Transactions of the Korean Nuclear Society Spring Meeting
Chuncheon, Korea, May 25-26 2006

Improvement of the Operability of D_2 Gas Analyzer in the Reflector Cover Gas System

Young-San Choi, Min-Jin Kim, Yong-Sub Lee, Sang-Hoon Bae, Hwan-Sung Jung.
yschoe@kaeri.re.kr

1. Introduction

The reflector cover gas system uses instrument air as a cover gas to pressurize the expansion tank. The volumetric concentration of D_2 gas contained in the instrument air is measured by the thermal conductivity type gas analyzer and indicated in the control room. Although this D_2 gas analyzer is very reliable and rugged, the moisture may be condensed due to the temperature difference between the main body of the analyzer located outside of the shielding concrete and sensing tube entry inside the shielding concrete entry and is very harmful to the thermal conductivity sensor. To prevent this situation, surrounding the sensing tubing line with heating cable that is located outside the shielding concrete was done among a few considerations. As a result, the cause of malfunction has been eliminated and the operability of D_2 gas analyzer has been improved.

2. The structure of cover gas system

The system is constructed with the expansion tank, sampling pipes, safety valves, connection pipes, valves and a gas analyzer [2]. The expansion tank takes total volume increase of heavy water from minimum temperature to the maximum design temperature 7 ℃ to 120 ℃ for the reflector system.

At the top of the expansion tank, the gas analyzer nozzle is connected to measure D_2 gas concentration and the alarm will go on if the concentration of D_2 gas in the air of the expansion tank exceeds 2%. [3] This alarm value is set at conservative rate compare to 4%, which is the highly possible explosion point. In addition, it is feasible to analyze using gas chromatograph after sampling.

3. D_2 gas Analyzer

3.1 Specification and structure

The model selected for sampling is Teledyne 235 Series and the concentration of D_2 gas will be measured by comparing the reference gas that has certain substances and the thermal conductivity of the sample gas. Since this method is not the absolute measuring method, a standardized gas substance that meets the bound of analyzing scope is essential. This gas is used when executing periodic calibration of the analyzer.

Electrical circuits are pinned in the plug-in type main board slot and a measuring sensor is surrounded in adiabatic case, which is easy to separate from a sash. In plug-in circuit, the sensor power supply/ amplifier circuit maintains cell voltage in 4.5 V and it is constructed with power supply circuit, alarm setting circuit, voltage/voltage converter and circuit that provides ±15V ±24VD.

3.1 Calibrations and the measurement principle

The figure 1 shows the port that connects to the analyzer and gas tube. The 0% zero gas and 3.8% span gas in a cylinder are used for calibration. First, inject the zero gas and adjust 4mA which is the minimum value, then inject the span gas and adjust 16.16mA which is the maximum value. After performing calibration, process the output for the D.C signal that develops while the sample gas to be measured is passing through the sensor as 0–1V via an amplifier and 4-20mA via V/I converter. .

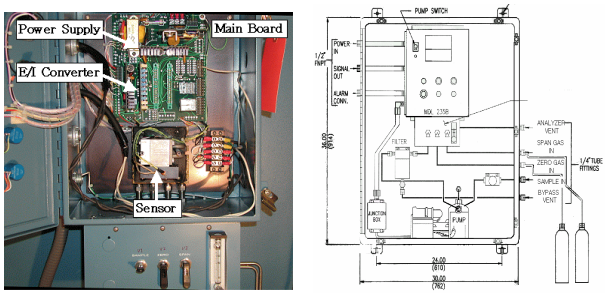


Fig. 1. Internal circuit of the analyzer and connections

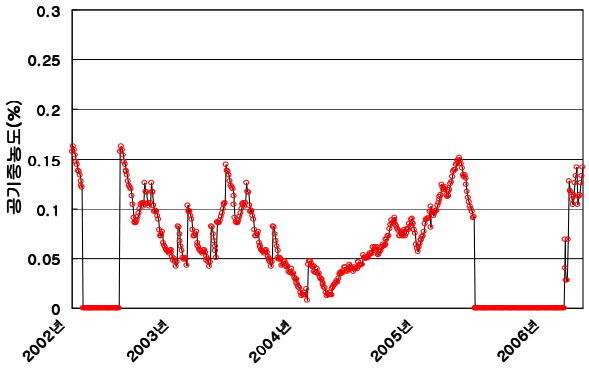
3.3 The history of operation and the concentration of D_2 gas in the air

Although the analyzer has been running continuously after a trial run, it was difficult to continue the process after imported standardized gas was exhausted. While running and calibrating the analyzer by introducing a standardized gas, a malfunction occurred in March 2002. Some moisture was developed due to the temperature difference in the sample gas pipe and the measuring sensor got broke down because it became damp. The figure 3 is a graphic showing running data of the gas analyzer. Since D_2 gas is known to have a possibility of explosion when the concentration of D_2 gas in the air is at 4%, the alarming value was conservatively set at 2%.

The concentration of D_2 gas, which is indicated in the graph is maintaining 0.2% showing far lower status than the alarming value. The period that shows 0%

indications the period when running process was halted to repair the gas analyzer.

Fig. 3. Operating data of the gas analyzer.



3.4 The problems and effect of improvements

The cause of mist development with sensor pipe was concluded as an installation defect. The Figure 4 is the elevation of the location where the analyzer and the expansion tank were installed. The temperature of indoor where the expansion tank is installed reaches up to 40℃ and the location where the analyzer is installed is being controlled at about 25℃ due to the normal ventilating system. Therefore, evaporated steam from the expansion tank due to the temperature difference confirmed its structure defect that allowed the analyzer sensor to flow in.

If the problem remains without a proper improvement, condensate will likely be developed consistently which is fatal to the sensor. Consequently, a method, as per the Figure 5 is suggested to remove moisture by winding heating cables around the tube. An installation was made using the heating cable and thermo start kit as the table 1. As of now, there is no apparent condensing problem with the pipe's moisture by setting temperature at 43℃.

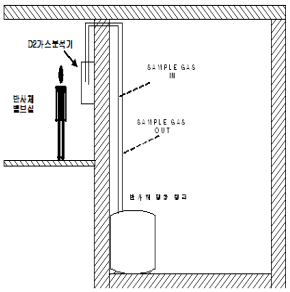


Fig. 4. Front view of the thermostat kit

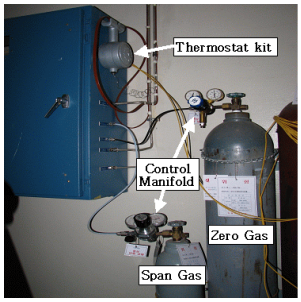


Fig. 5. heating cable and expansion tank and analyzer

Table 1. Specifications of heating cable and thermostat kit

	Heating cable	Thermostat kit
manufacture	LG	
model	30AHH2	HACC-TSK
specification	30 watt/meter 200-240VAC	Temp. ctrl.

4.0 A conclusion and a further counter plan

It has been about 4 years since running the mist remover using heating cables. The outcome so far is incredibly satisfied and it seems condensate that was generated in the D_2 gas analyzer pipe is no longer developing.

If the problem recur in the process of further running then considering installing a mist separator and a membrane filter could be a measurable plan. However, it appears additional installations of such instruments aren't the requirement.

In order to prevent the problems fundamentally, it is required to improve by feed back the kind of problems at the time designing the nuclear reactor system.

REFERENCES

[1] Kopec, "Design Description of Reflector Cooling system," KM - 323 - DD - P001 Rev.1

[2] Kopec, "Design Description of Reflector Cover Gas System," KM - 329 - DD - P001 Rev.1.

[3]Operating Instructions For Model 235 Series Thermal Conductivity Analyzer, Teledyne Analytical Instrument