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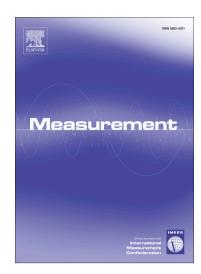
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PCA Exchange Method for Compensation of Error Sources in

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

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