STREG students visit to the CSIR- July 2011

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Four of the MScEng students from the Solar Thermal Energy Research Group (STERG) did four weeks of practical work at the CSIR campus in Pretoria from 4 to 28 July 2011. The four students were Sebastian Bode, Holger Kretzschmar, Willem Landman and André Louw.

The four weeks were spent working in conjunction with Mr Thomas Roos whom is currently doing his PhD on developing a receiver for a central tower solar power plant. He invited the students to complete a few projects to help him setup his experiment to test his receiver. The projects that were undertaken during this period were to assemble and mount 25m^2 heliostat, setup calorimeter measurement equipment, prepare the small 1.08m^2 heliostat, take solar flux measurements from calorimeter, re-designing the Compound Parabolic Concentrator's (CPC) cooling system and experimental testing with the thermal storage rig.

The 25 m^2 heliostat needed to be mounted onto the roof of one of the buildings at the CSIR. To accomplish this, a detailed study of the installation procedure to ensure the 3ton structure was at all times safe and balanced was done, also the 18 mirrors were installed onto the mirror frame and the heliostat drive mechanism was installed onto the heliostat structure. The mirror frame for the big heliostat with the mirror already installed can be seen in the figure 1 the heliostat structure is shown in figure 2.

Figure 1: Big heliostat (25 m^2) mirror frame

Figure 2: Big heliostat structure

The mirror was successfully mounted during the last week of the students work period. The students did unfortunately not have enough time to adjust the mirrors of the heliostat to form a single focal spot. A photograph of the heliostat being mounted is shown below in figure 3 and figure 4 shows the assembled heliostat on the roof of the building.

Figure 3: Heliostat assembly

Figure 4: Assembled heliostat

The task of setting up the 1.08 m^2 heliostat was the highest priority for Mr Thomas Roos; it formed part of a conference paper for Solar Paces. The small 1.08 m^2 heliostat was used to take solar flux measurements with the calorimeter to see if it gave reasonable measurements before it measures the solar flux from the big heliostat. The task was divided into two parts, one part was setting up calorimeter measurement equipment and the other part was setting up the mirrors.

In order to set up the system for testing, it had to be cleaned, flushed; and all the flow rates had to be recalibrated. The calorimeter and the measurement equipment are shown in figure 5 below.

Figure 5: Calorimeter and calorimeter test rig

Setting up the mirrors on the 1.08m^2 heliostat and attaining a decent focal spot was a surprisingly arduous task. Twelfth 30 X 30 cm bathroom mirrors were used and held in place by prestik and a 'mirror support structure' that had to be designed and built to keep the mirrors from moving and losing focus. In figure 6 below the small heliostat can be seen.

Figure 6: Small heliostat (1.08 m^2)

The small heliostat was also used to test the tracking system for the big heliostat; this was done by CSIR personnel. A photograph of the focal spot of the small heliostat is shown in figure 7 below.

Figure 7: Small heliostat focal spot

The solar flux from the small heliostat was focused on the beam down mirror that can also be seen in figure 7 on the left of the focal spot. In figure 8 the calorimeter can be seen illuminated by the small heliostat.

Figure 8: Calorimeter illuminated

On the last day of the students work period, measurements were taken but the result from the test was not what was expected. Only a very small temperature rise was recorded. It was suspected that the wrong settings were used in Signal Express to measure the temperature. Sebastian returned the next week to check for possible causes for the incorrect results. After eliminating all possible causes of error, two more tests were run over two days. These tests gave similar results as the first one, thus proving repeatability of the experiment.

The students also re-designed the cooling system that protects the mirrors of the CPC. The previous design leaked catastrophically in all sections. It was then decided to completely redesign the cooling system for the CPC based on the lessons learned from the previous design. The design was adjusted to accommodate for better sealing by splitting the complete CPC sections (that were originally one bent section) into various smaller straight sections. The completed design drawings for the CPC were handed in at the end of the month. The students unfortunately left before components were manufactured.

Thomas Roos is also a co-supervisor for Pieter Klein a MScEng student from the University of Witwatersrand who was doing thermal storage tests to validate his numerical model for the heat transfer through a packed bed. The students aided Pieter to run his experiments. A photograph of his experiment is shown in figure 9 below.

Figure 9: Packed bed thermal storage experiment

The gas burner needed to be modified to give a more evenly distributed flame. Once it was modified a charging and cooling test was done. The test however could not be completed because of a nationwide LPG gas shortage. There was enough gas to heat the bed half way through to 500℃, but the result from the test did not compare well to his numerical model. A possible reason for this was that there was a leak, but a leak test was done and there was no indication of a leak anywhere. Another possible explanation could be the fact that the air flow needed to be choked quite a lot to keep the temperature constant, causing inaccurate flow measurements. This test will need to be repeated in the future.

The hands on approach allowed the students to be involved in all aspects of the work ranging from design work, to physical installations and experiments. The students got very good exposure to the practical work around CSP technologies. The trip was a positive experience and the insight gained will prove beneficial to the students and the Masters projects they are involved in.