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Proficiency test for effective area determination of a pneumatic pressure balance in Mexico

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ABSTRACT

A pneumatic pressure proficiency test for effective area determination of a pressure balance was performed among 4 accredited calibration laboratories in Mexico. CENAM provided the reference values (making initial and final calibrations) and was the pilot laboratory. The Mexican Accreditation Entity (ema) collaborated. The participants calibrated, by cross floating, a Wika pressure balance model CPB 5000 with accuracy class 0.015% of the reading in the range 0.7–7 MPa. The calibration pressures were 0.7, 1.4, 2.1 3.5, 4.2, 5.6 and 7.0 MPa. For A_0 and A_e, the normalized error equation was used to compare the results of the laboratories with CENAM's reference values. The results obtained were satisfactory (E_n did not exceed the compatibility limit, $-1 \leqslant E_n \leqslant 1$).

1. Introduction

A pneumatic pressure proficiency test for effective area determination of a pressure balance was performed among 4 accredited secondary calibration laboratories in Mexico. CENAM provided the reference values and was the pilot laboratory. The Mexican Accreditation Entity (ema) collaborated in this proficiency test. Procedures in [1–3] were used as references.

2. Proficiency test description

The calibration of a Wika pressure balance model CPB 5000 with accuracy class 0.015% of the reading was performed by four Mexican accredited calibration laboratories in the measuring range from 0.7 MPa to 7 MPa by the cross floating method. CENAM made initial and final calibrations. The calibration pressure points were (0.7, 1.4, 2.1, 3.5, 4.2, 5.6 and 7.0 MPa). The minimum uncertainty sources included for the area zero, A_0, and effective area, A_e, were: (A) Uncertainty of the laboratory standard. (B) Column correction uncertainty. (C) Repeatability uncertainty. (D) Mobility uncertainty. (E) Linear regression uncertainty (for A_0 determination).

The laboratories' results were compared with the references values (CENAM) by means of the normalized error Eq. (1) for both A_0 and A_e.

$$E_n = \frac{x_{lab} - x_{ref}}{\sqrt{U_{lab}^2 + U_{ref}^2}} \tag{1}$$

where E_n is the normalized error, ($k = 2$), x_{lab} is the laboratory obtained value, x_{ref} is the reference value, U_{lab} is the laboratory expanded uncertainty, ($k = 2$), U_{ref} is the reference expanded uncertainty.

3. Transfer standard performance

For the purpose and period of the proficiency test the transfer standard (TS) had a good performance. Fig. 1 shows the TS performance, with a maximum relative difference (between the two CENAM's calibrations) of 21×10^{-6}. For A_0 the relative difference was 16×10^{-6}

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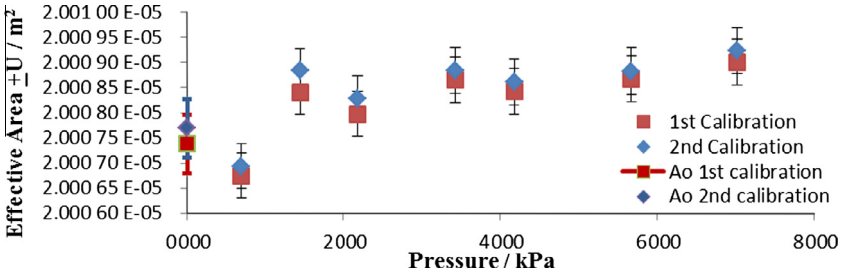

Fig. 1. Transfer standard performance.

Table 1
CENAM's A_e and its uncertainty values.

Nominal pressure (MPa)	A_e (m^2)	U (m^2)
0.7	2.00068E−05	4.6E−10
1.4	2.00086E−05	5.1E−10
2.1	2.00081E−05	4.8E−10
3.5	2.00087E−05	4.7E−10
4.2	2.00085E−05	4.7E−10
5.6	2.00088E−05	4.7E−10
7.0	2.00091E−05	4.7E−10

Table 2
CENAM's A_0 and λ with its uncertainty.

A_0 (20 °C) (m^2)	U (m^2)	Relative uncertainty	λ (1/Pa)	U (1/Pa)
2.00075E−05	±6.1E−10	±3.1E−05	1.2E−11	±4.6E−12

and the deformation coefficient had a relative difference of 8.9%.

4. Results

Tables 1 and 2 show A_e, A_0 and λ values obtained by CENAM. The values used are the average of the 2 CENAM's calibrations.

Graph 2 shows the A_e and its uncertainty obtained by the laboratories and CENAM for each measurement point (see Fig. 2).

Fig. 3 shows A_0 (pressure zero area) and its uncertainty obtained by the laboratories.

Fig. 4 shows A_e relative uncertainties obtained by the laboratories.

Fig. 5 shows the relative uncertainty values obtained by the laboratories for A_0.

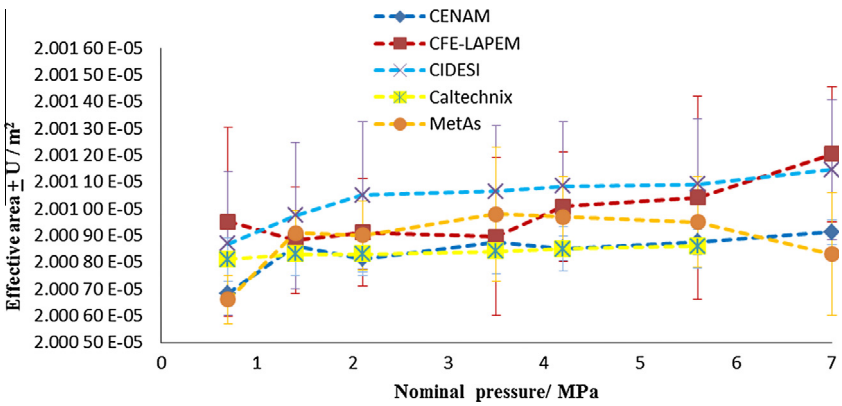

Fig. 2. A_e and its uncertainty for each measured pressure target point.

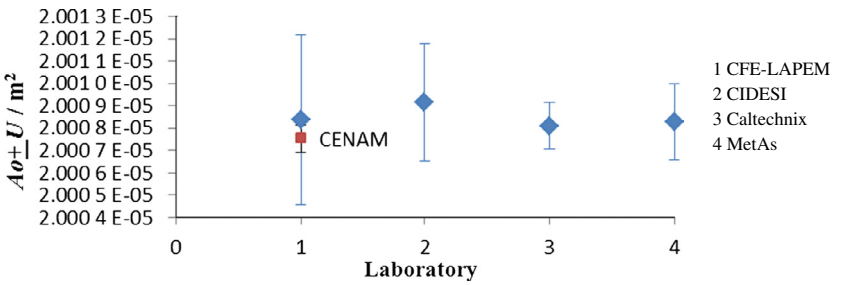

Fig. 3. A_0 and its uncertainty for each participating laboratory.