Monitoring of joint robustness using acoustic wave propagation and visualization of flow-induced noise due to leakage

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In the case of hydrogen refueling stations, pipes that can withstand high pressure are used to store and transport hydrogen gas. To prevent leaks from occurring in the piping, strong bolted joints are used. However, if vibrations from the outside or from compressors are transmitted to the piping, the robustness of the piping elements and joints is reduced, resulting in micro-leaks. For the safety of hydrogen refueling stations, it is important to have a technology to monitor the robustness of the joints and the presence of leaks. In this study, an experiment was conducted to verify the robustness of a joint by using the wave propagation characteristics and to determine whether a leak has occurred by visualizing the flow noise generated. A joint simulating a pipe was manufactured, and a force probe was attached to the head of the bolt. An accelerometer was attached to the nut on the opposite side of the joint to quantify the extent to which the propagation characteristics of the waves traveling through the joint change with clamping force. In addition, a piping structure that can leak through a metering valve was built, and the sound propagation characteristics of the leak were measured with a microphone. Based on the measured acoustic data, we visualized the propagation characteristics of flow noise caused by leakage, which is different from general noise, and further developed an algorithm that can determine the presence of leakage.