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Improving the NCG Analysis by Separation of Argon and Oxygen Chromatogram Using Gas Chromatography with PDHID Detector for Geochemical and Reservoir Evaluation in Kamojang Field

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ABSTRACT

Non Condensable gas (NCG) is one of the most important parameters in geothermal field. The concentration of non-condensable gas must be known for monitoring the quality of steam, conformity with the turbine requirement, geochemical data and reservoir evaluation. There are many methods for determine the NCG, but for the determining of every single parameter of NCG requires high level analysis. NCG is consisted of CO_2, H_2S, NH_3, H_2, Ar, N_2 and CH_4. The result of analysis Argon and Nitrogen must be corrected by Oxygen as air contamination. But the common problem in Argon analysis using gas chromatography is not a good separation between the peaks of Argon and Oxygen. Not all laboratories can analyze Argon and Oxygen with good separation. The studies that conducted by Laboratory of PT. Pertamina Geothermal Energy Kamojang Field, using gas chromatography with PDHID detector as the detector that 500 times more sensitive than TCD detector has successful identified five parameters of NCG that are H_2, Ar, O_2, N_2 and CH_4 in once running analysis. The test successfully separated the Argon and Oxygen at room temperature without using the cryogenic or changing the oven temperature to a minus temperature. With the good separation of Argon and Oxygen, the NCG analysis data can be used for geochemical and reservoir evaluations.

1. INTRODUCTION

Gas chromatography is one of techniques that have been widely used for gas analysis. In geothermal filed, gas chromatography is used for analyzing the non-absorbed gas of non-condensable gas (NCG). The non-absorbed gas is consisted of N_2, O_2, H_2, CH_4, and Ar that accumulated in head space of sample bottle. Giggenbach and Gougel (1989) described chemical analysis of non-absorbed gas performed by gas chromatography, like two distinct gas chromatographs. The detector used for analysis was thermal conductivity detector (TCD). Cisne A (2006) also described the chromatographic analysis that conducted in two steps; firstly, H_2, N_2, CH_4, and Ar + O_2 were determined using the so called “light gas” method, and secondly, run the sample again using a different method to quantify Argon.

In this study, the analysis of non-absorbed gas conducted by gas chromatography was equipped with a pulsed discharge helium ionization detector (PDHID). The pulsed discharge helium ionization detector (PDHID) is a sensitive and universal detector. The PDHID is 500 times more sensitive than the thermal conductivity detector (TCD) and 50 times more sensitive than the flame ionization detector (FID) (Roberge, 2004). Because the PDHID is a universal detector and has good sensitivity, this detector can be used for geothermal gas analysis (H_2, Ar, N_2, O_2 and CH_4).

Non-condensable gas analysis data has proven to be useful in modeling geothermal reservoirs. For this application, the data must have good quality. Good separation between the peaks of Argon and Oxygen in gas chromatography analysis is a prerequisite. The oxygen data is needed for air correction in Argon and Nitrogen analysis data. Analysis using PDHID detector can give chromatogram with good separated between the peaks of Argon and Oxygen in once running analysis. In this paper, the result of PDHID analysis is compared with the TCD result.

2. EXPERIMANTAL

2.1 Instrumentation

2.1.1 Gas Chromatography

Gas chromatography analysis were carried out using Dani Master GC. In this case, a Valco PDHID were installed. All data was collected in clarity software. Ultra high purity (UHP) helium was used as the carry gas. A Valco model HP2 helium purifier (Valco) were placed between the cylinder and the flow splitter.

2.1.2 Injection Sample

Injection sample was conducted by connecting the NCG sample bottle to the sample inlet line of the chromatograph, and the pressure was measured by manometer. Because the head space volume and the volume of the inlet line is known, this pressure can be used to compute the total amount of head space gas in the sample. The loop injector consisted of six-port two position valves with the volume of 5 mL.

2.2 Standard

Gas standard was used. The mix gas standard was consisted of Hydrogen, Argon, Oxygen, Nitrogen and Methane. The gas composition was 15.4% Hydrogen, 24.8% Methane, 1.04% Argon, 0.51% Oxygen and 58.25% Nitrogen.

2.3 Sample

The NCG sampled was collected using single stopcock valve gas bottle from geothermal well in Kamojang field. The method used for the collection NCG sample was ASTM E1675.

2.4 Separation Condition

H_2, O_2, N_2, CH_4 and Ar were separated in a molecular sieve, 5A porous-layer open tubular (PLOT) column, 30m × 0.32 mm. Carry gas flow rate was 4 ml/min and the split ratio was 1:15. The oven temperatures were set at 30◦C for 9 minute and then increased to 150◦C with the rate of 70◦C/minute. The detector temperature was 200 ◦C.

3. RESULT AND DISCUSION

GC with PDHID could identify five parameters of non-condensable gas that are H_2, Ar, O_2, N_2 and CH_4 in once running analysis. Total time for running the sample is 18 minutes. The peaks of Hydrogen, Argon and Oxygen are set to come when the oven temperature is 30◦C and the peaks of Nitrogen and Methane are set to come when the oven temperature is 150◦C. The retention time of every single parameter is given in Table 1.

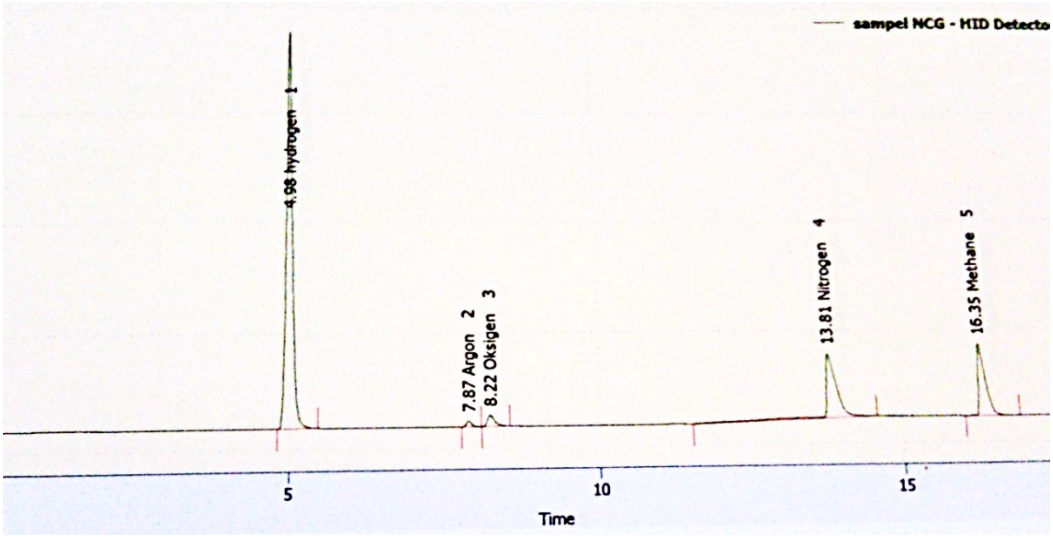

Figure 1: The figure above is the chromatogram of NCG analysis result using GC-PDHID detector.

Figure 1 shows that the chromatogram of NCG analysis results using GC-PDHID detector separates the peaks of Argon and oxygen with running at oven temperature 30^{o}C.

Table 1: The results of analysis data.

No	Compound Name	Area (%)	Response	Reten. Time (min)
1	Hydrogen	63.0	473.390	4.983
2	Argon	0.8	5.934	7.870
3	Oxygen	2.1	16.025	8.220
4	Nitrogen	20.0	150.222	13.810
5	Methane	14.1	105.971	16.353
		100.0		

Comparison between the analysis results of GC-PDHID detector and GC-TCD detector shows that the GC-PDHID detector is better than GC-TCD. The results of GC-TCD that have been conducted previously could not separate Argon and Oxygen chromatogram. Figure 2 shows the comparison the results of GC-PDHID and GC-TCD.

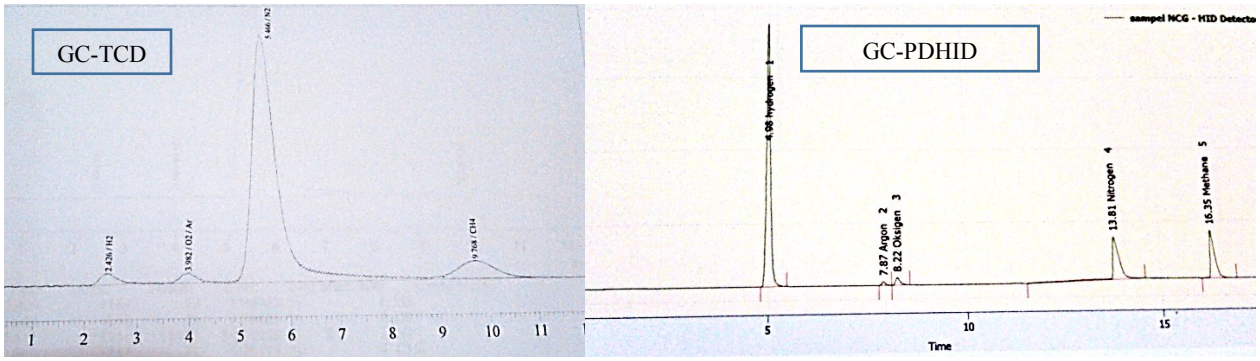

Figure 2: Comparison of the results of GC-PDHID and GC-TCD.

Analysis results of GC-TCD find four peaks that are Hydrogen, Argon+Oxygen (Not Separated), Nitrogen and Methane. However, the use of GC-PDHID finds five peaks, and Argon and oxygen are separated in same running condition (Oven temp 30^{o}C).

The analysis of non-absorbed gas in NCG samples should be making the calibration standard from the mix standard. The variation standard can be done by injecting mix standard with various pressures. As quality control would be better if it has other mixing gas standard cylinder with different concentrations, and also has other sample injection loops with different volumes. It will be useful for making variation standard and setting sample volume that will be injected.

4. CONCLUSION AND REMARKS

- GC-PDHID can be used for analyszing non-condensable gas (H_2, Ar, O_2, N_2 and CH_4) samples with good separation of Argon and Oxygen.
- Even though the results of GC-PDHID have good separation between argon and oxygen, the response is small. The use of gas cryogenic for decreasing the oven temperature and increasing the sensitivity of Argon and Oxygen is recommended.
- Proficiency testing with other laboratorys should be conducted to confirm these analysis results.

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