

Technical note: Pressure Stability of the Dialysis Probe

INTRODUCTION

The TRACE dialysis probe (Figure 1) is a reliable tool for online monitoring and control applications. Most of these are performed in small vessels making full use of the no-volume consuming properties of dialysis sampling. However, the probe can also be used in large industrial fermenters. Under these conditions higher pressures can occur regardless if due to hydrostatic pressure or charging of the medium with overpressure. The aim of this investigation was to characterize the behavior of the probe with respect to safety and performance.



Figure 1. Dialysis probe

The dialysis probe itself consists of stainless steel, which itself is very pressure resistant (maximum pressure tested: 10 bar. Burst pressure test according to pressure equipment directive 2014/68/EU). The critical part of the probe is the dialysis membrane.

PRESSURE TESTS

Pressure tests were performed at different overpressures ranging from 0 bar up to 3.4 bar (49,3 psi). The pressure was increased stepwise. During this procedure Glucose and Lactate measurements were performed. The results are shown in Table 1 and 2.

Over Pressure	0 bar	1 bar	2 bar	3.4 bar
Signal Glucose	1.027 g/L	1.139 g/L	1.254 g/L	1.403 g/L
Standard deviation	0.007 g/L	0.028 g/L	0.021 g/L	0.009 g/L
Variation	0.7 %	2.4 %	1.7 %	0.7 %
Recovery	103 %	114 %	125 %	140 %

Table 1. Pressure influence on glucose measurements

Over Pressure	0 bar	1 bar	2 bar	3.4 bar
Signal Lactate	0.510 g/L	0.570 g/L	0.614 g/L	0.675 g/L
Standard deviation	0.000 g/L	0.012 g/L	0.007 g/L	0.005 g/L
Variation	0.0 %	2.0 %	1.1 %	1.1 %
Recovery	102 %	114 %	123 %	135 %

Table 2. Pressure influence on lactate measurements

The resulting signals are increasing with pressure (approx. 10% per bar).

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The precision of the measurements is not affected by the higher pressure (see Figure 2).

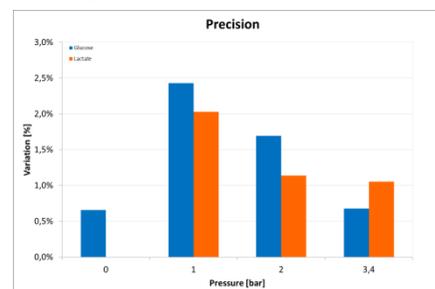


Figure 2. Precision



Figure 3. Pressure vessel with dialysis probe

Burst test

A burst test was performed at 6 bar (87 psi) overpressure (see Figure 3). Even under the extreme condition with the analytical side open (see yellow arrow / no tubeset connected), the membrane withstood this high pressure without any damage.

Long-term overpressure test

A long-term test was performed over 6 days at 3.4 bar (49,3 psi) overpressure. The membrane showed no damage during this test period. Analytical performance of glucose and lactate measurements was as reliable and as precise as under normal pressure.

CONCLUSION

The TRACE dialysis probe can be safely used in large reactors. Its dialysis membrane does not suffer from higher pressure due to hydrostatic and/ or pressurized conditions.

As expected, the higher pressure supports the penetration of analyte through the membrane resulting in higher signals with pressure increase (approx. 10% per 1 bar). However, this effect is either constant and thus included in the calibration or can be compensated for in case of dramatic pressure changes within the duration of the cultivation process.