A STUDY ON MECHANICAL PROPERTIES OF NATURAL GAS PIPE MATERIAL IN HIGH PRESSURE HYDROGEN GAS ENVIRONMENT

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In recent years, many countries around the world have actively researched eco-friendly energy sources due to the issues of carbon neutrality and energy security. Among eco-friendly energies, policies related to the utilization of hydrogen energy are being strengthened worldwide and businesses are actively progressing in various fields such as materials, chemistry, energy and mobility. As the use of hydrogen energy increases, the construction of a supply chain that accompanies it becomes essential and research for this purpose has been varied out for a long time. Hydrogen has to be produced and transported until it is used by the consumer, currently mainly using tube trailers. However, it is expected that the use of demand energy will increase, so it is judged that large-capacity transportation of hydrogen will be necessary. To that end, transportation through pipelines with high-pressure gas has emerged as the most efficient and rational method. The European Union and the United States have already announced plans to build pipelines for long-distance hydrogen transport and pipelines are under construction across the country and with other countries. When transporting high-pressure hydrogen through pipelines, the most important part is the hydrogen embrittlement of pipeline materials. Much research has been done over the years on hydrogen embrittlement. As a material for transporting high-pressure hydrogen gas, the use of natural gas pipe material is being researched with the highest priority. In this study, it was confirmed that the API 5L grade material used as a natural gas pipe material is suitable for use in a high-pressure hydrogen environment. The evaluating of suitability was based on CSA CHMC 1 (Test methods for evaluating material compatibility in compressed hydrogen applications-Metals), a standard for determining whether materials are suitable for use in high pressure hydrogen environment. According to the standard, if it is a ferritic material, the slow strain rate test is first performed in a high-pressure hydrogen environment to check the Relative Notch Tensile Strength (RNTS) and if the value is 0.5 or more, additional fracture and fatigue tests are performed. Therefore, this evaluating primarily was conducted the slow strain rate test under high-pressure hydrogen environment for API 5L grade materials. The materials used for the evaluation were API 5L X52 and X65 grade materials and test pieces were made from the base material and welded parts of both materials of pipe. The 2 pipes are 20inches (API 5L X52) and 30 inches (API 5L X65) respectively and were made by submerged arc welding and the gas pressure used for the evaluation was 80bar. Hydrogen as was used to determine RNTS and nitrogen gas was used as a reference gas and the testing criteria for the slow strain rate test followed ASTM G142-98. The evaluation results showed that both materials decreased both tensile strength and reduction of area in hydrogen gas and both RNTS values were greater than 0.5.

REFERENCES

ASTM G142-98, “Standard Test Method for Determination of Susceptibility of Metals to Embrittlement in Hydrogen Containing Environment at High pressure, High Temperature, or Both”

ASME B31.12, “Hydrogen piping and pipeline”

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