Measurement of Temperature of 48Y-cylinder Exposed to Sun

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INTRODUCTION

According to the IAEA'85 regulation para.543, when the temperature of a Type B package is evaluated under normal conditions of transport, the solar insolation conditions should be assumed to be as specified in Table XII(para.546), and the ambient temperature should be assumed to be 38°C(para. 545).

Natural UF6 is not regulated by these requirements, because it is classified as the Industrial package. However, it is desirable that the temperature rise is evaluated by thermal analysis or experiment, because natural UF6 has the triple point at 64°C-1140mHg, the sublimation point at 56.4°C-760mHg and liquifies above 64°C.

In order to confirm that UF6 in 48Y cylinder does not liquify during midsummer, temperatures at the surface and inside of 48Y-cylinder were measured last summer (Aug. 1991); the cylinder was filled with steelshot, which has a similar thermal conductivity to UF6.

SPECIMENS

We used three specimens with the differences of painting, contents and protection cover as follows :

Table 1. Specifications of 48Y cylinders

Name	Specifications	Note
A	painted with steelshot with thermal protection cover	to simulate the temperature rise of actual cylinder
B	painted with steelshot without thermal protection cover	to confirm the effect of thermal protection cover
C	not painted (with rust) with steelshot without thermal protection cover	to confirm the effects of painting and of steelshot

Cylinder A and B were painted with silver-metallic color and those cylinders contained steelshot (average particle size: 2mm) which was the substitute of UF6 (Yamakawa et al. 1988). The surface of cylinder C was covered with rust, because it had been exposed to 800℃ temperature in the previous fire test (Abe et al. 1989).

Besides, cylinder A wore the thermal protection cover (thickness: 13mm), which had been developed by CRIEPI and MHI in the joint study of Japanese 10 utilities

(Abe et al. 1989), on both sides of the cylinder. The cover was made of ceramic-fiber cloth, ceramic blanket and glass-fiber cloth coated with silicon resin. Then it is expected to protect from the fire environments or in hot temperature.

Table 2. Thermal characteristics of UF6 and steelshot

Item / Material	Heat capacity $\times 10^3$ Kcal/m^3 ℃	Specific heat Kcal/Kg
Natural Uranium Hexafluoride (UF6)	0.474	0.12 (at 50℃)
Steelshot (2mmΦ)	0.48	0.11

METHODS

The measurement system was composed of three 48Y-cylinders, thermocouples, switch boxes, automatic strain-recorder, personal computer, infrared thermograph, pyrheliometer, and other equipment. Each component of the measurement system is shown in Figure 1. The measuring items were temperature by thermocouples and direct solar radiation by pyrheliometer. There were 48 measurement points located on the surface of three cylinders, in the cavity of cylinders and in steelshot. The personal computer controlled the infrared thermograph and the data logger by basic program. Using this program, we can recall the thermal graphic data in anytime, while we can always monitor the thermal distribution of each part of cylinders.

The measurement started at sunrise and ended at the next sunrise (24Hrs). The measurement interval was 10 minutes during the day and 30 minutes at night.

RESULTS AND EVALUATION

Figure 2 shows the surface temperature of each cylinder which is supposed to indicate the highest temperature. Figure 3 shows the temperature in cavity of cylinder A and B and shows the temperature in the steelshot of cylinder A and B. Figure 4 shows longitudinal temperature distribution of cylinder A. Figure 5 shows longitudinal temperature distribution of cylinder B. Figure 6 shows latitudinal temperature distribution of cylinder B. Figure 7 shows the change of ambient temperature. Finally, figure 8 shows the change of direct solar radiation by pyrheliometer.

The main results were as follows:

1) When the ambient temperature was 30°C, the maximum temperature in the steelshot of the cylinder A with a thermal protection cover developed in CRIEPI was only 27.5°C; the temperature in steelshot of the cylinder B without the cover was 34.5°C, putting a cover over both ends of the cylinder. The cover provided fairly effective insulation and reduced the temperature of steelshot by as much as 7 degrees.

2) When the ambient temperature was 30°C, the surface temperature of cylinder A reached 45°C. The surface temperature of cylinder B reached 49.2°C, and the surface temperature of cylinder C, which surface was red with rust, reached 54°C. Measurement points were not affected by heat conduction to steelshot. It was confirmed that cylinder paint affects the surface emissivity and consequently determines the surface temperature of the cylinder.

CONCLUSION

In midsummer, the temperature rise of steelshot is not so high because of its big heat capacity, while the surface temperature of 48Y cylindeer reaches over 50°C. As a general rule, if the ambient temperature is 38°C, the surface temperature of cylinder A will stay at 53°C; so it is supposed that the UF6 won't liquify.

REFERENCES

Abe, H. et al. "The Integrity Verification Tests and Analysis of a 48Y Cylinder for Transportation of Natural Uranium Hexafluoride", PATRAM'89 Proceedings Volume III (1989)

Yamakawa, H. et al. "Safety Evaluation of The Transport Container for Natural Uranium Hexafluoride under Fire Accident", Uranium Hexafluoride - Safe Handling, Processing, and Transporting Conference Proceedings (1988)

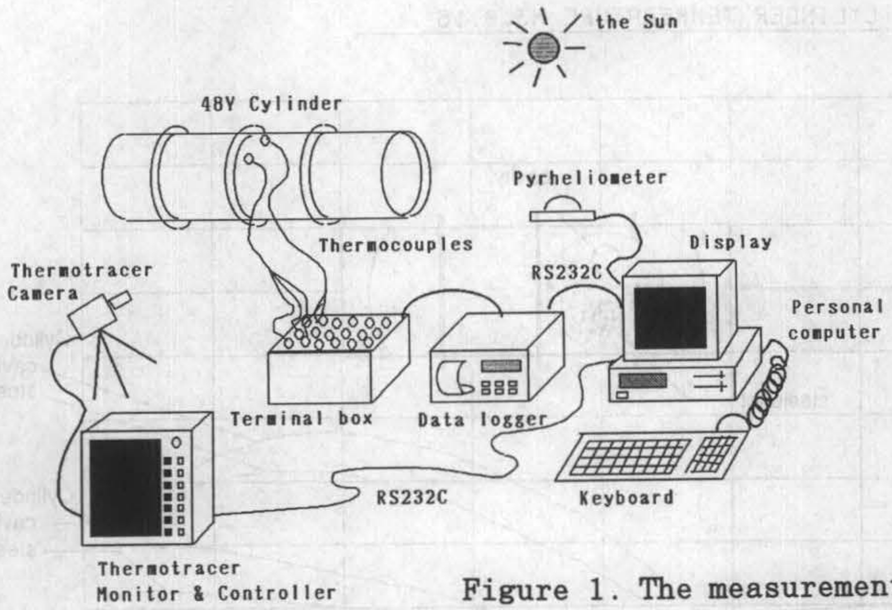

Figure 1. The measurement system

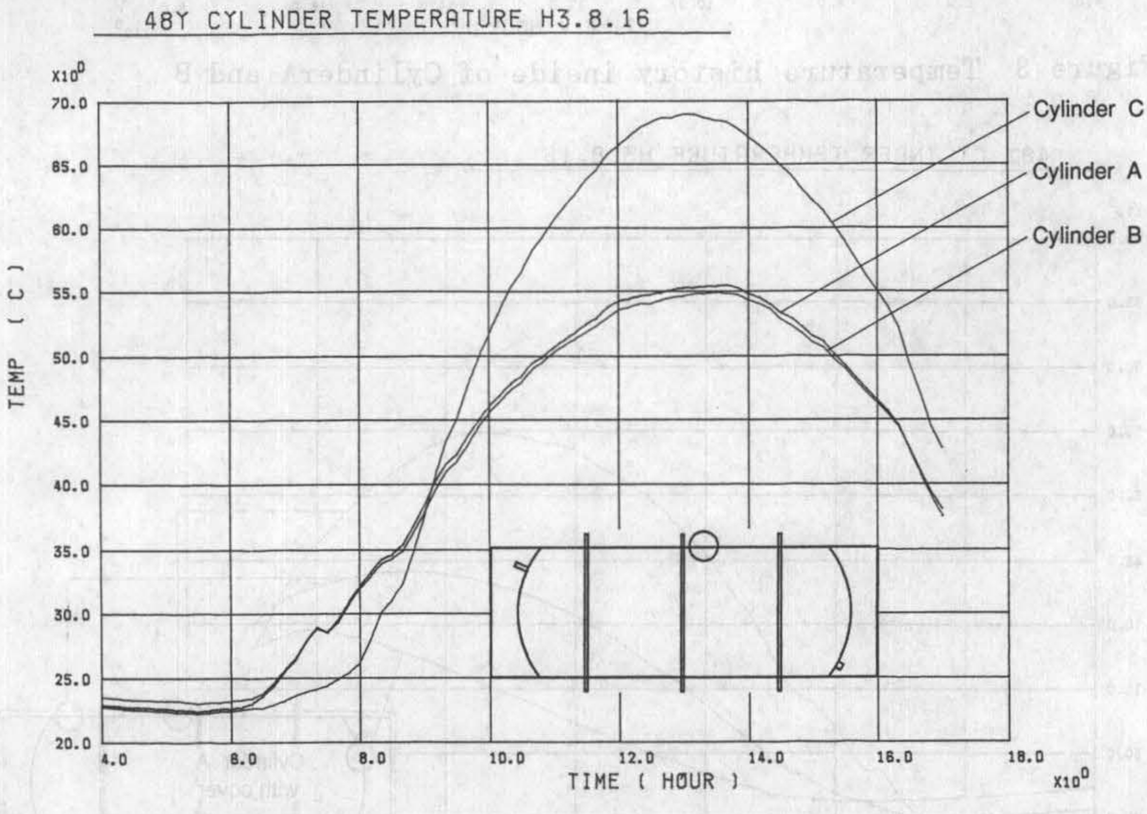

Figure 2. Temperature history at the top surface of each cylinder

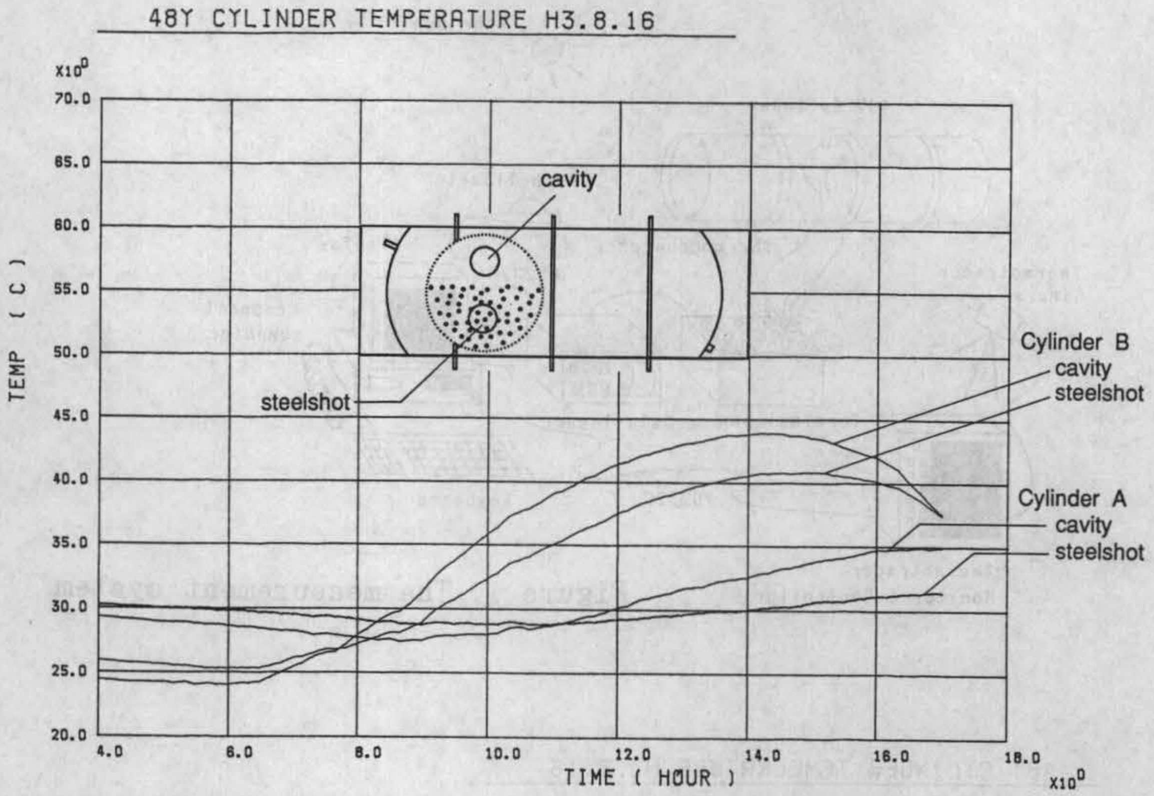

Figure 3. Temperature history inside of CylinderA and B

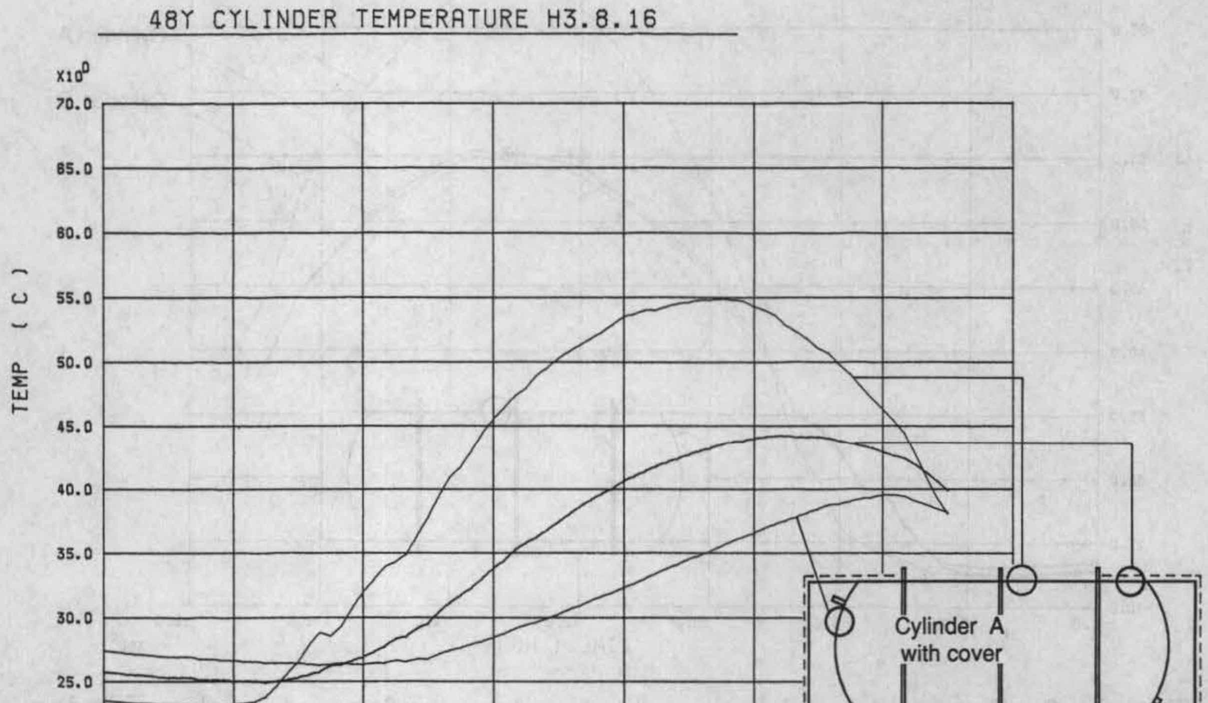

Figure 4. Temperature history at each surface of Cylinder A

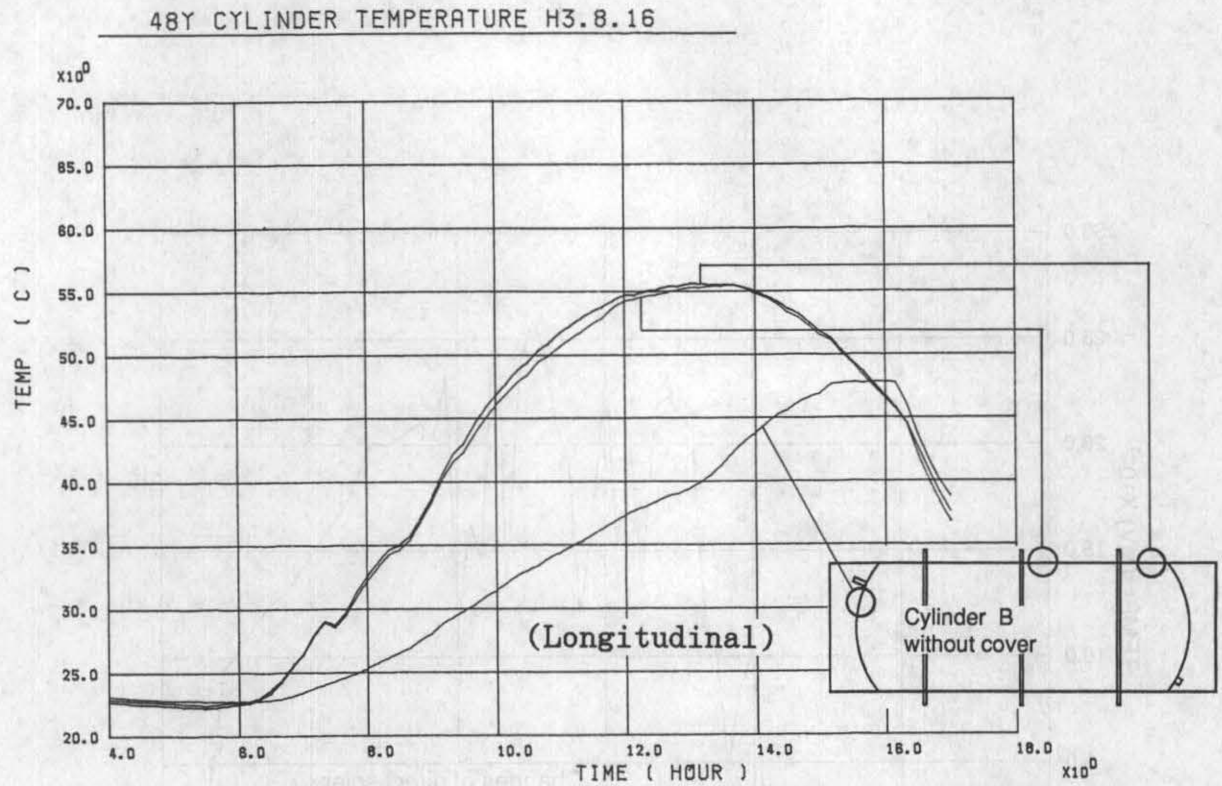

Figure 5. Temperature history at each surface of Cylinder B

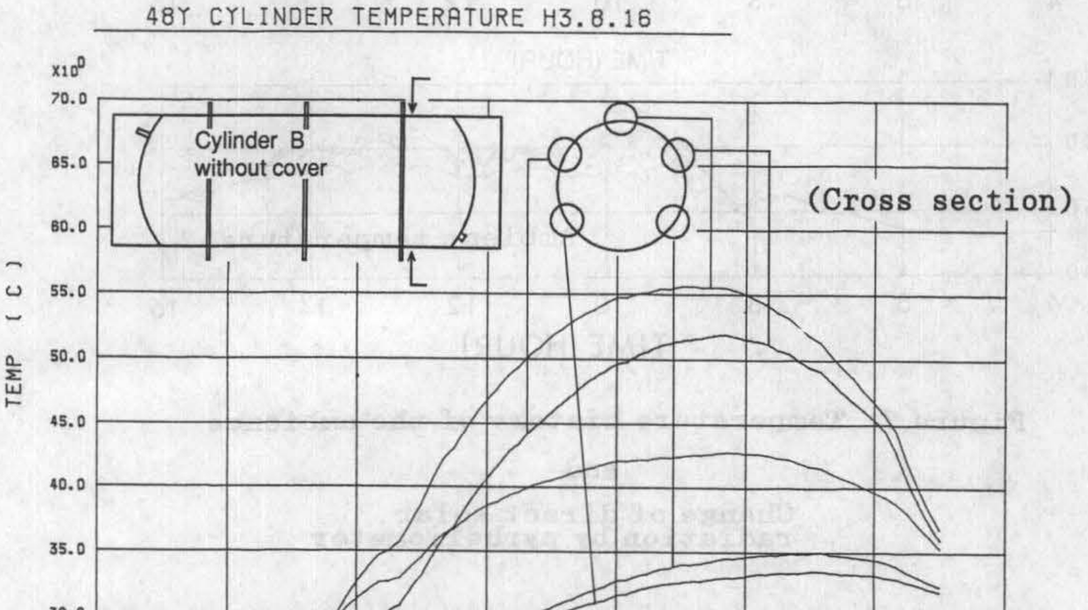

Figure 6. Temperature history at each surface of Cylinder B

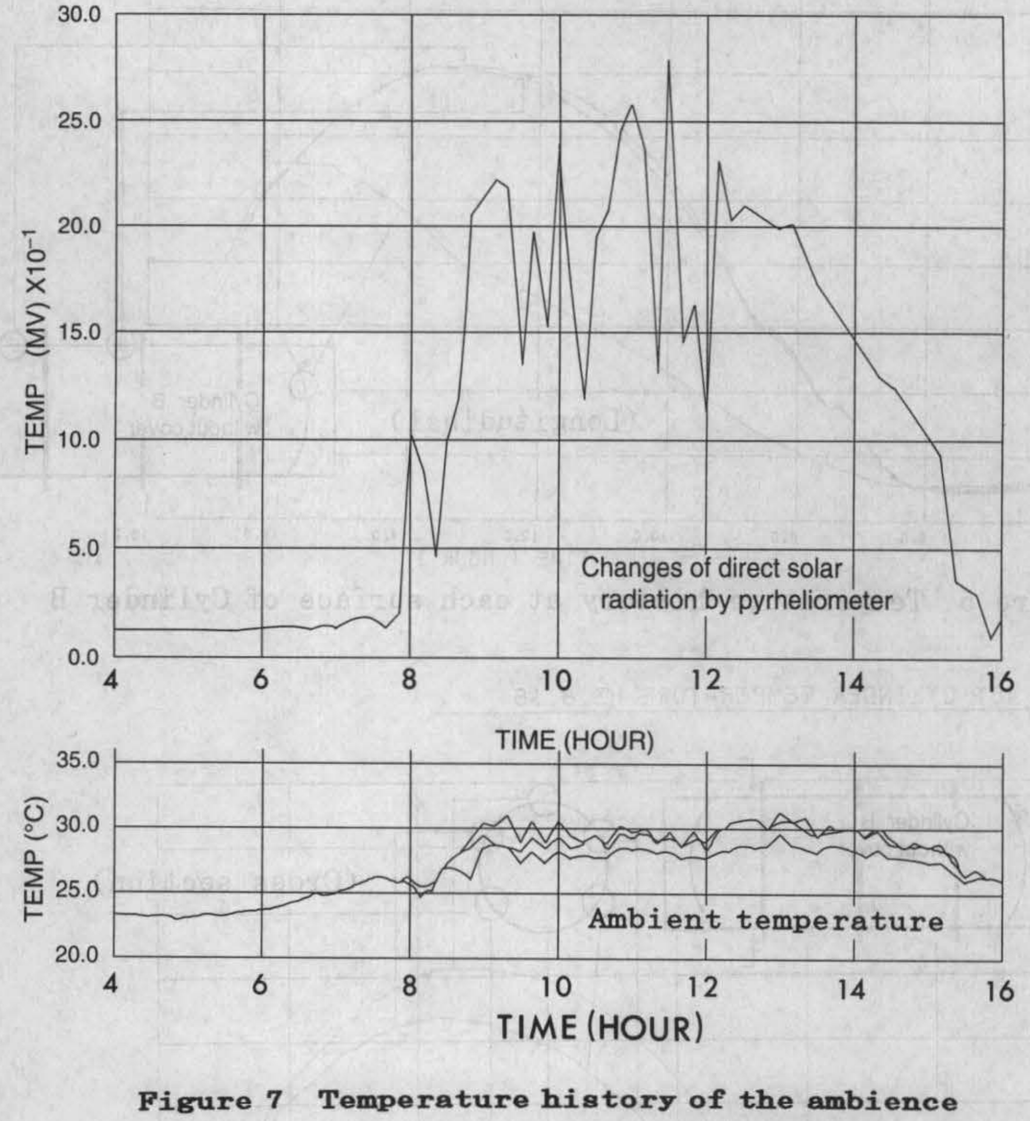

Figure 7 Temperature history of the ambience

and

Change of direct solar radiation by pyrheliometer