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pooled standard deviation

A problem often arises when the combination of several series of measurements performed under similar conditions is desired to achieve an improved estimate of the imprecision of the process. If it can be assumed that all the series are of the same precision although their means may differ, the pooled standard deviations s_p from k series of measurements can be calculated as

$$s_p = \sqrt{\frac{(n_1 - 1)\, s_1{}^2 + (n_2 - 1)\, s_2{}^2 + ... + (n_k - 1)\, s_k{}^2}{n_1 + n_2 + ... + n_k - k}}$$

The suffices 1, 2, ..., k refer to the different series of measurements. In this case it is assumed that there exists a single underlying standard deviation σ of which the pooled standard deviation s_p is a better estimate than the individual calculated standard deviations s_1, s_2, ..., s_k, For the special case where k sets of duplicate measurements are available, the above equation reduces to

$$s_p = \sqrt{\frac{\sum (x_{i1} - x_{i2})^2}{2\, k}}$$

Results from various series of measurements can be combined in the following way to give a pooled relative standard deviation $s_{r,p}$:

$$s_{r,p} = \sqrt{\frac{\sum (n_i - 1)\, s_{r,i}{}^2}{\sum n_i - 1}} = \sqrt{\frac{\sum (n_i - 1)\, s_i^2\, x_i^{-2}}{\sum n_i - 1}}$$

Source:
PAC, 1981, *53*, 1805 *(Assignment and presentation of uncertainties of the numerical results of thermodynamic measurements (Provisional))* on page 1821

