

Current State of Gas Analysis System of SPARC Test Facility

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Abstract

Gas analysis system of SPARC test facility is composed of gas supply system, pre-processing system, gas analyzer and gas venting system. Calibration tests of gas analyzer of SPARC test facility were conducted to adjust the measured concentration to the Standard Gas concentration. In order to enhance the response speed of gas analysis system, pre-processing system has been improved. The difference from the past system was volumetric capacity. The consequence was that the response speed of gas analyzers has increased. Calibration method of gas analyzer is a two-point calibration which requires two kinds of gases, offset/zero gas and gain/span gas. For two point calibration of hydrogen analyzers, Standard Gas containing hydrogen and nitrogen have been utilized. Oxygen analyzers have made use of oxygen and nitrogen mixture gas for two point calibration.

Introduction

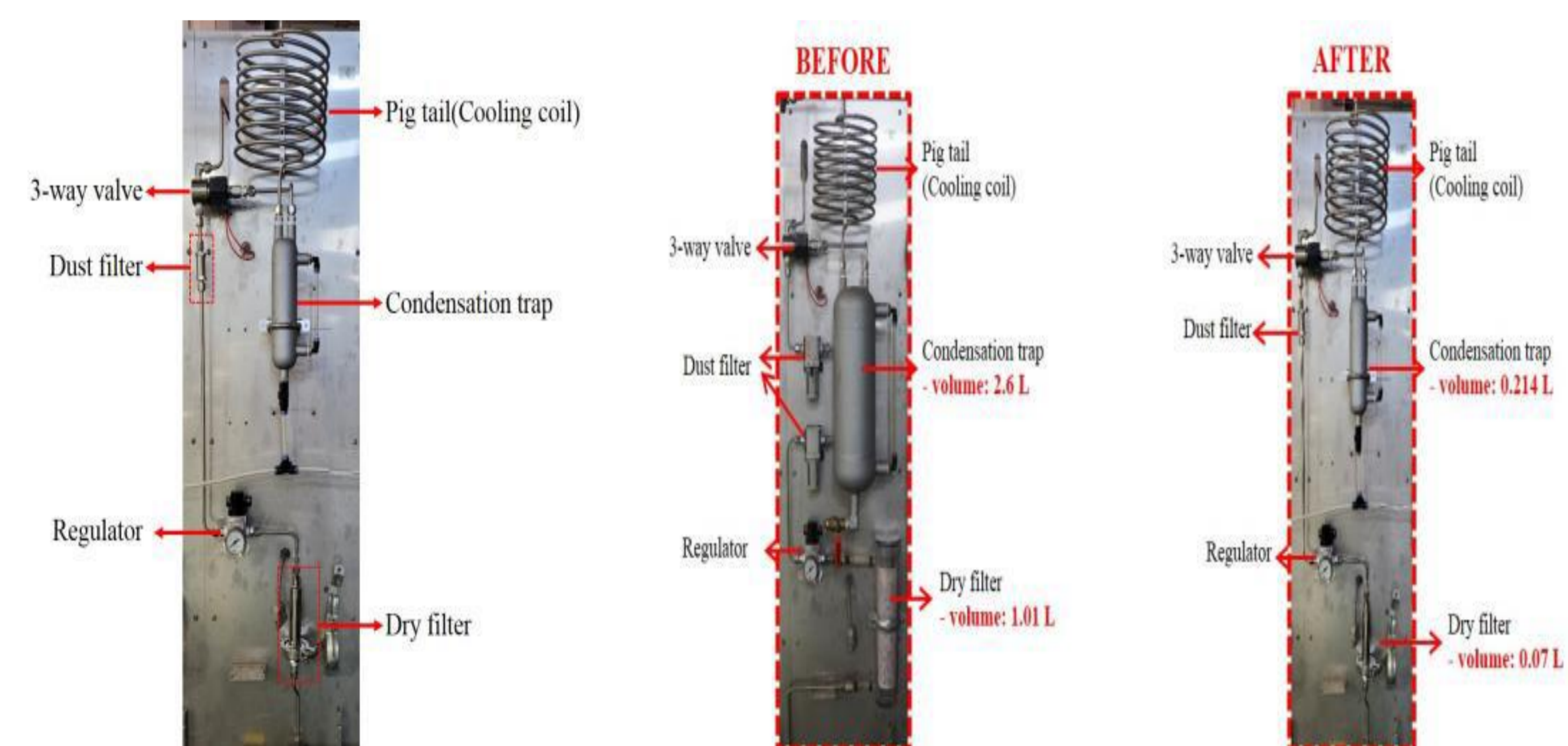
- Hydrogen can be generated in the event of a severe accident. The hydrogen created in the reactor building can be released into the containment building.
- The investigations concerning the hydrogen behavior inside the containment, distribution, combustion, mitigation and interaction with mitigation measures and safety system have been performed.
- Experiments about hydrogen behavior interaction with passive auto-catalytic recombiners (PAR) or spray system have been conducted in SPARC test facility.
- Gas analysis system plays an important role in understanding of a hydrogen gas concentration distribution inside the SPARC pressure vessel.
- This paper described the improvements of gas analysis system and the calibration of gas analyzers.

Method and Results



Process of gas analysis system of SPARC test facility

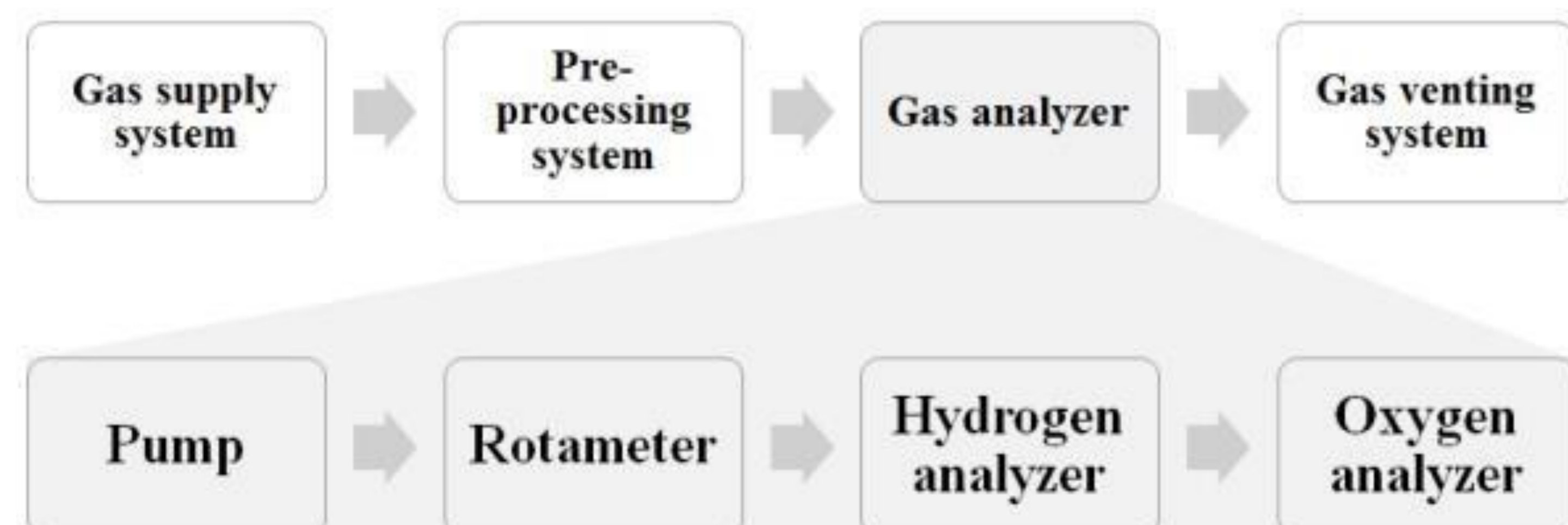
- Gas analysis system is composed of gas supply system, pre-processing system, gas analyzer and gas venting system.



Pre-processing system of SPARC

Pre-processing pictures of before-and after

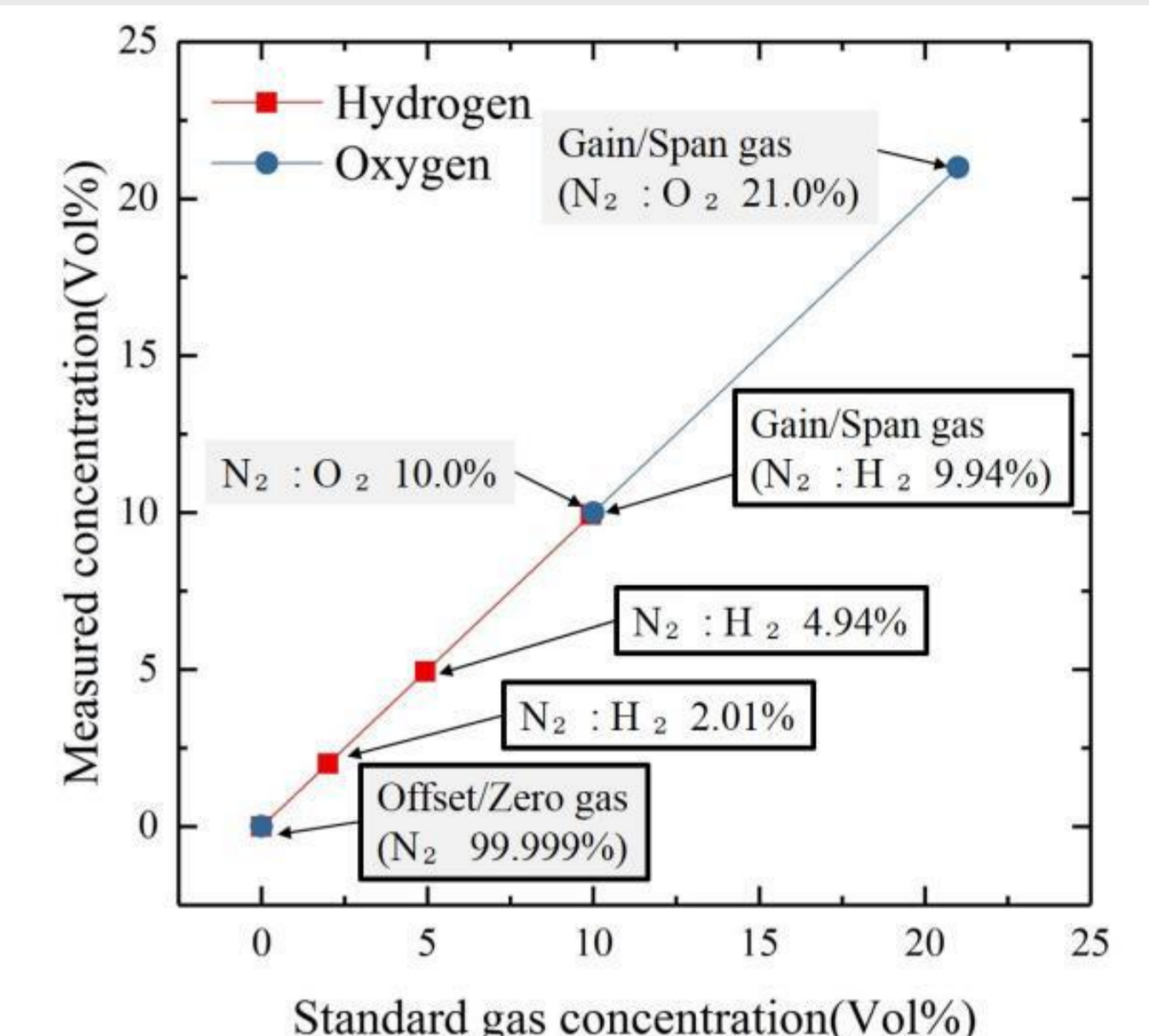
- To meet the requirements of gas analyzer, mixture gas will start in SPARC test facility, pass through pig tail(cooling coil), condensation trap, dust filter, regulator and dry filter and enter gas analyzer.
- For enhancing the response speed of gas analysis system, the volume of mixture gas passing through has been decreased.
- The size of air filter, condensation trap and dry filter has been reduced.
- After upgrading the pre-processing system, tests have been performed by supplying Standard Gas to each pre-processing system.
- The response speed of gas analyzers was evaluated depending on the pre-processing systems.
- The test confirms that the response speed of gas analyzers with improved pre-processing system is about 300 sec faster than the response speed of gas analyzers with previous version of pre-processing system.



Process of gas analyzer

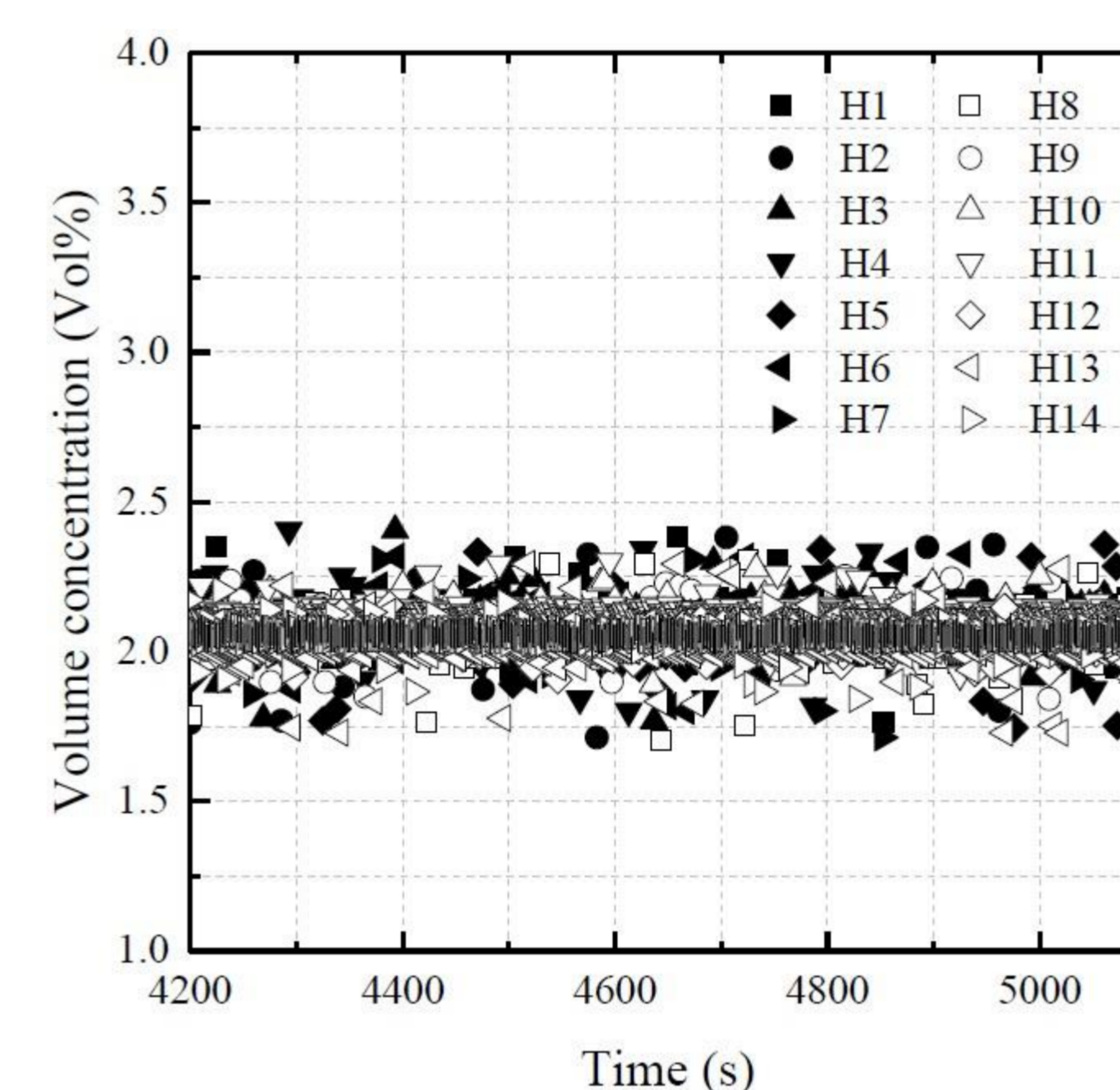
Manufacturer	Messkonzept GmbH
Model	FTC300
Range	0 ~ 100 %
Accuracy	< 1% of range
Flow rate of sample gas	60 l/h ~ 80 l/h
Gas pressure	Max. 20 bar(abs)
Response time(T90)	< 1 sec at 60 l/h
Measurement principle	Thermal conductivity

Hydrogen analyzer

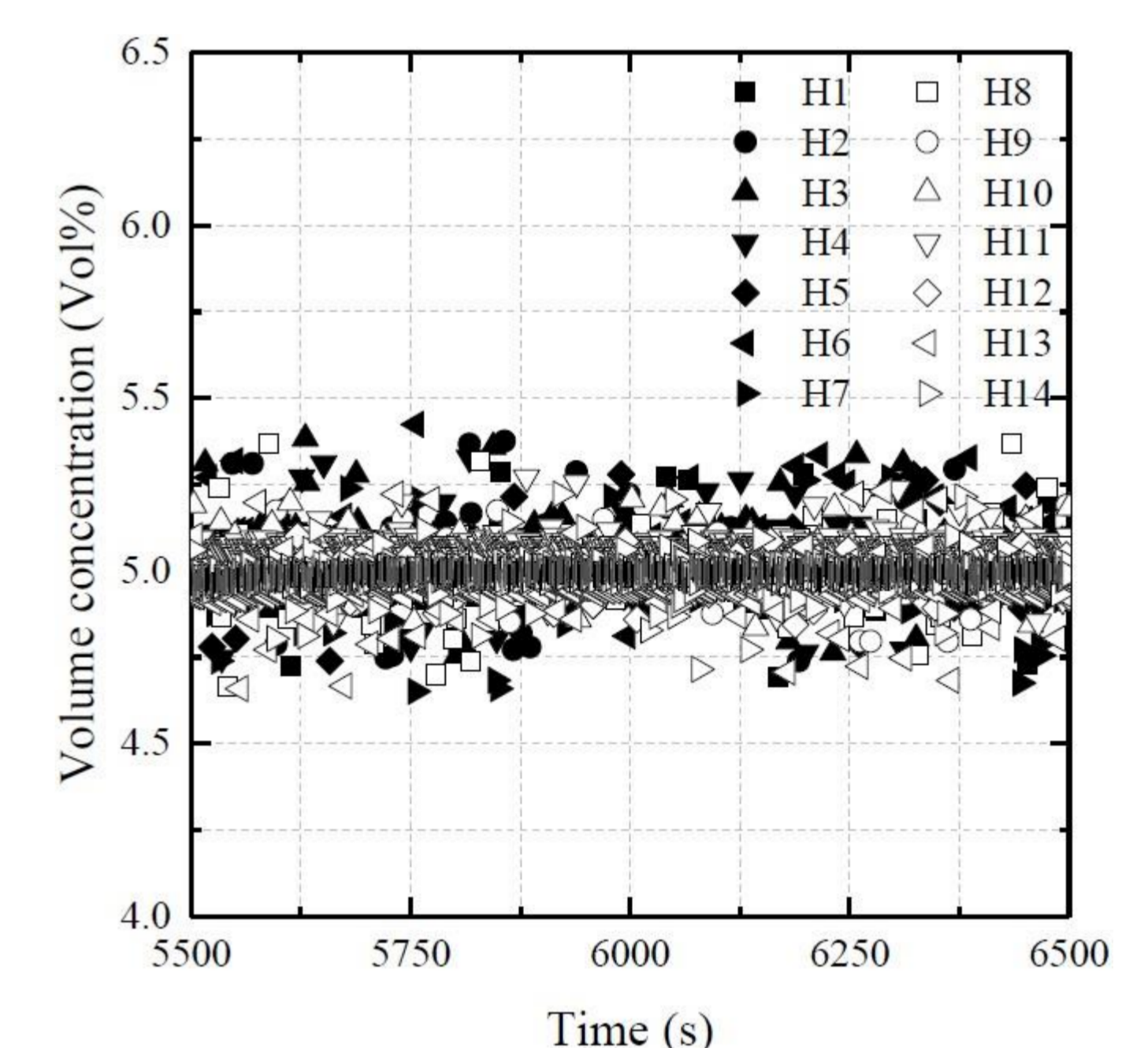


The method of two point calibration

- SPARC test facility is equipped with fourteen hydrogen analyzer for measuring hydrogen or helium concentration and fourteen oxygen analyzers.
- The objective of calibration test is to adjust the measured concentration to the Standard Gas concentration.
- Calibration Method of gas analyzer is a two-point calibration which requires two kinds of gases, offset/zero gas and gain/span gas.



When 2.01 % hydrogen mixture gas supplied



When 4.94 % hydrogen mixture gas supplied

- High purity nitrogen(99.999% N₂) gas and 9.94% hydrogen and nitrogen mixture gas have been used as offset/zero gas and gain/span gas, respectively.
- Two kinds of hydrogen Standard Gas were supplied to hydrogen analyzers to check if the two point calibration was performed correctly.
- Oxygen analyzers have made use of 99.999% N₂ gas and 21.0% oxygen and nitrogen mixture gas as offset gas and gain gas, respectively.

Conclusion

- The internal volume of pre-processing system which the sampling gas pass through has been decreased.
- The consequence was that the response speed of gas analyzers has increased.
- The difference in response speed of gas analyzers was clear depending on the length of sampling tube.
- The calibration tests have been conducted for hydrogen gas analyzers and oxygen gas analyzers.
- The measured concentrations of hydrogen and oxygen analyzers are within the margin of error.

Reference

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- [2] J. Kim, S-H Hong, J-H Kim and H.T.Kim, SPARC-PAR Experimental Simulation of PAR-induced Hydrogen Stratification, International Workshop on Post-Fukushima Challenges on Severe Accident Mitigation and Research Collaboration, Korea, 2019.
- [3] Y.S. Na, S-H Hong and S-W Hong, Calibration test of gas analysis system of SPARC test facility, KAERI/TR-6393/2016.

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