Fermentation Yield Coefficients from Batch Data

Biomass, product and oxygen yield coefficients from a fermentation's start and end concentrations, with the product's share of the theoretical yield.

Method: Doran; Bioprocess Engineering Principles; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial biomass	0.50000	g/L
Final biomass	5.5000	g/L
Initial substrate	180.00	g/L
Final substrate	2.0000	g/L
Initial product	0	g/L
Final product	84.000	g/L
Oxygen consumed per litre (0 for anaerobic)	0	g/L
Theoretical product yield (same substrate basis as S) Ethanol: 0.511 kg/kg on glucose (hexose); 0.538 on sucrose. Use the basis your substrate is measured on.	0.51100	kg/kg

Calculated results

Parameter	Value	Unit
Biomass yield on substrate	0.028090	kg/kg
Product yield on substrate	0.47191	kg/kg
Product per biomass formed	16.800	kg/kg
Share of the theoretical product yield	92.350	%

Notes for this case

- Observed yields include maintenance; true yields come from chemostat data at several dilution rates. Correct for volume change and sampling in fed-batch runs.
- No oxygen consumed (anaerobic): the yield on oxygen is not shown.

Formula and method

$$Y_{X/S} = \frac{X_1 - X_0}{S_0 - S_1}, \quad Y_{P/S} = \frac{P_1 - P_0}{S_0 - S_1}, \quad Y_{P/X} = \frac{P_1 - P_0}{X_1 - X_0}, \quad Y_{X/O} = \frac{X_1 - X_0}{O_2}, \quad \eta = \frac{Y_{P/S}}{Y_{P/S,th}}$$

Variables

X_0	Initial biomass	kg/m³
X_1	Final biomass	kg/m³
S_0	Initial substrate	kg/m³
S_1	Final substrate	kg/m³
P_0	Initial product	kg/m³
P_1	Final product	kg/m³
O_2	Oxygen consumed per litre (0 for anaerobic)	kg/m³
$Y_{P/S,th}$	Theoretical product yield	kg/kg
$Y_{X/S}$	Biomass yield on substrate	kg/kg
$Y_{P/S}$	Product yield on substrate	kg/kg
$Y_{P/X}$	Product per biomass formed	kg/kg

$Y_{X/O}$	Biomass yield on oxygen	kg/kg
η	Share of the theoretical product yield	-

Method and standards

Yield definitions.

Assumptions and limits

- Batch; constant volume.
- The theoretical yield must be on the same substrate basis as S: 0.511 kg ethanol per kg glucose, 0.538 per kg sucrose.
- Y_P/X is not shown when the biomass does not grow, and Y_X/O when no oxygen is consumed. Notes flag negative yields and a yield above theory.

References

• Doran
• Bioprocess Engineering Principles
• 2nd ed. (Academic Press, 2013)
• ch. 4 and 12 (yield coefficients)

Report details

Report reference	FCC-DSZ0-2NRT (the same inputs always give the same reference)
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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

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/fermentation-yield-coefficients

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.