Some Processes Have a Yield Above One; What Exceeds One Is Not the Balance but the Boundary Used to Count Mass

— starch's repeating unit of **162.1406** gives glucose at **180.1559**, so the mass yield of saccharification is **1.111109**, above one — the separator is whether water is counted as a feedstock — [Paper 718]

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— *From thinking to syncing.* —

Abstract

A process yield is assumed to be at most one. In saccharification it is more.Where the excess comes from is counted, in mass.No new theorem or law is claimed. First, the mass yield of saccharification exceeds one——the repeating unit of 162.1406 gives glucose at 180.1559, hence 1.111109 (Section 2). **Second, the value depends on where the cutting stops——stopping at maltose gives 1.055555, halving the excess** (Section 2). **Third, the ratio of the excesses equals the ratio of bonds cut——measured at 2.000000, so the reading "one water enters per cut" appears directly as a ratio** (Section 2). **Fourth, and this is the core. The excess is exactly the water taken up——the excess of 11.110912 g from 100 g of starch agrees with the mass of water entering to within 10^{-15}** (Section 3). **Fifth, so exceeding one is not a failure of conservation——water, a reactant, is left out of the feedstock and counted in the product: a placement of the boundary** (Section 3). **Sixth, the separator is whether water is counted as a feedstock ——count it and the yield never exceeds one; leave it out and it does** (Section 4). **Keywords**: hydrolysis, saccharification, mass yield, stoichiometry, system boundary, counting water as feedstock.

Scope of this paper (scope note): **No new theorem or law is claimed——the stoichiometry of starch hydrolysis and the mass gain in saccharification are both standard (Fischer 1894, Bailey and Ollis 1986).Enzyme kinetics are not treated——the balance between amylase activity and denaturation, and the choice of temperature and time, are not entered; only the stoichiometry is used.No real yield is claimed——actual yields of malting and mashing, and the fraction of unfermentable sugars, are not treated.Starch structure is not discussed——crystallinity, gelatinisation and the degree of branching are not treated.Chain ends are ignored——the chain is taken as long enough that the terminal unit is not counted; for short chains the yield is slightly lower.Relation to earlier papers**: **Paper 716 showed that fermentation does not reach a hundred percent because the catalyst has to build itself——there the ceiling lay below one, the theoretical yield being 0.511423. Here, under the same word "yield", the value exceeds one. Two sides of one word about the number one.**What is added is **deriving the mass yield of saccharification as 1.111109, showing it becomes 1.055555 depending on where one stops, showing the ratio of excesses to equal the ratio of bonds cut at 2.000000, showing the excess to agree with the water taken up to within 10^{-15}, and placing the separator on whether water is counted as a feedstock**.

1. Notation and the Question

Setting: **starch is a chain of repeating units. Each bond cut takes in one molecule of water.**

$$(\mathrm{C_6H_{10}O_5})_n + n\,\mathrm{H_2O} \to n\,\mathrm{C_6H_{12}O_6}, \qquad Y = \frac{M_{\text{sugar}}}{k\,M_{\text{unit}}}$$

k is the number of units the sugar contains. The chain is taken as long enough that the terminal unit is not counted.

Question: **must a process yield be at most one?**

2. The Value Depends on Where One Stops

Computation 2.1: **with a repeating unit of 162.1406 and water at 18.0153, the yield was derived for two stopping points.**

sugar	molar mass	units	mass yield
glucose	**180.1559**	**1**	**1.111109**
maltose	**342.2965**	**2**	**1.055555**

Observation 2.2

both exceed one.The difference is 0.055555——cutting to glucose takes in one water per unit; stopping at maltose takes in one per two units.

Observation 2.3

the ratio of the excesses equals the ratio of bonds cut.The measured ratio of excesses is 2.000000——the reading “one water per cut” emerges directly in the form of a ratio.

3. The Excess Is the Water That Entered

Computation 3.1: **the mass of sugar from 100 g of starch, and the mass of water taken up, were derived separately.**

sugar	sugar obtained	excess	water taken up
glucose	**111.110912** g	**11.110912** g	**11.110912** g
maltose	**105.555456** g	**5.555456** g	**5.555456** g

Observation 3.2

this is the core: the two columns come from different formulas and agree to within 10^{-15}.The left comes from a ratio of molar masses, the right from the number of bonds cut——the excess is not mass created but mass transferred in.

Observation 3.3

so exceeding one is not a failure of conservation.Water is a reactant, yet it is left out of the feedstock mass and included in the product mass——within one number, the numerator and the denominator use different boundaries.

Observation 3.4

count the water as feedstock and the yield never exceeds one.From 100 g of starch and 11.110912 g of water comes 111.110912 g of sugar——counted that way the yield is exactly one and the excess disappears.

Observation 3.5

and joining the stages puts both sides of one in a row.Multiplying by the theoretical yield of 0.511423 from Paper 716 gives 0.568247 g/g of ethanol from starch——a stage above one and a stage below one in series, with both hidden if only the overall figure is read.

4. The Separator

Observation 4.1

the separator is whether water is counted as a feedstock.Count it and the yield never exceeds one; leave it out and it does——neither is wrong, but mixing the two makes comparison meaningless.

Observation 4.2

beside Paper 716.Paper 716 showed that fermentation falls short of one because the catalyst must build itself ——there the ceiling lay below one. Here the same word takes a value above one. Two sides of one word about the number one.

Observation 4.3

what is not said.Enzyme kinetics, real mashing yields and starch crystallinity are not treated, and chain ends are not counted——what is shown is that a yield can exceed one, and what it is that exceeds.

5. Roll Call and Closing

1. **1.111109 to glucose** (Computation 2.1): **above one.**

2. **1.055555 at maltose** (Computation 2.1): **the stopping point matters.**
3. **difference 0.055555** (Observation 2.2): **the bonds not cut.**
4. **ratio of excesses 2.000000** (Observation 2.3): **the reading as a ratio.**
5. **111.110912 g of sugar** (Computation 3.1): **from 100 g of starch.**
6. **excess 11.110912 g** (Computation 3.1): **the core.**
7. **water also 11.110912 g** (Computation 3.1): **from another formula.**
8. **5.555456 g for maltose** (Computation 3.1): **that one agrees too.**
9. **the product is 0.568247** (Observation 3.5): **both sides hidden.**
10. **is water a feedstock** (Observation 4.1): **the separator; Paper 716.**

Closing: **Some processes have a yield above one; what exceeds one is not the balance but the boundary used to count mass.Starch's repeating unit of 162.1406 gives glucose at 180.1559, so the mass yield of saccharification is 1.111109, falling to 1.055555 if one stops at maltose——the ratio of the two excesses is exactly 2.000000, the ratio of the bonds cut, so the reading "one water per cut" appears in the form of a ratio.And the excess of 11.110912 g in the 111.110912 g of glucose from 100 g of starch agrees with the mass of water taken up to within 10^{-15}——the two columns come from a ratio of molar masses and from a count of bonds, so the agreement is not a coincidence.Exceeding one is therefore not a failure of conservation but a placement of the boundary: water is left out of the feedstock and counted in the product——include it and the yield is exactly one and the excess disappears.Joining the stages, the theoretical yield of 0.511423 from Paper 716 gives 0.568247 g/g of ethanol from starch, a stage above one and a stage below one in series.The separator is whether water is counted as a feedstock.Placed among the earlier papers——in Paper 716 the ceiling lay below one; here the same word takes a value above it.To be honest——enzyme kinetics and real mashing are not treated, and the terminal unit of the chain is not counted.**

References

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