

Calculation of OTR/CTR in shake flasks

OTR	Oxygen transfer rate [mol/l h]
CTR	Carbon dioxide transfer rate [mol/l h]
V _{flask}	Volume of shake flask (e.g. 1,22 l) in Litre
V _{sample}	Volume of the liquid sample (e.g. = 0,05 l) in Litre
V _{volume gas}	Volume of the gas in the shake flask in Litre
V _{CO2}	Volume of CO2 in shake flask in Litre
V _{O2}	Volume of O2 in shake flask in Litre
V _{Mol}	Volume of 1 Mol gas = 22,4 l/mol
CO ₂ ambient	Concentration of CO2 in the atmosphere [Vol.%) (ambient 0,04 Vol.%)
O ₂ ambient	Concentration of O2 in the atmosphere [Vol.%) (ambient 20,97 Vol.%)
CO ₂	Concentration of CO2 in shake flask [Vol.%)
O ₂	Concentration of O2 in shake flask [Vol.%)
N _{CO2}	Current moles of CO2 [mol]
N _{CO2old}	Moles CO2 one former measurement [mol] (depends on the measuring interval)
N _{O2}	Current moles of O2 [mol]
N _{O2old}	Moles O2 one former measurement [mol] (depends on the measuring interval)
D _{NO2}	Difference of Oxygen between to measurements [mol]
D _{NCO2}	Difference of Carbon dioxide between to measurements [mol]
DK _{CO2}	Diffusion constant of CO2 (specific for shake flasks) [1/h]
DK _{O2}	Diffusion constant of O2 (specific for shake flasks) [1/h]
t	Time between to measurements [h]

OTR

$$N_{O_2} = ((O_2_{\text{ambient}} - O_2) / 100) / V_{\text{mol}} * (V_{\text{flask}} - V_{\text{sample}})$$

$$D_{NO_2} = N_{O_2} - N_{O_2\text{old}} + N_{O_2\text{old}} * DK_{O_2} * t$$

$$OTR = D_{NO_2} / (V_{\text{sample}} * t)$$

CTR

$$N_{CO_2} = ((CO_2 - CO_{2\text{ambient}}) / 100) / V_{\text{mol}} * (V_{\text{flask}} - V_{\text{sample}})$$

$$D_{NCO_2} = N_{CO_2} - N_{CO_2\text{old}} + N_{CO_2\text{old}} * DK_{CO_2} * t$$

$$CTR = D_{NCO_2} / (V_{\text{sample}} * t)$$