Küppers Elektromechanik GmbH

Certified according to DIN EN ISO 9001

# DKD

## Calibration of Flow Meters

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Calibration is the expert method to determine precise and usable information on the accuracy of a measuring device. Being manufacturers of flow meters, we supply individual calibration records for all flow meters. Records are also available for reverse flow and different viscosities.

Our calibration records contain:

- K-factor and linearity error for the entire measuring range
- K-factor and linearity error at different flow rates within the measuring range

We calibrate flow meters on our gravimetric or one of our volumetric calibration rigs. The gravimetric rig is the heart of our calibration laboratory DKD-04701. This laboratory is affiliated to the DKD, Deutscher Kalibrierdienst (German Calibration Service) and accredited to DIN EN ISO / IEC 17025/2005

Gravimetric Calibration Rig (DKD-K-04701)
- Measuring range: 0.016 up to 2.,000 ltr./min
- Accuracy: 0.10% of actual flow
- Calibration viscosities: up to 100 mm²/s

## Calibration as per the weigh-time system

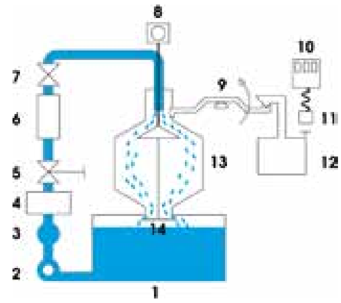
The weighing system measures the time interval it takes to collect a predetermined weight of test liquid (predetermined mass) that has passed through the flow meter. The electronic millisecond timer accurately measures the elapsed time of each weigh cycle, indicating directly in units of tenths, hundreths and thousandths of seconds. The timer has its own crystal frequency standard (1 Mhz). Having precisely determined the mass flow per time unit, volume units, e.g. ltr/min, can be derived considering the densitiy of the calibration medium and calculating factors.

All components are selected and designed for optimum flow characteristics and reliability necessary to maintain the high accuracy and repeatability over many years of service. For instance, standard calibration weights are placed on the scales for the test cycle. They serve to provide a constant, unchanging weight reference. To reduce frictional forces, the beam is supported on self-aligning Stellite knife edges and Wallex saddles. The entire system has unparalleled sensitivity.

Each weighing cycle is carried out strictly in line with the following scheme.

### Running operation before test

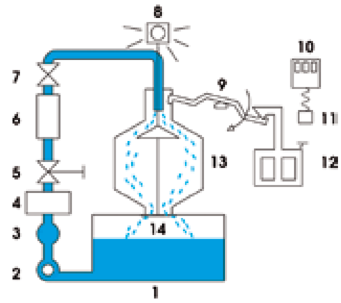
Fluid contained in the reservoir (1) is pumped (2) through a closed hydraulic circuit (cf. page 6). First, it enters a filter (3) and then a heat exchanger (4), which controls the temperature. It then passes through the control valves (5), the flow meter to be tested (6), the backpressure valve (7), the weighing tank (13), and finally back into the reservoir (1).

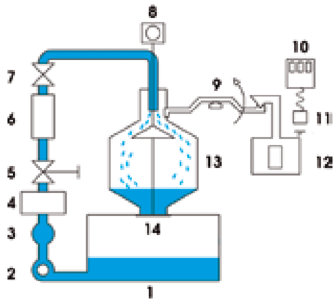



### Start of preliminary fill (tare time)

The preliminary fill is carried out to calibrate the weighing system. When the control valves (7) have been adjusted for the desired flow, a tare weight (12) is placed on the scales.

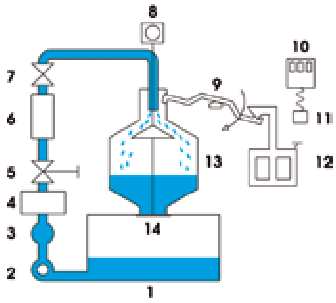
Then the cycle start button (8) is pushed, resetting the timer (10), closing the dump valve (14), and the weighing tank (13) is filled.






## End of pre-fill, start of weighing cycle

As the weighing tank (13) fills, the scales rise (12), tripping the timer actuator (11) and the electronic timer (10) begins counting in milliseconds, starting the actual weighing cycle. The preliminary fill, balanced out by the tare weight before actual weighing begins, permits a net measurement of the new fluid added after preliminary fill. The preliminary filling method permits measurement of only a portion of the cycle, eliminating the mechanical errors in the start and stop portions, and eleminates dynamic errors.

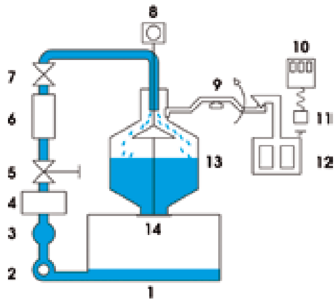



## Weighing cycle in operation

The weighing cycle is continued as a precision weight is placed on the scales, again deflecting the beam. The uniquely designed cone-shaped deflector at the inlet of the weigh tank (13) permits the even distribution of the metered fluid.

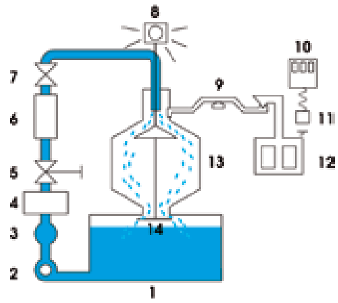
## End of weighing cycle

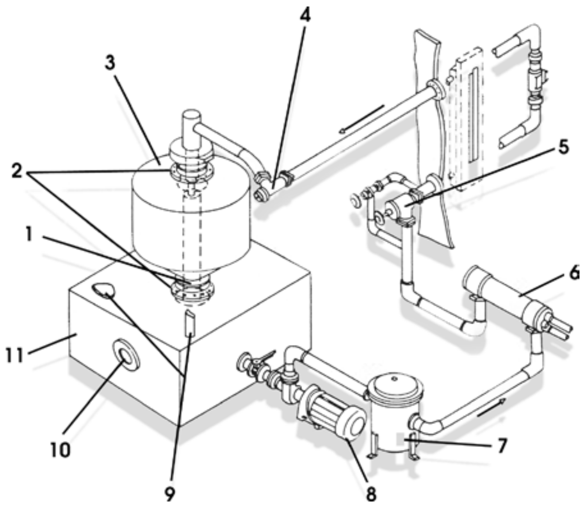
As the tank (13) fills, the weigh pan (12) rises, until it again trips the timer actuator (11), stopping the timer and indicating the time within a thousandth of a second. By combining the calibrated test weight with the timed interval, the actual flow rate in pounds per hour is easily and accurately determined. From these basic mass units. other flow units can be precisely calculated..




## Emptying for the next cycle

After the beam movement trips the timer, the weighing tank automatically empties in less than 25 seconds at maximum flow. The calibrator is now ready for the next measuring cycle.






## Hydraulic Circuit

1. Dump Valve. A unique design permitting the weighing tank to empty in 25 seconds or less at max flow rate, without need for reducing flow. It is specially designed for leak-proof operation.
2. Vapour Seals on both ends of the weighing chamber, prevent significant vapour loss. Seals are liquid and will never wear out.
3. Weighing Tank. A stainless steel construction with overflow facility to the reservoir at maximum flow rate.
4. Back Pressure Control prevents cavitation that can occur with light fluids. It is adjusted from the front panel and it automatically maintains the desired set point.
5. Flow Control Station. It employs unique valves designed specifically by COX flow specialists to achieve the precise flow so critical to high-accuracy calibration.
6. The Heat Exchanger is water-fed and electrically heated (95kW).
7. The Filter prevents contaminants from affecting the flow meter to be tested, or from building up in the reservoir and also serves to reduce turbulence in fluid flow.
8. The Centrifugal Pump is corrosion resistant. Precision balanced, it provides a constant flow rate with a minimum of pulsations.
9. Reservoir Fill. There are two methods of filling the reservoir. One is through the manual safety fill, and the other is through an external pressure fill connection.
10. The Viewing Port allows the operator to examine the reservoir or the dump valve at any time during the weighing cycle. It also permits immediate spotting of dump valve seals leaks.
11. The Reservoir is made from stainless steel, internally baffled, and self-draining (this is important when changing fluids).

## Specifications

| Calibration Value | Measuring Range | Measuring Conditions | Min. Meas. Error | Remarks |
|---|---|---|---|---|
| Mass | m = 0,9 kg<br>up to m = 8 kg<br>m = 90 kg<br>up to m = 600 kg | weighing system | Δ m = 0,1%<br>of actual value | measuring medium:<br>fluids<br>specific gravity from<br>p = 650 kg/$m^2$ up to<br>p = 1000 kg/$m^2$<br>and viscosities from<br>v = 1 $mm^2$/s<br>v = 100 $mm^2$/s<br>humidity<br>60% ± 30%<br>air pressure<br>1013 mbar ± 50 mbar<br>ambient temperature<br>23°C ± 5°C |
| Mass Flow Rate | dm/dt = 0,015 kg/min<br>up to<br>dm/dt = 1500 kg/kg | weighing system | Δ dm/dt = 0,1%<br>of actual value | |
| Volume | V = 1 ltr.<br>up to V = 10 ltr.<br>V = 100 ltr.<br>up to V = 800 ltr. | weighing system<br>with specific gravity<br>computation | Δ v = 0,3%<br>of actual value | |
| Volume Flow Rate | dv/dt = 0,01 ltr./min<br>up to<br>dv/dt = 2000 ltr./min | weighing system<br>with specific gravity<br>computation | Δ dv/dt = 0,3%<br>of actual value | |

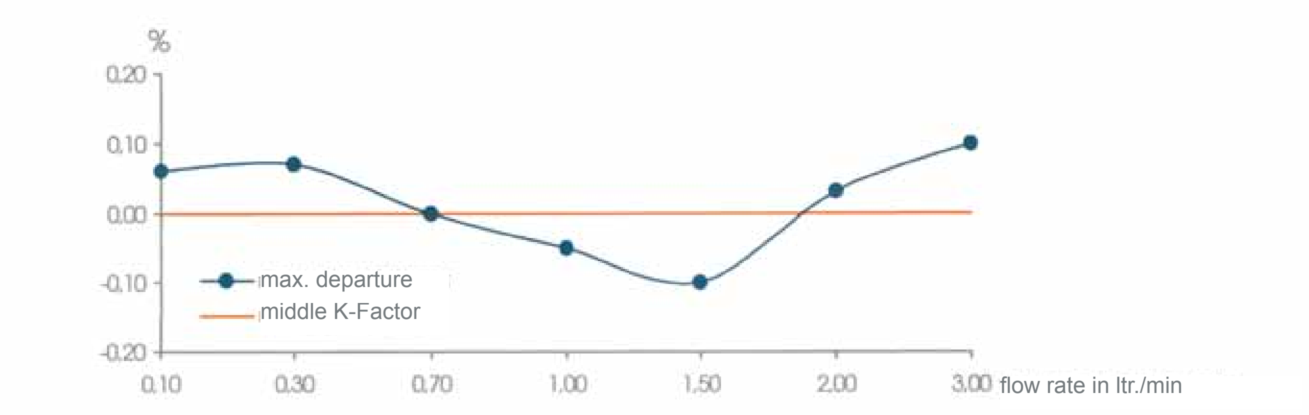
## General

Measuring ranges: 0.001 bis 20.000 ltr./min
Accuracy: 0,1% volume error

During the calibration process the volume of a tank, determined as accurately as ± 0.01%, will be filled with a constant flow passing through the flow meter. The output pulses of the flow meter are added electronically and calculated for a volume unit to receive the K-factor in pulses per litre. Strictly speaking, this K-factor applies only to a certain flow velocity or volume flow. However, for the application of flow meters it is necessary to know the linear measuring range, i.e. the range with a constant K-factor. This range is determined by successively repeating the filling process at different flow velocities. The K-factor will slightly change in accordance with the flow velocity. The individual measurements will result in the calibration curve from which the average K-factor can be drawn. The average K-factor applies for the entire flow range of the meter.

Our DKD Calibration Laboratory (cf. page 3 to 5) ensures that calibration results have a valid relationship to nationally recognized standards.

**Calibration curve with 7 measuring points**




## Accuracy of the flow meters

**1. Linearity corresponding to the actual flow:**
Defining the max percentual deviation of a specific K-factor compared with the average K-factor. Linearity usually amounts to ± 0.15 % up to ± 1 % of the actual flow rate within the linear measuring range of the meter. In terms of final value linearity improves considerably.

**2. Repeatability: Scattering of the calibration curve**
The repeatability defines the percentual differents between measuring results of repeated measurements at constant flow. The repeatability usually amounts to 0.05 % up to 0.1 %. Only with small turbine flow meters below 9 mm dia will the repeatability increase to 0.2 %.

Deutscher Kalibrierdienst (DKD)
Akkreditierungsstelle
vertreten im

# Deutschen AkkreditierungsRat

## Akkreditierung

Die Akkreditierungsstelle des **Deutschen Kalibrierdienstes** akkreditiert hiermit

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nach DIN EN ISO/IEC 17025: 2005 für Kalibrierungen im Bereich / in den Bereichen:

Strömungsmessgrößen

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Braunschweig, 2007-05-25

Dr.-Ing. Wolfgang Bosch
Leiter der Akkreditierungsstelle

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Siehe Hinweise auf der Rückseite

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