



HOW TO DETERMINE THE CALIBRATION FACTOR AND HOW TO USE IT

1 Introduction

To ensure the highest possible accuracy, all em-tec BioProTT™ Clamp-Ons* are pre-adjusted and calibrated according to customers' requirements prior to shipment. However, what if the medium that is used later on differs from the one the sensor was adjusted and calibrated for? The answer can be the use of a calibration factor. This TechNote will highlight what a calibration factor is and also explain how to determine it.

2 What Is the Calibration Factor?

If the medium used or its temperature is different from the one the sensor was adjusted and calibrated for, the calibration factor linearly adjusts the measured flow.

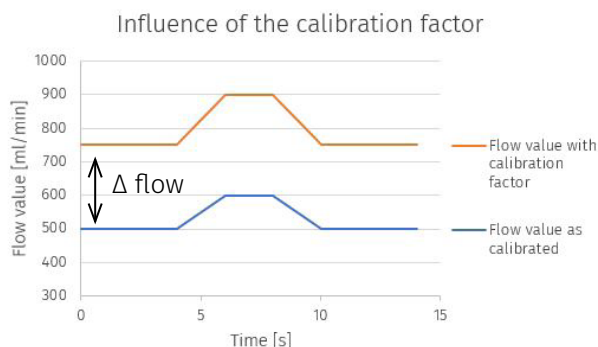


Figure 1: Influence of the Calibration Factor

Generally speaking, the calibration factor can help to increase the accuracy of the measurement if there are any changes to the medium.

3 Methods to Determine the Calibration Factor

In order to be able to determine the calibration factor, a reference system is required. Applicable reference systems are different flow measurement systems such as, for example, a Coriolis flow meter. Another possibility would be to simply measure the fluid volume over time in ml/min, or the use of scales.

Please note that to ensure the highest possible accuracy of the calibration factor, it is recommended to determine the calibration factor at several flow values — the verification points — and to then use the mean value of those as the final calibration factor.

3.1 Using Scales

An easy to perform way is the use of scales. For this method, the following items and information are needed:

- scale
- pump
- timer/ time setting on the pump
- medium (tempered according to the calibration information sheet)
- reservoir (should hold at least 3 liters)
- density of the medium
- BioProTT™ Clamp-On and transmitter

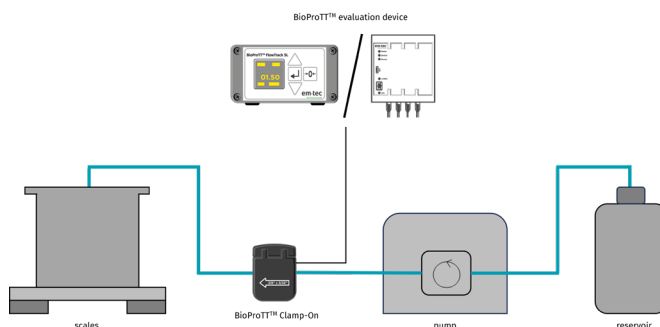


Figure 2: Setup Scales, Example

Simply perform the following steps:

1. Place a container on the scale and tare the weight.
2. Take the tube which was used for the adjustment and the calibration and attach the sensor to it.
3. Connect the BioProTT™ Clamp-On to the transmitter.
4. Run the tube through the pump/connect it with the pump and the medium reservoir.
5. Fill the tubing system completely with the medium and ensure it is bubble-free. Don't include the weight into the calculation (tare again if necessary).
6. Stop the pump and ensure that the fluid inside the tube does not move. Then zero the system.

7. Set the dosing time on the pump to a chosen value or use the timer to take the time.
8. Start the flow measurement of the BioProTT™ FlowMeasurement System.
9. Start the pump. If a timer is used, stop the time it takes to reach a chosen weight.
10. Stop the pump. Note down the weight and the time.

After the above-mentioned steps were performed, the calibration factor can be calculated as follows:

$$CF = \frac{\frac{m}{\delta} \times \frac{1}{t}}{\text{stable flow measurement of the em-tec sensor in ml/min}}$$

CF = calibration factor

m = mass of the medium in the container in g

δ = density of the medium at the specified temperature in g/ml

t = dosing time of the pump or manually stopped time in min

For more information regarding the actual use of the calibration factor, please refer to chapter 4 of this TechNote.

3.2 Using a Coriolis or Similar Flow Meter

If a Coriolis, or another reference flow meter, is available, this method guarantees the least laborious determination of the calibration factor.

For this method, the following items are needed:

- reference flow meter (e.g. Coriolis)
 - more precise than the targeted accuracy of the BioProTT™ FlowMeasurement System
- pump
- medium (tempered according to the calibration information sheet)
- reservoir (should hold at least 3 liters)
- BioProTT™ Clamp-On and transmitter

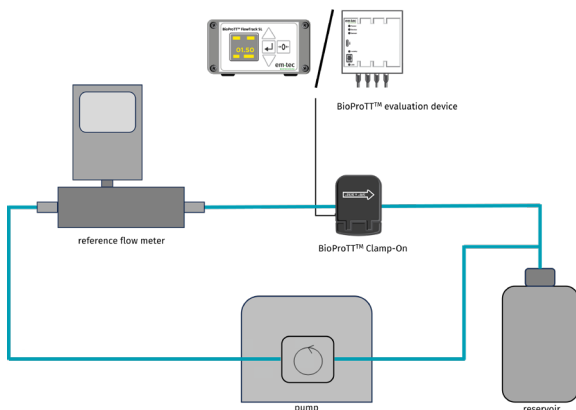


Figure 3: Setup Coriolis, Example

How to perform the measurement:

1. Connect the tube with the medium reservoir, the pump, and the other flow meter.
2. Clamp on the BioProTT™ Clamp-On and connect it to the transmitter, then switch it on.
3. Switch on the Coriolis flow meter and choose ml/min as unit.
4. Fill the tubing system completely with the medium and ensure it is bubble-free.
5. Stop the pump afterwards and ensure that the fluid inside the tube does not move.
6. Zero both flow meters.
7. Switch on the pump and start the flow measurement on both flow meters.
8. Perform the measurement for a few minutes in order to reach stable flow values.
9. Switch off the pump.
10. Compare the two flow values as follows:

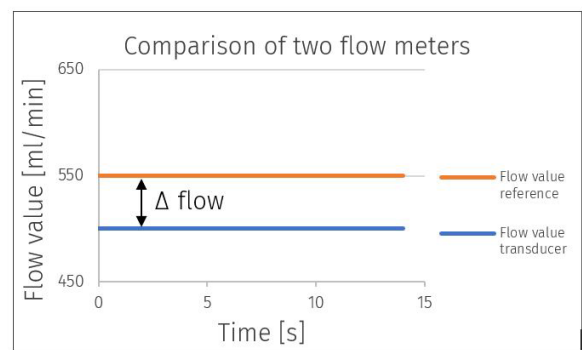


Figure 4: Comparison of Two Flow Meters

The calibration factor can be calculated with the aid of the difference in flow values between the two systems:

$$CF = \frac{\text{reference flow [ml/min]}}{\text{stable measurement em-tec sensor [ml/min]}}$$

For more information regarding the actual use of the calibration factor, please refer to chapter 4 of this TechNote.

3.3 Measurement of Volume over Time

Another easy way to determine the calibration factor is the measurement of fluid volume over time.

All items required for this method are:

- measuring cylinder
- pump
- timer
- medium (tempered according to the calibration information sheet)
- reservoir (should hold at least 3 liters)
- BioProTT™ Clamp-On and transmitter.

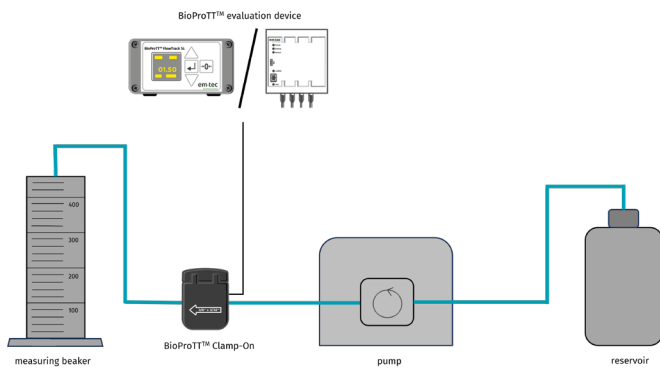


Figure 5: Setup Volume over Time, Example

Steps to perform the measurement:

1. Connect the tube with the medium reservoir and the pump.
2. Clamp on the BioProTT™ Clamp-On and connect it to the transmitter.
3. Fill the tubing system completely with the medium and ensure it is bubble-free. Stop the pump afterwards.
4. Ensure that the fluid inside the tube does not move. Then zero the system.
5. Start the pump and the timer at the same time.
6. Fill the measuring cylinder until the chosen volume is reached.
7. Stop taking the time and stop the pump.
8. Note down the fluid volume and the time.
9. Divide the fluid volume in ml by the time in min.

To calculate the calibration factor, the following equation can be used:

$$CF = \frac{\text{fluid volume over time [ml/min]}}{\text{stable measurement of the em-tec sensor [ml/min]}}$$

For more information regarding the actual use of the calibration factor, please refer to the following section.

4 Using the Calibration Factor

Ideally, the calibration factor is determined for all the verification points that were used for the original calibration. These verification points are stated in the Calibration Information Sheet, which is part of every BioProTT™ Clamp-On order. So once the factor was determined for these flow values, it is possible to calculate their average:

Flow value reference flow meter	Flow value em-tec flow meter	Flow value reference flow meter / Flow value em-tec flow meter
100 ml/min	102 ml/min	0.980
500 ml/min	511 ml/min	0.978
1000 ml/min	1025 ml/min	0.976
3000 ml/min	3075 ml/min	0.976

Resulting Calibration Factor

⇒ Calibration Factor 0.98

After the factor was determined with one of the mentioned methods, it can be set on the transmitter. For the BioProTT™ FlowTrack plus, this is done directly on the device using the display, for the BioProTT™ FlowMCP the calibration factor can be set on the web interface. For more information concerning the setting of the calibration factor, please refer to the respective user manuals of the devices.

*Please note:

When using BioProTT™ Clamp-On, within this TechNote, it refers to both the BioProTT™ Clamp-On Transducers (red lid) as well as to the newer BioProTT™ Clamp-On SLs (black lid).

5 Contact

If there are any questions concerning the information in this document or if you are having trouble at some point during the calibration, please contact em-tec GmbH.

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