

Technical Specifications - Dissolved Oxygen (DO)

Pill core material	PA-6
Form factor - pill	
Pill volume	1.3 cm ³
Pill density	1.25 g/cm ³
Form factor - marble	
Pill volume	1.8 cm ³
Pill density	1.1 g/cm ³
Sterilization	Beta irradiated at 25 kGy
Response time t_{90}^{1-3} (typical)	< 60s
Shaking noise^{4,6} (typical)	
Peak-to-peak,	1 – 8 %
Standard deviation	0.5 – 1.5 %
Accuracy (typical)	
5 % air saturation ⁵	4 %
95 % air saturation ⁵	2 %
Resolution (typical)	
5 % air saturation ⁵	0.2 mbar or 0.1 % air saturation
95 % air saturation ⁵	0.2 mbar or 0.1 % air saturation
240 % air saturation ⁵	0.2 mbar
Measuring range	0 – 470 % air saturation ⁵
Detection limit	0 – 0.5 % air saturation ^{5,6}
Drift	< 0.2 %/day ⁷
Lifetime (typical)	> 1 million data points
Shelf life	6 months in original packaging ⁸
Storage conditions	Dry, dark, and at room temperature

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Cross sensitivities

Organic solvents at high concentrations, bleach

Chemical compatibility^{6 9} (typical)

Compound	Maximum concentration ¹⁰
Ethanol	10 %
Methanol	5 %
Ammonia	1 %
Ammonium Chloride	1 %
Acetic acid	5 %
HCl	1 %
NaOH	1 %
Tris-HCl	50 mM

1 All measurement specifications represent typical values under commonly observed cultivation conditions. Each measurement specification may be influenced by cultivation, ambient and shaking conditions, compounds in the media, handling of Pills and devices, calibration codes provided to the DOTS Software as well as other factors or parameters unknown to the author.

2 Time to reach 90 % of the equilibrium sensor signal during a step response from 100 % DO in ambient air to 0 % DO via sulfite addition. Recorded at 30 °C in PBS, 250 mL shake flask with 10 % filling volume, at 300 rpm with 25 mm shaking diameter. The DO was changed instantly from air saturation to zero DO by catalyzed sulfite reaction (copper(II) oxide and sodium sulfite).

3 Response time may furthermore depend on agitation, temperature, pressure, medium polarity and other media and ambient conditions.

4 Shaking noise describes the maximum signal deviation from signal average during shaking.

5 Air saturation at 30 °C, 1013 mbar air pressure, 0 % humidity.

6 Strongly depends on the shaking conditions as well as flask size, liquid levels and dynamics.

7 Drift given in percent deviation from initial DO Partial Pressure signal. Recorded under constant shaking, air saturation at 30 °C, 100 % humidity, measured in PBS. Value refers to first week of continuous operation. The drift rate decreases after several days of operation.

8 A recalibration of the DO Sensor Pills may be required after prolonged storage (> 2 months).

9 The DO Sensor Pills are generally resistant to typical chemicals and typical concentrations found in microbial and cell cultures. The list only shows prominent examples. However, depending on the exact media composition, the chemical compatibility of the DO Pills may be different or cross-influenced by other compounds.

10 Compounds tested as additives in PBS. %-Concentrations are given in weight-percent.

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Recommended Operating Conditions - Dissolved Oxygen Sensor Pills - Form Factor: Pill

Temperature	4 - 45 °C
Shake flask type	Glass flask without baffles
Shake flask filling volume	
100 ml shake flask	10 - 20 %
250 ml shake flask	5 - 20 %
500 - 2000 ml shake flask	5 - 10 %
Shaking speed	
Optimal range	200 - 300 rpm
shaking diameter ≤ 2.5 cm	200 - 350 rpm
shaking diameter ≤ 5.0 cm	180 - 300 rpm

1 For process conditions that include low rpm ($\ll 200$ rpm), or other conditions that do not enable Pill movement with the liquid, Pills with a different form factor may enable DO measurements. Please contact our support team.

2 For 100 ml shake flasks, and 250 ml shake flask with less than 10 % filling volume, a minimum of 250 rpm applies.

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Recommended Operating Conditions - Dissolved Oxygen Sensor Pills - Form Factor: Marble

Temperature	4 - 45 °C
Shake flask type	Glass or plastic flask without baffles
Shake flask filling volume	
100 ml shake flask	10 - 50 %
250 ml shake flask	5 - 40 ² %
500 - 2000 ml shake flask	5 - 30 ³ %
Shaking speed⁴	
Optimal range ⁵	180 ⁶ - 250 rpm
shaking diameter ≤ 2.5 cm	120 ⁷ - 250 rpm
shaking diameter ≤ 5.0 cm	110 - 250 rpm

1 Applicable ranges of filling volumes may be extended for certain models of plastic shake flasks.

2 For 2.5 cm shaking diameter, a maximum of 32 % shake flask filling volume applies.

3 For 2.5 cm shaking diameter, a maximum of 20 % shake flask filling volume applies.

4 Shaking speed limits apply to the complete recommended range of filling volumes. Lower shaking speeds are possible with low filling volumes.

5 Optimal shaking speeds ensure a regular circulation of the marble in the shake flask liquid with optimal data quality. At lower shaking speeds, marbles may not follow the liquid in a regular pattern. While DO measurements are possible, the irregular marble movement in the shake flask potentially affects other measurements by the MPS.

6 For 100 ml flasks, a minimum of 200 rpm applies.

7 For 100 ml flasks, a minimum of 140 rpm applies.

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