CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Results

Typical data collected from one test is shown in Appendix A. A complete data book and results obtained from this work are filed in the Chemical Technology Department.

Figure 4.1 shows the plot of disk temperature against local time for the testing of three different radiometer sizes, i.e., for unit 5, 6 and 7. The detailed dimensions of these units can be found in Table 3.1. All the disks were of the same material, size and thickness. They were made of brass, with 12 cm. diameter and 0.3 mm. thickness. Besides they were coated with the same kind of flat black paint, PYLOX. The readings were about the same, showing that the radiometer sizes in the range of this study had no effect on their performance. Hence the selection of a proper radiometer size could easily be done by choosing anyone of the units.

For the effect of disk material, the result of the testing is shown in Figure 4.2 where disk temperatures are plotted against local time for four different disk materials but having the same size and thickness. Disk diameters were 12 cm and their thicknesses were 0.3 mm. The plot confirmed that they produced the same result. This indicated that the disk material had no effect on the readings.

The effect of disk thickness was also investigated for five values using stainless steel as the disk material. The disk thickness was varied from 0.3 mm to 3.0 mm. Figure 4.3 shows that the thinner ones had better sensitivity and higher disk temperature readings were obtained.

In order to select a proper disk diameter, the effect of disk diameter was also studied. Figure 4.4 shows plots of disk temperature against local time taken from two different disk diameters. One was 10 cm in diameter while the other was 12 cm. All other variables were held constant. Both disks produced the same readings.

Generally, coating spray paints applied on the radiometer disk play an important role in the radiometer performance. Four locally manufactured flat black paints available in the market were tested. These paints were Pylox, Pagoda, Tora and Nissan. For more details of them, refer to Table 3.3. The testing result is shown in Figure 4.5. The temperature readings of the disks were of similar magnitudes, indicating that any one of the paints would be used for this purpose.

Typical data for calibration of radiometer is also shown in Appendix A. in Table A.2. The recorded graph from the standard pyranometer and the graph constructed from the radiometer readings are shown in Figure A.1 and A.2 respectively. It is noted that the shapes of both curves were of similar pattern. From these two figures conversion constants for hour

Date	: Apr. 30, 77
Radiometer size	: Unit no. 5, 6 and 7
Disk material	: Brass
Disk thickness	: 0.3 mm
Disk diameter	: 12 cm
Coating paint	: Pylox

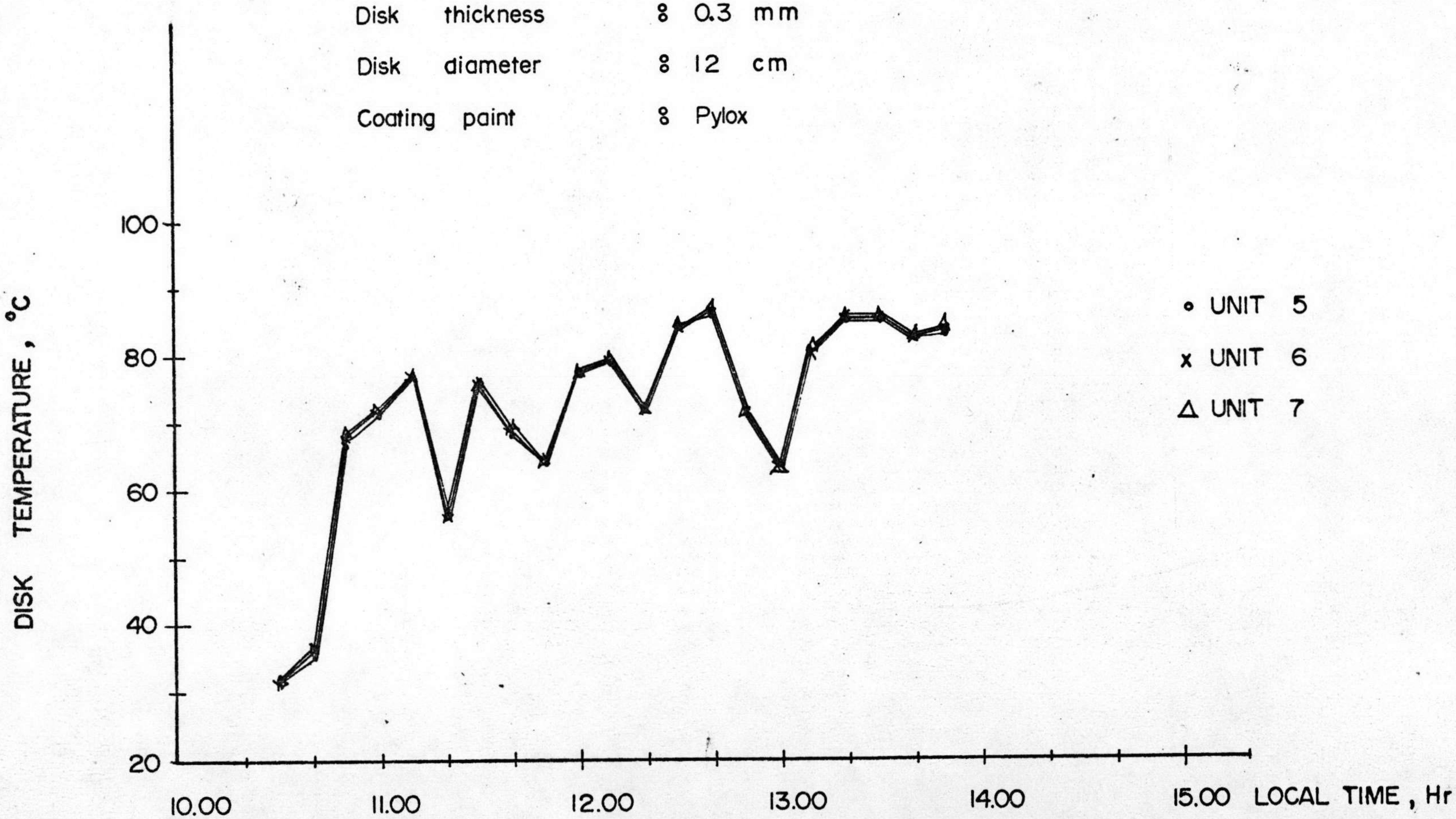

FIGURE 4.1 EFFECT OF RADIOMETER SIZE

Date	:	Apr. 23, 77
Radiometer size	:	Unit no. 1, 2, 3, 4 and 5
Disk material	:	Aluminium, Brass, Stainless steel and Zinc
Disk thickness	:	0.3 mm
Disk diameter	:	12 cm
Coating paint	:	Pylox

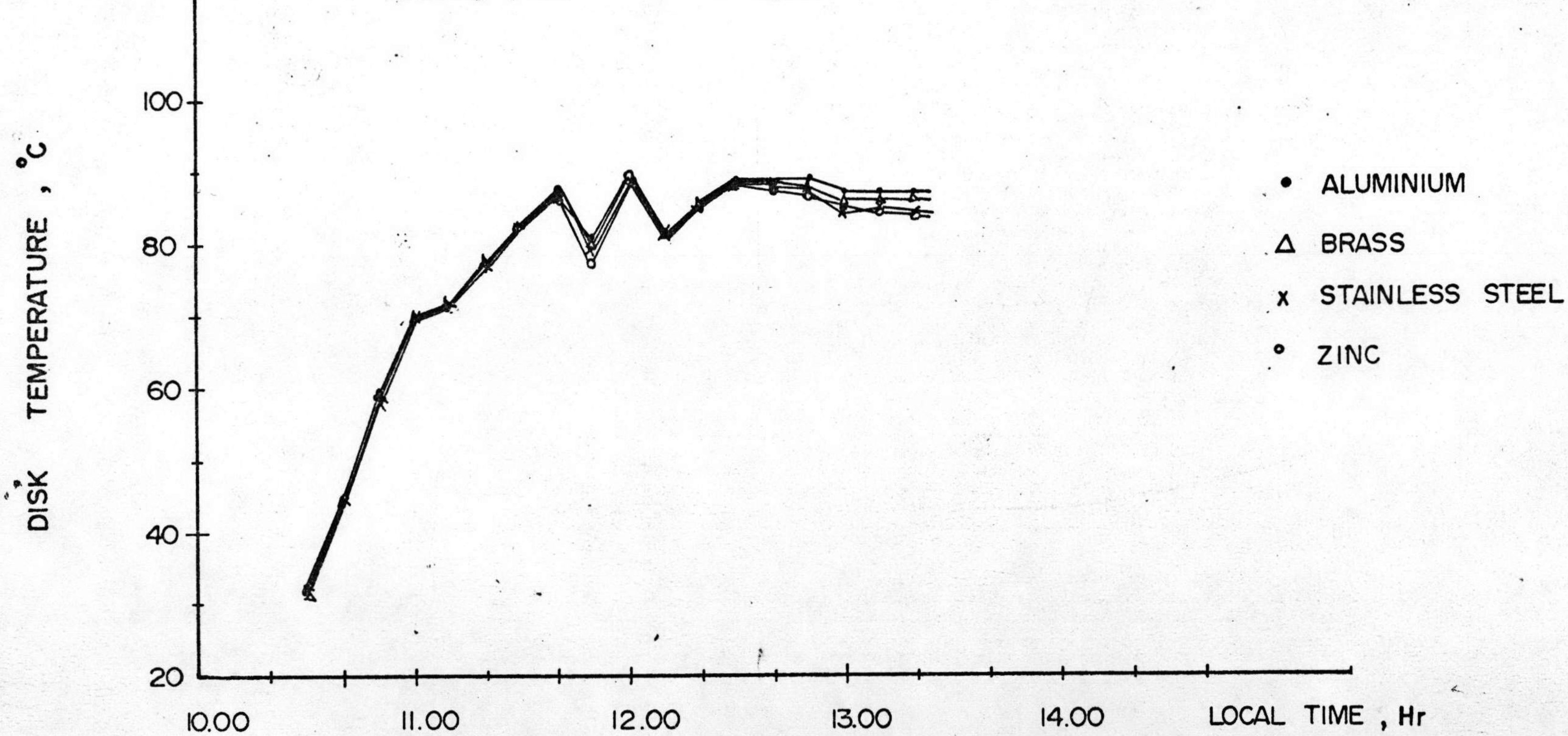

FIGURE 4.2 EFFECT OF DISK MATERIAL

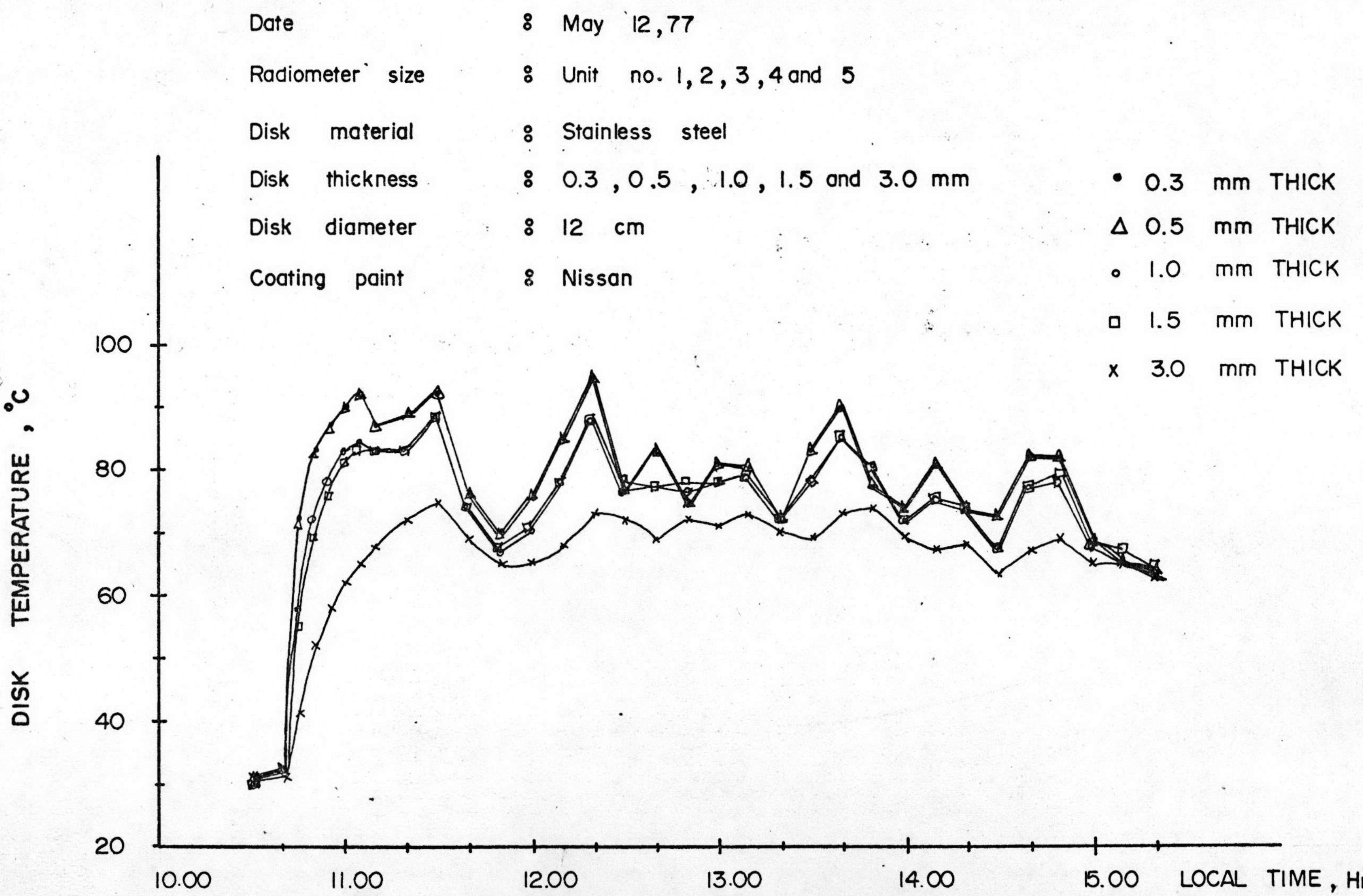

FIGURE 4.3 EFFECT OF DISK THICKNESS.

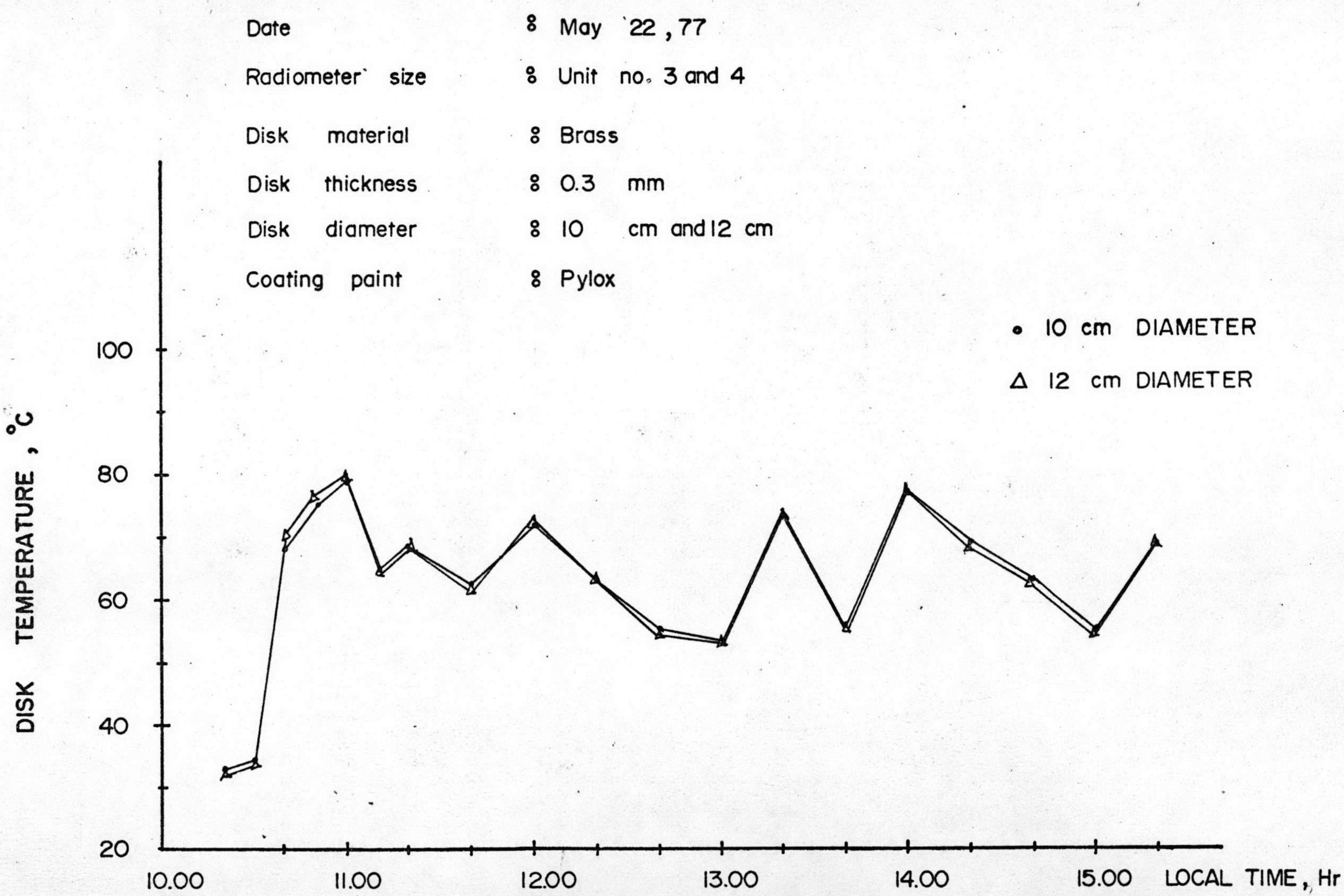

FIGURE 4.4 EFFECT OF DISK DIAMETER

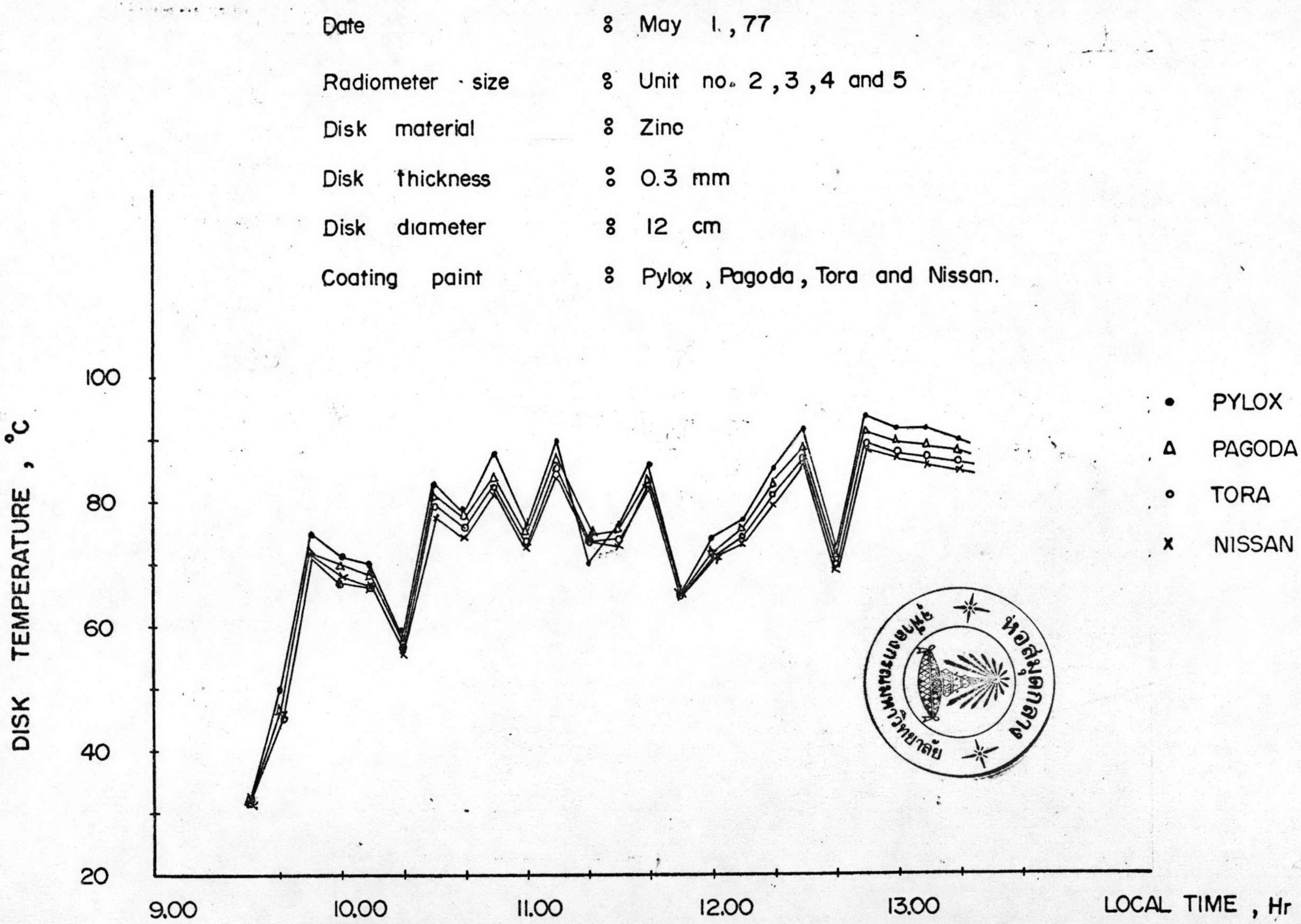

FIGURE 4.5 EFFECT OF DISK COATING

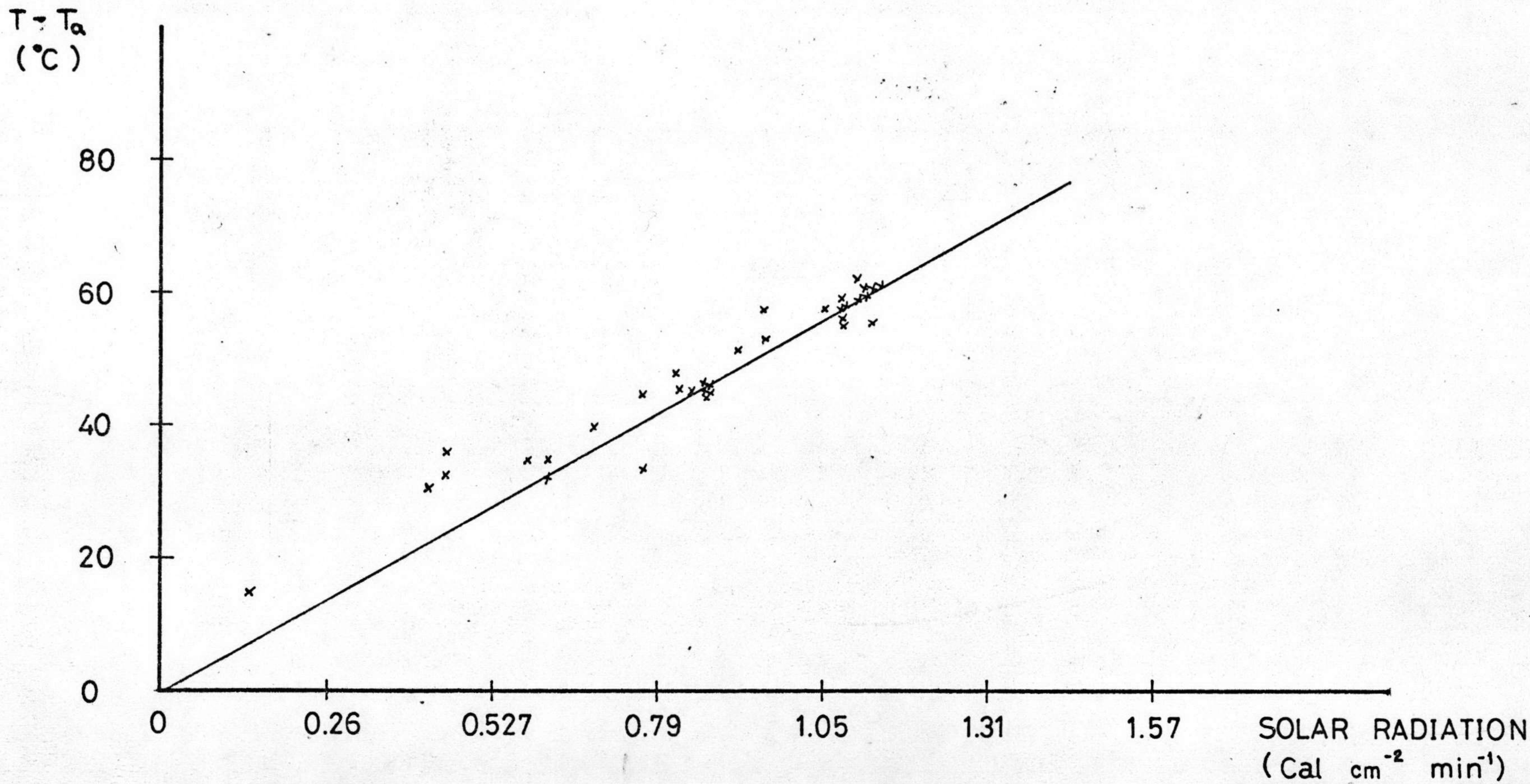

FIGURE 4.6 CALIBRATION CHART FOR INSTANTANEOUS READING

reading were calculated for the day. Sample of calculation is shown in Appendix B. Average values of the constants were obtained from repeated results of many testings. The results are tabulated in Table 4.1.

Calibration chart for instantaneous reading is shown in Figure 4.6. It is a plot of $(T-T_a)$, i.e., difference between disk and ambient temperatures in ^oC versus solar radiation in $cal/cm^2\ min^{-1}$. A straight line was obtained on the plot with a slope of $53^oC/cal\ cm^{-2}min^{-1}$. This value could simply be used for obtaining the instantaneous solar flux on the earth surface.

4.2 Discussion

In the design of a low cost portable solar radiometer for measuring total solar radiation several simple models were designed, constructed and tested. The results presented previously could be considered as from the final design. It should be noted that the instrument was made air-tight in order to avoid moisture condensation on the glass cover andfree from the effect of wind. The results of the investigations on the performance of radiometers showing the dependency of a number of variables were presented in Figures 4.1 to 4.5. These variables were radiometer size, disk material, disk thickness, disk diameter and disk coating paint.

The test result as shown in Figure 4.1 indicated that within the size range selected for the study, there was no effect upon the radiometer readings. However, due to its compactness, the size of unit no.5 was recommended. Therefore, in later tests for the study of the influence of other variables, only the size of unit

Table 4.1 Conversion Constants for Hour Reading

Local Time, Hr	K cal cm^{-4} hr^{-1}
9.00-10.00	14.95
10.00-11.00	13.66
11.00-12.00	13.66
12.00-13.00	13.39
13.00-14.00	12.34
14.00 15.00	13.13
15.00-16.00	11.55

no.5 was used.

Figure 4.2 has confirmed that the selected materials for making radiometer disks would produce the similar result. In fact these materials i.e., aluminium, brass, stainless steel and zinc have high values of thermal conductivity and the disks were rather thin so that they could distribute heat evenly and fast to the temperature sensing element, the thermometer placing underneath. Hence the selection of disk material was based on other criteria such as its availability, cost and other properties. The above metals are commercially available and their costs are not much different provided that the quantity needed is relatively small. The stainless steel is preferred due of its strength and anti-corrosion property.

For the selection of disk thickness, the size of unit no.5 together with stainless steel disks were tested for different disk thicknesses.

As shown in Figure 4.3 the 0.3 and 0.5 mm thick disk had about the same response and temperature. The thicker disks had slower response. In general, faster response is preferred but if the disk is too thin there would be some difficulties in fabrication and usage. Therefore, upon considering the above points, the 0.5 mm disk thickness was recommended. However, other thickness in this neighbourhood will also do the job if this thickness is unavailable.

According to a heat balance equation written for a receiving surface, i.e., disk, disk diameter should not have any effect on the disk temperature readings. This was confirmed in the result shown in Figure 4.4. Two sizes of disk diameter which were about suitable for using in the radiometer size of unit no. 5 were tested. They were 10 and 12 cm. in diameter. The 12 cm. diameter was selected in later tests. It should be kept in mind that if the disk diameter is too small it will be difficult in the fabrication. On the other hand if it is too large, the shadow may be formed on the edge of the disk when performing the test early in the morning or late in the evening.

For the effects of disk coating, four types of flat black spraying paints were tested. As the result shown in Figure 4.5, they all can be employed for the coating. However, the selection of these paints were made from other criteria such as the smoothness of the coated surface, durability after long period of exposure to the sun and so on. In this study the PYLOX was found to be better than all of other three kinds and was used in subsequent tests.

An analysis of the heat transfer processes taking place in the radiometer was attempted. But due to some uncertain variables and insufficient data, a mathematical model could not be successfully set up to explain the performance of the radiometer.