kLa by the Dynamic Gassing-Out Method, with a van 't Riet Estimate

Oxygen transfer coefficient kLa from two dissolved-oxygen readings during re-aeration, and van 't Riet's estimate from power per volume and gas velocity.

Method: Doran; Bioprocess Engineering Principles; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Saturation dissolved oxygen	7.5000	mg/L
Dissolved oxygen at t_1	2.0000	mg/L
Dissolved oxygen at t_2	6.0000	mg/L
Time between the readings	40.000	s
Gassed power per volume	1.0000	kW/m³
Superficial gas velocity	0.010000	m/s
Liquid type	Coalescing (pure water, simple media)	

Calculated results

Parameter	Value	Unit
kLa from the readings	116.94	1/h
kLa by van 't Riet	148.35	1/h
Maximum oxygen transfer rate at C = 0	0.87702	kg/(m³·h)

Notes for this case

- Correct for probe response time when 1/kLa is less than about five times the probe's time constant. Van 't Riet's correlations hold within about 20–40 % for vessels up to 2.6 m³.

Formula and method

$$\ln\frac{C^* - C_1}{C^* - C_2} = k_L a (t_2 - t_1)$$

$$k_L a = 0.026 \left(\frac{P}{V}\right)^{0.4} v_s^{0.5}\ (\text{coalescing}), \quad 0.002 \left(\frac{P}{V}\right)^{0.7} v_s^{0.2}\ (\text{non}-\text{coalescing}) \quad (\text{SI})$$

Variables

C^*	Saturation dissolved oxygen	kg/m³
C_1	Dissolved oxygen at t_1	kg/m³
C_2	Dissolved oxygen at t_2	kg/m³
$t_2 - t_1$	Time between the readings	s
P/V	Gassed power per volume	W/m³
v_s	Superficial gas velocity	m/s
liquid	Liquid type	-
$k_L a$	kLa from the readings	1/s
$k_L a_{vR}$	kLa by van 't Riet	1/s
OTR_{max}	Maximum oxygen transfer rate at C = 0	kg/(m³·s)

Method and standards

Dynamic method; van 't Riet correlations.

Assumptions and limits

- Well-mixed liquid; constant C*.
- The two-point form holds when the liquid takes up no oxygen during re-aeration (water or broth without respiring cells). With a respiring culture the balance is dC/dt = kLa(C* − C) − OUR, and the oxygen uptake rate must be included.
- Van 't Riet's correlations come from vessels up to 2.6 m³ over their own ranges of power input and gas velocity; at larger scale or far outside those conditions treat the estimate as indicative only.

References

• Doran
• Bioprocess Engineering Principles
• 2nd ed. (Academic Press, 2013)
• ch. 10 (oxygen transfer, dynamic method)
• van 't Riet (1979)
• Ind. Eng. Chem. Process Des. Dev. 18: 357

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/bioprocess/kla-dynamic-gassing-out

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Reopens the calculator with the inputs of this report.