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Standardization of negative gauge pressures using piston balances

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Abstract

Standardization of negative gauge pressures is a peripheral branch of pressure metrology, but this approach is unfair. Although this pressure mode can be ensured simply by liquid columns, the utilization of pressure balances in this area brings many technically interesting solutions. They include an inverse piston-cylinder design (it is the basis of most commercial solutions), a classical pressure balance with generation of negative gauge pressure under a bell jar, a digital piston manometer and a pressure divider designed for absolute pressure mode.

The paper focuses on the methods utilized in the Czech Metrology Institute, i. e. the generation of negative gauge pressure under a bell jar and, newly, the use of the absolute pressure divider and also a digital non-rotating-piston manometer for the range of very low negative gauge pressures that are very hard to reach by other methods.

The paper introduces their principles, ways of ensuring their metrological traceability, the detailed analyses of their uncertainty budgets, practical experiences and the results of their mutual experimental comparison. Furthermore, there are described methodologies of calibration of the secondary standards of negative gauge pressure. Finally, all the methods are compared from the viewpoints of the uncertainties that can be reached and the suitability of each standard for practical calibrations.

Keywords: Gauges, negative pressure, piston balances, standardization.

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