DIFFERENTIAL QUARTZ CRYSTAL MICROBALANCE

General considerations

The program allows a much enhanced accuracy in QCM measurements. Spurious effects generated by temperature, stress, hydrostatic pressure and viscosity of both gases and liquids can be significantly reduced and even eliminated when one the two quartz crystals is used as a reference, while the other is performing mass measurements. Using differential measurements the spurious effect of the temperature was greatly reduced allowing reliable mass measurements up to 500°C [1].

For measurements in liquids the reference crystal will be put in contact simultaneously with the same fluids, as the measuring crystal which has, in addition, an active film deposited on its surface.

The deposited film thickness and mass are calculated using the following equations:

$$L_f = \frac{1.324N}{nDF_{m0}}\left\{\frac{{F_{m0}}^2}{[F_{m0}-(dF-dF_0)]^2}-1\right\}$$

$$M_f = \frac{1.324NSu}{nF_{m0}}\left\{\frac{{F_{m0}}^2}{[F_{m0}-(dF-dF_0)]^2}-1\right\}$$

Where F_{m0} is the frequency of the measuring crystal at the starting of the measurements (record) and dF is the current difference between the frequency of the reference crystal and the frequency of the measuring crystal:

$dF = F_r - F_m$

It is assumed that the frequency of the reference crystal is higher than the frequency of the measuring crystal.

$dF_0 = F_{r0} - F_{m0}$

is the difference between the frequencies of the two crystals at the starting of the measurements (record).

N is the frequency constant, **n** is the overtone number, **D** is the density of the film deposited on the surface of the measuring crystal and **Su** is the area of this film.
The constant 1.324 is just half of the quartz density in (g/cm^3).
Measurements with AT-cut crystals (N=1.67 MHz . mm) vibrating on their fundamental mode (n=1) are set as default.

The program measures series resistance of both the reference and measuring crystals and calculate their difference:

$dR = R_m - R_r$

It is assumed that the series resistance of the coated crystal is higher than the series resistance of the uncoated crystal used as reference.

The use of this software program is similar to that described for “Dual QCM”. In addition, this program calculates and displays the rate in film thickness change and the rate in mass change.

References

[1]. V.M. Mecea, J.O. Carlsson, P. Heszler and M. Bartan. Development and testing of a high temperature quartz crystal microbalance. *Vacuum,* 46 (1995) 691-694.