towards to the sun, the concentration in the focus is higher.

2. COMPUTATIONAL PROCEDURE

The solar tracking systems models can have one or two axes of movement, when one axis can perform the east-west, north-south or vertical orientation. With two axes, one of them is vertical, and it sets the Azimuth surface angle, the second is horizontal, it tilts the panel surface towards the sun. Six types of tracking systems can be developed from the analytical equations and implemented in electronic devices associated to tracking systems (Duffie and Beckman, 2006). In figure 1 it is possible to demonstrate the model plane with fixed inclination, turned over a vertical axis was used for the development of this proposed study. According to Paiva (2009), this model uses a motor in the vertical axis and swivels in the east-west direction (apparent solar path). In addition, it presents a low cost of maintenance and assembly, and also good performance in mechanical and electrical.

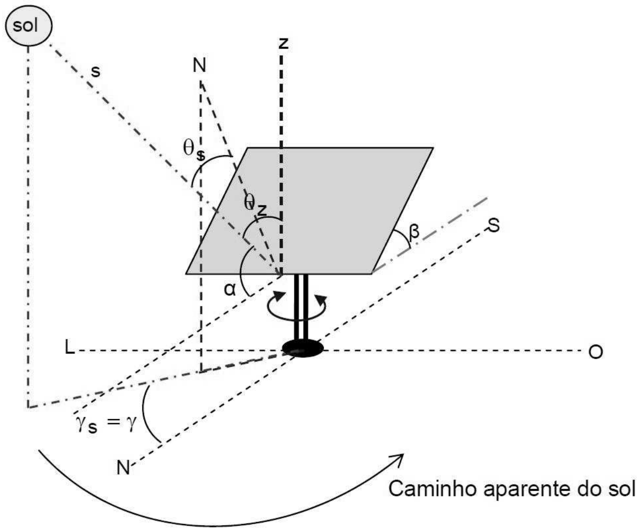

Figure 1. Mobile vertical tracking axis. Source: Paiva, 2009.

3. RESULTS AND DISCUSSION

Figures 2 and 3 were obtained considering a tracking system studied for the period of January the first to January the tenth, respectively. From these figures, Duffie and Beckman (1991) and (2006) observed that the Azimuth angle in function of the solar hour does not present significate differences in terms of scale. It's noticeable on figures 2 and 3 that at solar midday the azimuth solar angle is 0º. For the January first (Figure 2), there are maximum differences of 3.54º at 11:00 and 13:00 hours and 2.92º at 08:00 and 16:00 hours. For the January tenth (figure 3), it is noticeable maximum errors of 3.88º at 11:00 and 13:00 hours and 3.05º at 08:00 and 16:00 hours.

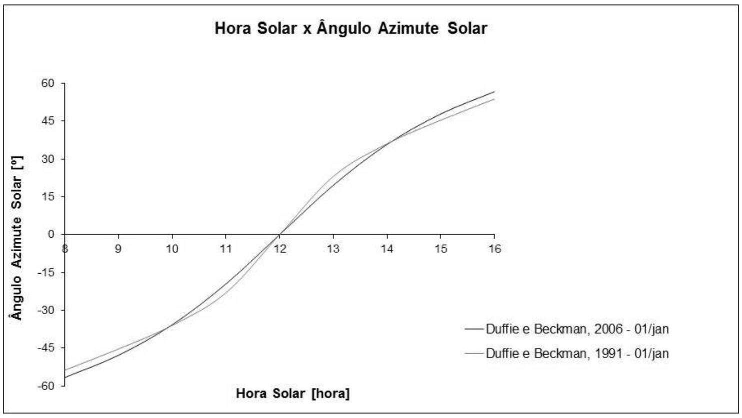

Figure 2. Solar Hour x Solar Azimuth Angle, for Jan-1st. Duffie, 1991 and Beckman, 2006.

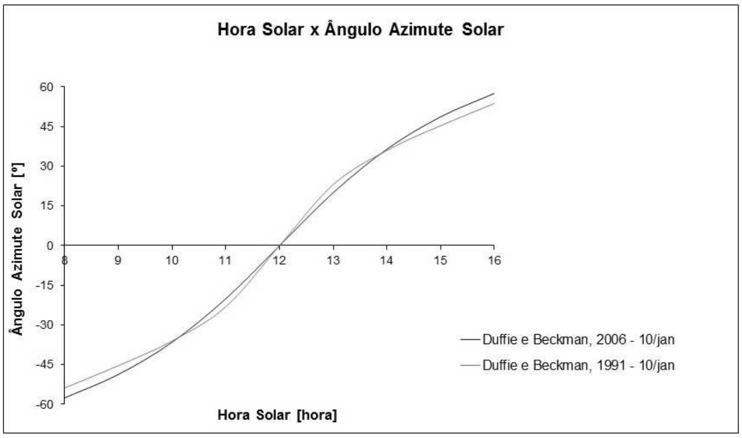

Figure 3. Solar Hour x Solar Azimuth Angle, for Jan-10th. Duffie, 1991 and Beckman, 2006.

Table 1 shows the inclination of the sun regarding the chosen inclination for the solar concentrator, keeping β constant, variable which could be reoriented. On figure 4, the azimuth solar angle versus radiation incidence angle is shown, the used equation for the Solar Azimuth Angle was presented by Duffie and Beckman (2006), supposing this equation more adequate for being newer. According to figure 4, data obtained for a β inclination, calculated for the concentrator, at solar midday, hour angle equal to 0º, the radiation incidence angle over the concentrator is 15.71º in January the first and 16.13º on January the tenth.

Table 1- Sun inclination regarding to the chosen inclination of the solar concentrator, β constant.

ANGLE BY TIME (º) (Ω)	THETHA ANGLE (º) – INCIDENCE ANGLE (Θ)									
	01/Jan	02/Jan	03/Jan	04/Jan	05/Jan	06/Jan	07/Jan	08/Jan	09/Jan	10/Jan
-60	41,34	41,41	41,5	41,59	41,68	41,79	41,9	42,01	42,13	42,26
-45	32,07	32,13	32,2	32,28	32,36	32,44	32,53	32,63	32,73	32,83
-30	23,89	23,94	23,99	24,05	24,12	24,18	24,25	24,33	24,41	24,49
-15	17,95	17,99	18,03	18,08	18,13	18,18	18,24	18,3	18,36	18,42
0	15,71	15,74	15,78	15,82	15,87	15,91	15,96	16,02	16,07	16,13
15	17,95	17,99	18,03	18,08	18,13	18,18	18,24	18,3	18,36	18,42
30	23,89	23,94	23,99	24,05	24,12	24,18	24,25	24,33	24,41	24,49
45	32,07	32,13	32,2	32,28	32,36	32,44	32,53	32,63	32,73	32,83
60	41,34	41,41	41,5	41,59	41,68	41,79	41,9	42,01	42,13	42,26

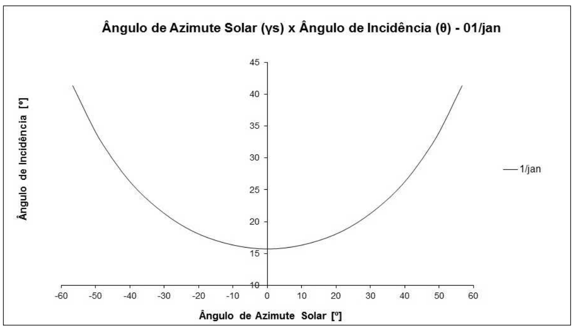

Figure 4. Solar Azimuth Angle x Incidence Angle - 01/Jan.

4. CONCLUSION

Implementation of an algorithm for the feasibility of solar tracking systems with fixed orientation plane, rotation around vertical axis for timed command was developed on MATLAB software for computational simulation. The simulation with the use of radiation sensors. The tracking system was implemented from the Duffie (1991) and Beckman (2006) methodology. The physical model construction to the mathematical model use of the solar tracking is being finalized and preliminary tests have already been performed. In addition to the analytical model, a physical tracking system has been implemented in this physical model using LDR sensors that randomly deviate from any light source.

5. REFERENCE

Duffie, John A., Beckman, WilliamA., 1991. *Solar engineering of thermal processes*. John Wiley & Sons, New Jersey, 2nd edition.

Duffie, John A., Beckman, WilliamA., 2006. *Solar engineering of thermal processes*. John Wiley & Sons, New Jersey, 3rd edition.

Paiva, Edinei., 2009. *Desenvolvimento de um rastreador solar microcontrolado para um coletor solar concentrador*. Ph.D. thesis, Federal University of Viçosa, Viçosa-MG.

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