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ICE POINT BLACKBODY CAVITY FOR CHECKING THE PERFORMANCE OF AN INFRARED RADIATION THERMOMETER OPERATING NEAR 0 °C

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Abstract: An ice point blackbody cavity has been designed and constructed at NML-SIRIM, Malaysia. It is a mean to measure the ice point reading of client's infrared radiation thermometer that operates near 0 °C. The ice point check will predict the performance of the thermometer at other temperature range.

Keywords: ice point cavity, ice point check, infrared radiation thermometer

1. INTRODUCTION

Today, the usage of infrared radiation thermometers has expanded tremendously. Their distinct capability of measuring an object's temperature without contact has boost up its popularity among industries such as frozen food manufacturing companies and medical application sectors. By using non-contact method, the temperature measurement can be done without damaging or contaminating the object. But after frequent use, the infrared radiation thermometers need to be checked if any drift occurs which leads to an error in the measurement. For an infrared radiation thermometer that operates near 0 °C, the simplest method to check if it is working reliably is by using ice point check. The ice point check should be performed at regular basis and the ice point reading is normally taken as the first impression of the thermometer's performance.

2. ICE POINT BLACKBODY CAVITY

At NML-SIRIM, the assembly of the ice point blackbody cavity (see Figure 1) consists of the following apparatus:

2.1. Insulating container

A boro-silicate glass dewar flask of Model 1249 Type C Coated Blue Cover by the German manufacturer, KGW Isotherm, is used as the vacuum-insulated container. The model has a strong design with inner diameter of 158 mm and depth of 400 mm. The flask is deep enough to form a hole with a depth of more than five times the field of view of the infrared radiation thermometer being used [1]. The dimensions of the hole of the blackbody cavity is given by the values in Table 1:

Table 1. Dimension of hole.

Dimension	Size
Aperture	23 mm
Depth	300 mm

2.2. A siphon tube

In order to ensure that temperature of bottom cavity maintains at 0 °C, a siphon tube was placed in the flask to facilitate the removal process of excess water.

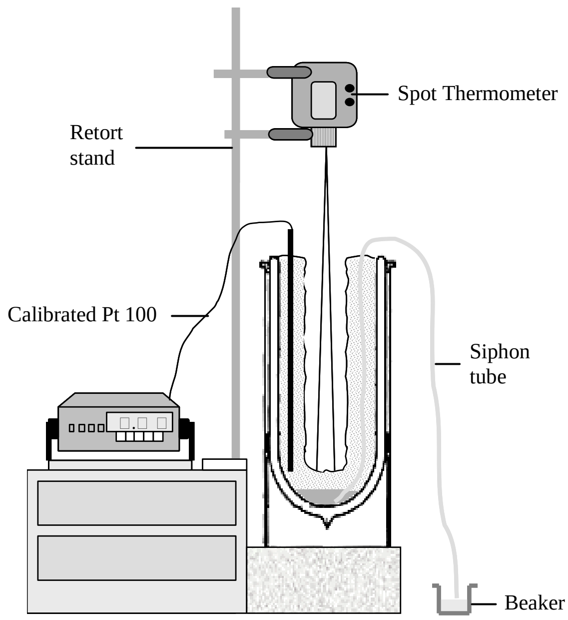

Figure 1. NML-SIRIM ice point blackbody cavity

2.3. Clean, shaved ice

There are two types of ice formation process at NML-SIRIM. The first type is from the automatic ice flake machine using the filtered water from the main tap. The second one is manually prepared in cubes from the distilled water and later kept in the freezer. Both types were then be shaved to smaller pieces using an automatic ice slicer. To ensure that all the ice is at 0 °C, the formation of the slush is crucial [2]. Therefore all the shaved ice is mixed with the distilled water and then is filled up into the dewar flask. The mixture was given about 20 minutes to reach a constant temperature before the measurement using an infrared radiation thermometer was performed.

The measurement

A Konica Minolta TA-0150bF spot thermometer with spectral response of 8 to 13 µm was used to measure the temperature at the bottom cavity. The minimum subject size for the thermometer is 9 x 3 mm at 500 mm subject distance. The accuracy for measured temperature 0 °C or below is ± 3 °C [3].

The thermometer was aligned so as to be coaxial with the blackbody cavity. A retort stand was used to enable the thermometer to rest on the arms in order to facilitate during focusing process. The measuring button was pressed in the manual-measuring mode when measuring the temperature reading of the thermometer. The emissivity setting of the thermometer was set to 0.97 [4].

The temperature of the bottom cavity was measured by a calibrated Pt100 probe. The temperature output of both Pt100 and spot thermometer were recorded simultaneously with 10 seconds time interval. A set of data was obtained after 10 readings of each were taken. The measurement was performed with the room lights off. The second set was recorded after 10 minutes of separation time. The third set of data was recorded when the measurement was repeated again after 3 hours. The purpose was to check the stability of the temperature of the bottom cavity against time. Another two sets of data, Set 4 and Set 5, were obtained when the measurement was repeated to check for the drift and by different personnel to check for the reproducibility respectively.

The results

The measurement results are shown in Table 2. The four sets of data were found to be good with a repeatability and reproducibility of better than 0.01 °C. The temperature of the bottom cavity was also found to be very stable with reading output maintained at 0.00 °C throughout the measurement. The expanded uncertainty of the measurement was calculated and found to be better than 0.2 °C.

Table 2

February 2006	Average Pt100 (°C)	Average Spot Thermometer (°C)
Set 1	0.000	-0.04
Set 2	0.000	-0.05
Set 3	0.000	-0.05

Mid April 2006	Average Pt100 (°C)	Average Spot Thermometer (°C)
Set 4	0.000	-0.05

Different Personnel	Average Pt100 (°C)	Average Spot Thermometer (°C)
Set 5	0.000	-0.04

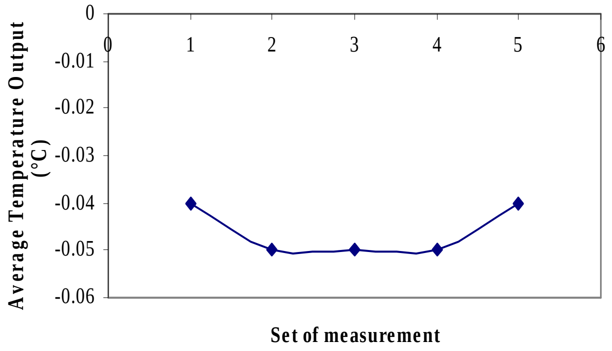

Figure 2. Repeatability of Spot Thermometer (TA-0150bF)

3. CONCLUSION

With the good repeatability and reproducibility, the ice point blackbody cavity with the designed hole dimension could be considered as good enough to enable the checking of the performance of an infrared radiation thermometer with suitable size of measurement area.

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