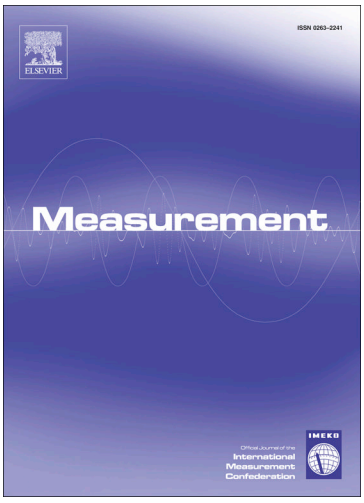

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PCA Exchange Method for Compensation of Error Sources in Pressure Balance Calibration

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Abstract

Many things, such as tilt effect of the piston and cylinder assembly (PCA), temperature, air buoyancy, etc., significantly affect pressure measurement results when using a pressure balance in a high-pressure measurement environment. These effects can not only increase the uncertainty of the effective area determination but also cause problems in the performance of the pressure balance. Among the above effects, the tilt of the PCA is one of the significant uncertainty sources to be considered in the calibration. In the case of two pressure balances that have exchangeable PCAs, most uncertainty sources could be eliminated by exchanging two PCAs and averaging two calibration results because symmetric behaviors can be theoretically obtained. To investigate the above effects, an oil-operated pressure balance was used to calibrate another identical pressure balance with an exchangeable PCA up to 500 MPa. Before the calibration, the vertical condition of the PCA close to the gravitational axis was determined using a precise pressure gauge by calibrating it according to the tilt angle of the pressure balance.

In the case of a marginal tilt angle of the PCA, the calibration results of a cross-float method before and after exchanging two PCAs, had symmetric behaviors, but they did not follow a cosine effect. The results could be dependent on pressure, piston materials, and PCA adoption methods. In conclusion, the distortion coefficient could be changed due to the tilt since the central piston axis is not coincident with one of the cylinder anymore.

Keywords: Pressure Balance, Tilt Angle, Cosine Effect, Distortion Coefficient