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ESTABLISHMENT THE MEXICAN NATIONAL STANDARD IN DENSITY

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Abstract: Nowadays CENAM is being developing the national standard of density, standard that will offer traceability on density measurements to all our country.
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1 INTRODUCTION

Nowadays there is a density lab at CENAM whose measurements and calibrations are based on water density according to the BIPM equation, where water is function of temperature, of course water most to be pure (free of solids and solved gasses), water class I ASTM, near to 18 M of resistivity to 1 cm of length, see fig. 1. The goal of the national density lab is to offer best uncertainty to calibrations of device that are being using on different productive sectors of the country.

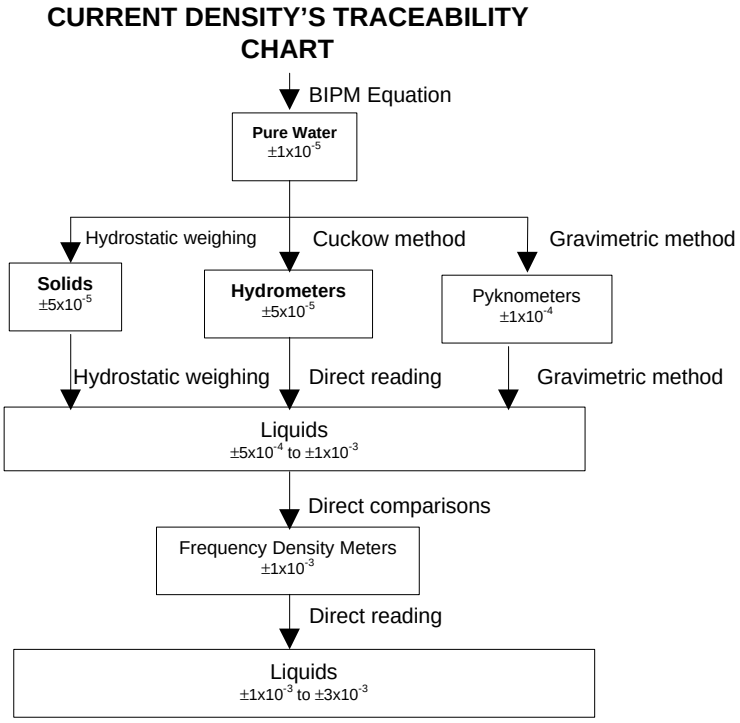

Figure 1. Measurement density's traceability chart based on water's density

2 DEVELOP

Density is a derived quantity of mass and length, a primary standard of density imply to have a standard of best metrological quality on its quantity, and hadn't being calibrated by other density standard.

On future would be excellent that Mexico would have a solid density standard (fig 2), a sphere made on zerodur or silicon with relative uncertainty of its radius around $\pm 2{,}7 \times 10^{-7}$ (±12,5 nm on approx. 4,672 cm) that length on volume means relative uncertainty about $\pm 8 \times 10^{-7}$ ($\pm 3{,}4 \times 10^{-4}$ cm^3 on approx. 427,075 cm^3), mass could be measured with relative uncertainty of $\pm 2 \times 10^{-7}$ (±200 µg en approx. 1006,709 g) and both volume and mass combined would offer relative uncertainty near to $\pm 8{,}3 \times 10^{-7}$ (±0,000 019 5 g/cm^3 on approx. 2,357 221 3 g/cm^3). All uncertainties to 1 ó.

Figure 2. Solid density standard

To obtain that uncertainty of radius of sphere is not a problem of measurement, it is a problem of manufacture. Nowadays CSIRO of Australia offer spheres with these characteristics.

By economy reasons, CENAM decided to acquire a secondary density standard, a couple of zerodur spheres named as Z-01 and Z-02. These spheres was manufactured on Research Center of Optics (CIO) placed on León Guanajuato, Mexico, spheres have uncertainty of radius about 120 nm, such uncertainty is not enough for primary standard, but its characteristics of surface finished and spherically are enough to hope a good behavior as secondary density standard. These spheres were calibrated by PTB of Germany, using primary density standards of this country, (ZK1 and ZK2) made of same material.

Results of calibration are the following,

Z-01		
Volume	393,592 8 cm^3	± 0,000 4 cm^3 (k=1)
Mass	998,147 83 g	±0,000 075 g (k=1)
Density	2,535 991 08 g/cm^3	±0,000 002 58 g/cm^3 (k=1)
Z-02		
Volume	394,850 9 cm^3	± 0,000 4 cm^3 (k=1)
Mass	1001,334 29 g	±0,000 075 g (k=1)
Density	2,535 980 77 g/cm^3	±0,000 002 58 g/cm^3 (k=1)

The relative uncertainty of these standards are approximate to 1×10^{-6}, that are one level less than relative uncertainty of pure water approximate 1×10^{-5}.

To have density standards with relative uncertainty better than water's density, will get solids and liquids with relative uncertainty similar than water's equation offer. This situation is very important especially for frequency density meter calibration (density meters of the oscillating type).

Density meter of oscillating type being came replacing to hydrometer and pycnometers on density measurements on industrial task, nowadays its relative uncertainty of calibration of density meter type oscillating usually couldn't be better than $1x10^{-3}$, with the new scheme of trazabillity based on solid density standards (spheres) these uncertainty of calibration could reach to $5x10^{-5}$, these would happen because they come up two levels of trazabillity chart.

It is the same with uncertainty of solids and liquids, because we hope to reach uncertainties around to $5x10^{-5}$ for liquids and solids instead of $5x10^{-5}$ y $1x10^{-4}$ respectively, see fig 3.

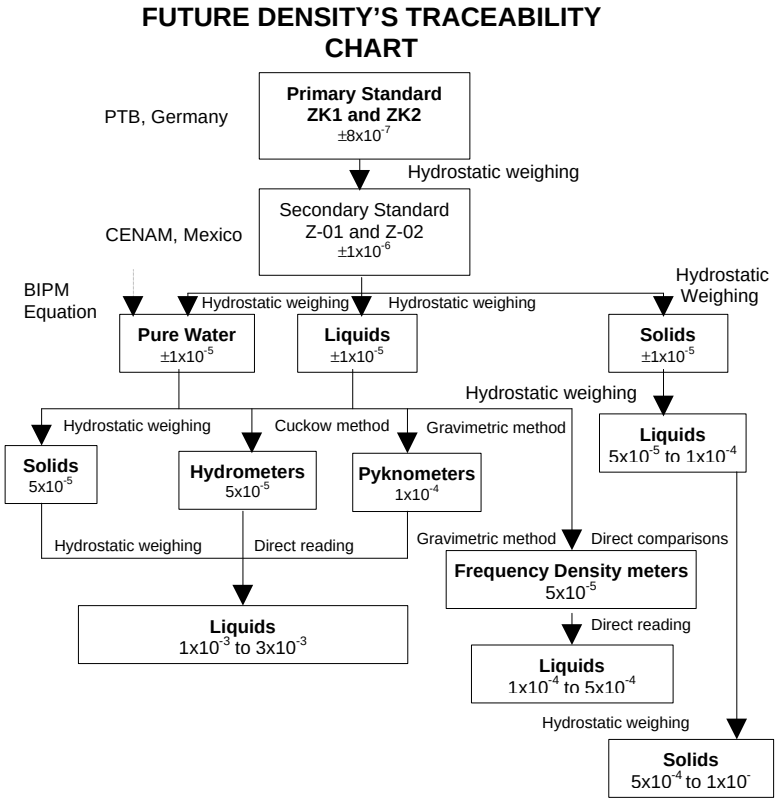

Figure 3. Measurement density's traceability based on solid density standards

3 SYSTEM

To transfer density's accuracy from spheres to other solids or liquids it have been developing a vertical hydrostatic weighing system.

The system consist in to weight spheres below balance in a liquid, that liquid some times works as a transfer liquid and other times as a measurand.

By using an automatic mechanism, spheres will be place one by one on suspension that it be directly connected to the pan of balance. Balance will be placed on a tall table especially available to weight below balance, see fig. 4. To get the levels of uncertainty pretends, it will be use a mass comparator of capability of 1 kg and readability of 10 ìg, a thermostatic bath to keep liquid temperature and spheres temperature about 5 milikelvins will be used too.

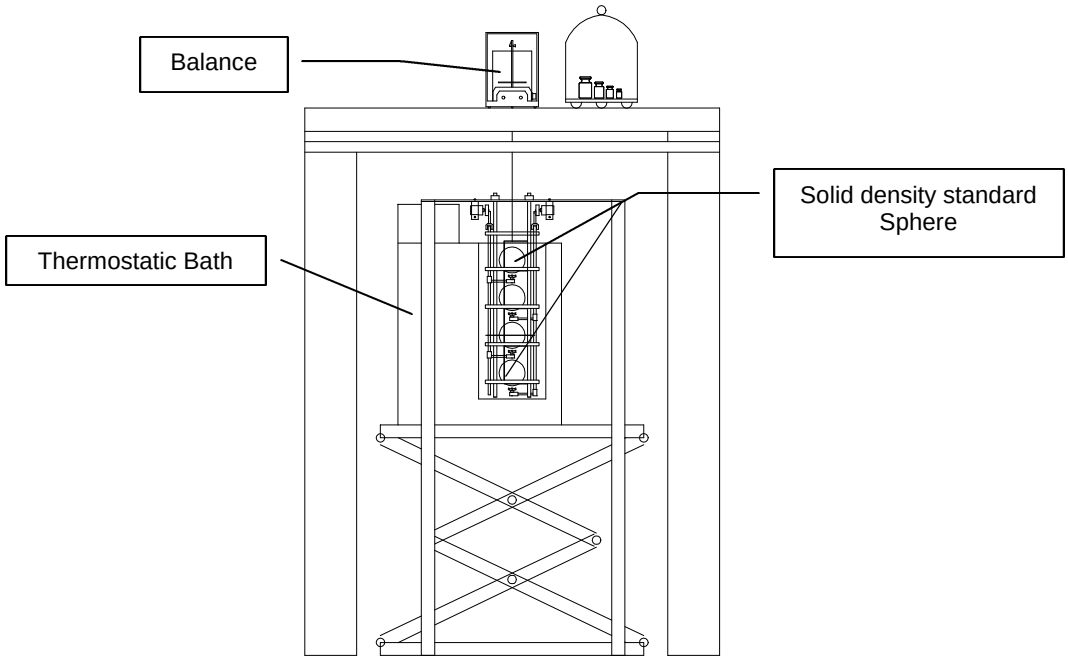

Figure 4. System of hydrostatic weighing for solid density standards

Measurement of spheres (solids)

To measurement of solids, it will make a series of comparison between spheres on air and lately in a transfer liquid, by differences of air and liquid buoyancy read on balance, it calculates volume of spheres.

Measurements of liquids

By measurements of apparent mass of spheres in a liquid (to determinate its density), it measure its liquid's buoyancy and, with the volume of the spheres and buoyancy value it will be calculate liquid density.

4 CONCLUSIONS

A secondary density standard will works appropriately due mainly to two raisons, first, we will get liquids with the same uncertainty of density's water but with low surface tension coefficient and with different density value for calibrations of devices and, second, will getting better uncertainty of calibration of devices for industrial purposes.

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