

High-Pressure Gas Property Measurements

An increasing motivation to reduce gas emissions worldwide and an economically unfavorable market for sulfur recovery have generated a need for high-pressure gas reinjection compressors. Use of high-pressure reinjection compression solves the disposal and emission issues while supplying pressure support for tertiary oil and gas recovery. Reinjection compressors must be capable of compressing acid gas mixtures, namely high H_2S and CO_2 contents in the range of 50–90%.

Centrifugal compressor design optimization focuses on reducing entropy-generating losses and achieving an optimum Mach number at each inlet stage. The mechanical design of the compressor relies on calculation of relative gas velocity, temperature rise and flow rate for the stage-to-stage impeller geometry and material selection. Effective design requires prediction of speed of sound, gas density, compressibility and specific heats. If three of these fundamental properties can be validated experimentally at the compressor equipment operating points, a given equation-of-state model is sufficiently confined and all other gas properties may be held to the uncertainty limits of the model.

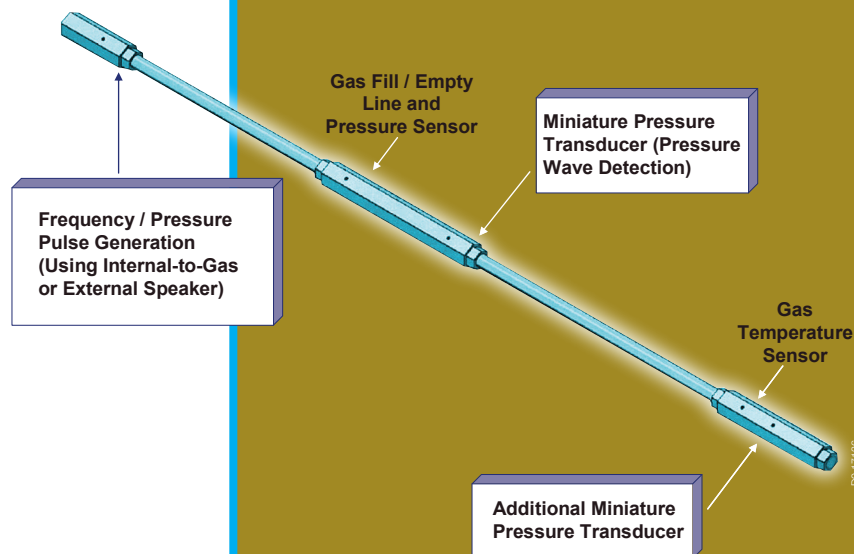
Test Methods

Southwest Research Institute® (SwRI®) has developed high-accuracy test methods for speed of sound, density and specific heat determination to enable compressor and turbomachinery designs in the high-pressure, supercritical regime (1,200–10,000 psi or 137–689 bar).

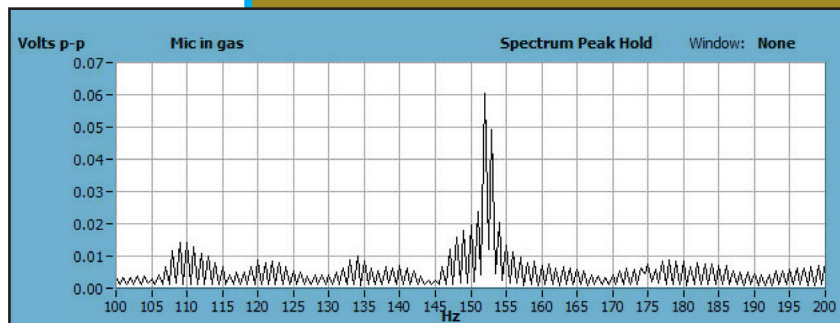
Test Fixtures

The Institute performs high-pressure gas property testing using specialized anti-corrosion, high-pressure, SwRI-designed test fixtures to meet the low uncertainty requirements of gas property testing campaigns. Each fixture is equipped with specialized electrical wire pass-through fittings, in-gas thermocouples, surface-mounted thermocouples and high-pressure transducers. These sensors and fittings are selected to fit the corrosion, temperature and pressure requirements of each test.

SwRI has also developed and validated specialized test fixtures through testing programs in 2007–2009. These designs will accommodate speed of sound, density and specific heat measurements.



SwRI high-pressure acid gas test fixture design



Determination of speed of sound using half-wave resonant frequency



High-pressure adiabatic test fixture for measurement of specific heat



Typical SwRI high-pressure test instrumentation

Test Instrumentation

All test instrumentation is maintained and calibrated over the expected range of conditions prior to the test. The test fixtures and SwRI test facilities are capable of handling wet gas, hydrocarbon, high CO₂ and high H₂S (acid gas) mixtures. Onsite SwRI testing can also provide gas species analysis at particular temperature and pressure points to verify the two-phase region and liquid/gas content determination. Test gas mixtures are obtained from an offsite certified gas laboratory and can include water and hydrocarbons in addition to CO₂ and H₂S.



Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,300 employees who perform contract work for industry and government clients.



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