Management Summary of "first inventory of hydrogen leakages at small permissible leaks"

Present norms (NEN1078 and NEN7244-7) for DSOs assess natural gas leakages up to 1 litre per hour as acceptable for both the natural gas grid and indoor installations. This project is an first initial investigation to conclude whether replacement of natural gas with hydrogen has a negative impact on this safety assessment. This might be the case, because hydrogen has different characteristics from natural gas. Four Dutch DSOs Liander, Stedin, Enexis and Rendo requested Kiwa Technology to investigate this further.

Theory

Outflow of gas from a leak will be laminar or turbulent based on the gas characteristics and the ratio of hole area versus length of the leak.

- Laminar: Increase in flow rate is inversely proportional to the dynamic viscosity. Laminar leaks are typically found in fittings. Methane (as part of natural gas) has a 25% higher viscosity compared to hydrogen. For a laminar leak, the flow rate of hydrogen is expected to be 25% more.
- Turbulent: Turbulent leaks are typically found from holes in pipes. Increase in flow rate is proportional to the square root of the difference in density. Methane has a density of 0.83 kg/m^3; hydrogen has a density of 0.09 kg/m^3. Therefore, the flow rate of hydrogen is expected to be a factor 3 times faster than methane at the same pressure.

Leaks in practice lead to a flow with both laminar and turbulent characteristics. In theory the outflow of hydrogen should be a factor of 1.25-3 more compared with natural gas.

Project progress

Test were performed to measure the amount of hydrogen outflow at a leak that would lead to 1 litre per hour outflow of natural gas. These tests were performed with a setup of pipes and connectors with predefined leaks, with operating pressures of both 25mbar and 100mbar. 5 leaks were created in the order of 0.1 l/h, 0.5 l/h, 1 l/h, 5 l/h and 10 l/h. The outflow was measured with a mass-flow meter.

Results

Test results showed that the outflow of hydrogen (as compared to natural gas) at the same leak is a factor 1.64 more with operating pressures from 25-100mbar.

Due to the limited amount of tests in this first investigation, these results are not normative. The clients concluded, for safety reasons, to assume that hydrogen leaks at twice the rate of natural gas. Additional research can provide a more definitive insight.