

Summary from yesterday

Pressure balance equation

$$p_e = \frac{\sum_i m_i * g * \left(1 - \frac{\rho_a}{\rho_{mi}}\right) + \sigma * c}{A_0 * (1 + \lambda * p) * [1 + (\alpha_p + \alpha_c) * (t - t_r)]}$$

EURAMET cg-3, Calibration of Pressure Balances

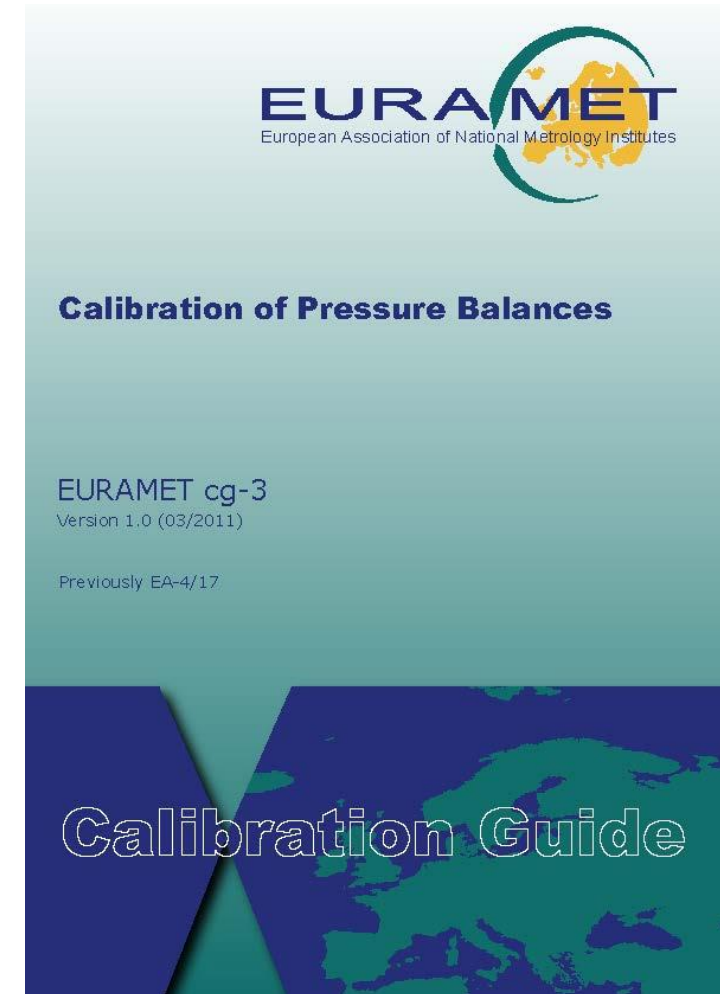
A document on how to calibrate and use pressure balances

Based on previous EA-4/17

Worked out by the EURAMET Technical Committee for Mass

Contains a lot of useful information including worked-out examples

Free to download from the EURAMET website, www.euramet.org



EURAMET cg-3

Preparation of the devices before calibration

Procedure of cross floating

Evaluation of data

Uncertainty analysis

Two basic methods of calibrating pressure balances:

- Method A, Bias error without weighing the masses
- Method B, calculating effective area, requires weighting of the masses

Preparation before calibration

Checking oil quality and change if necessary

Check smoothness of operation, operating the pump

Cleaning of piston and cylinder if required

Check fall rate and rotation time

- Fall rate is checked using maximum load. The time for the piston to fall from top to bottom position have to exceed 3 minutes
- Rotation time is checked at 20% of full load with a starting rotation speed of 30 rpm. The time to stop have to exceed 3 minutes. Not applicable on pressure balances with motor rotation.

Check reference level of both reference and object, and if possible adjust to minimum difference. Otherwise estimate the difference for later correction of fluid head.

Check performance of the object for dependencies of rotation direction

Performing the cross float

The cross float is carried out in the same way for both Method A and B

- Place the nominal masses on the two balances, corresponding to the first pressure level.
- With the valve closed between the balances, pressurize each of them to note the fall rate for them.
- Open the valve and balance them by adjusting the masses until equilibrium being established. This is defined as when both balances have the same fall rate as when the valve was closed. If not there will be a flow between them, giving a resulting pressure difference between the two.
- Note the ambient condition (barometric pressure, temperature and humidity) and for each balance the masses used and piston/cylinder temperatures
- Continue with the next point.

Cross floating

For method B, the calibration have to be carried out over at least six points covering the range from lowest point, $1/20$ to $1/10$ of maximum pressure up to full range

For method A it is to be carried out at the levels agreed upon with the customer. Try to involve each mass at least one time.

Each level is to be repeated at least three times for both methods.

How about hysteresis

What is the influence of hysteresis and the order of taking the measurement points?

So far no significant hysteresis have been observed and there is no need to perform the calibration in a certain order.

Practical hints

Cleaning

Intermediate checks, fall rate and rotation time

Evacuate gas

Cleaning of piston and cylinder

After dismounting the units, check for scratches and damages on the surface

If necessary clean the piston and cylinder using a suitable solvent. Checking the procedure of the manufacturer is a good idea but not perfect.

Use a suitable paper tissue to wipe the piston and cylinder

The main issue is that the solvent must not leave any residuals on the surface

I prefer using isopropanol (normal window cleaning agent) but other solvent works as fine.

Finish with blowing the piston and cylinder with clean air. Do not use shop air since it is not pure and quite often contain oil drops. Use bottle air instead.

Don't be afraid to scratch the units while cleaning them. You can use very hard pressure on the tissue during the cleaning. They are made by tungsten carbide which does not scratch easily.

Still very gentle handling of them.

After mounting the piston and cylinder

When assembling a hydraulic system, you very easy get some air trapped in the system
evacuating this air is very important to get a proper behaviour of the system
having a drain at the highest point is very useful

Also some air might be trapped below the p/c unit giving high fall rate in the beginning.

After mounting the system:

- Let the system rest for a while to let the air accumulate at the highest position.
- Pressurize the system slightly
- Drain the system using the top valve while keeping the system pressurized.
- Apply some masses to the piston and keep the system pressurized while floating the piston to evacuate the air being trapped below the piston.

Initial and intermediate checks

In the calibration certificate for the p/c unit fall rate and rotational times as measured by the reference laboratory shall be stated.

By regular checks of these parameters the performance of the system can be determined.

A higher fall rate indicates a leak in the system

A shorter rotation time indicates a dirty piston, time for a cleaning

Just a comment

At this time, only three countries - Burma, Liberia, and the US - have not adopted the International System of Units (SI, or metric system) as their official system of weights and measures.

Although use of the metric system has been sanctioned by law in the US since 1866, it has been slow in displacing the American adaptation of the British Imperial System known as the US Customary System.

The US is the only industrialized nation that does not mainly use the metric system in its commercial and standards activities, but there is increasing acceptance in science, medicine, government, and many sectors of industry.