$$\frac{dc_1}{dt} = qu_1 - qc_1 - yV_1 \frac{c_1}{k_1+c_1} \cdot \frac{c_2}{k_2+c_2}$$

$$\frac{dc_2}{dt} = qu_2 - qc_2 - yV_2 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}$$ ← glucose consumption term

$$\frac{dy}{dt} = yR \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2} - qy$$

Based on notes from class on 3.16.17,

fermentation will be rewritten as V_2, or rather in terms of V_2 since V_2 shouldn't be treated as a constant

R also not a constant?

- fermentation preferred.

Old fermentation rate:

$$\frac{df}{dt} = yRfm - qf$$

← m no longer a thing. Instead write in terms of glucose consumption term? But glucose consumption doesn't seem to fit in here well. Possibly write in terms of R & V_2 ← and change variable for alcohol conc. to a to make it clearer.

so, * glucose consumption term is $\boxed{-yV_2 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}}$

* use V_2 term for alcohol conc. dependent term (stand-in for fermentation term)
* increasing pop increases fermentative ability
* low glucose means no/smaller amount of fermentation
* fermentation related to glucose consumption through V_2 term
* V_2 originally was volume in tank - for glucose/related to glucose. If not constant, need to figure out what this term can be expressed in. Definitely related to population & glucose, and alcohol for that matter. As alcohol goes up, V_2 must go down. Wait no → V_2 must go up because that means more glucose is consumed, making the $\frac{dc_2}{dt}$ term go down over time.

So;

$$\frac{dV_2}{dt} = qa + \boxed{y R \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}}$$

alcohol produced → remnant of $\frac{df}{dt}$ term from old model

~~so qa is diluted~~
~~so volume~~

ignore; still just jotting stuff down

$\frac{dV_2}{dt}$ is modeling volume in tank in regards to glucose in the tank, and rate the volume changes at.

Wait going back to 3.16.17 notes, Dr. Fitzpatrick wrote...

the alcohol term as potentially being

$$\frac{da}{dt} = -qa + \underbrace{\boxed{}}_{\text{yeast produce it}}$$

Yeast produce it term being in regards to glucose consumption fermentation controlled by population, y

so ultimately going to be similar to $\frac{dy}{dt}$ term because it's being produced.

ok so how to include $\frac{da}{dt}$ in with everything else.

R & V_2 are deemed to not be constants, and both increasing / dependent on a & y

Constants in sense they only appear once? No need to set them as their own state variables.

ok ~~but~~ so R & V_2 are variables in the same way m was a variable in original model.

Both dependent on a & y.

R is standing for relative efficiency turning nutrient mass into yeast mass. Relies on u_1 & u_2 as well as a & y.

V_2 is volume of mixture specifically glucose still? so will just be in terms of glucose-related things → u_2, a & y

R = units not known

V_2 = units not really known

Both are increasing over time or as u_1 increases though it seems like.

so ... R: something related to overall metabolism

~~u_2 decreases over ti~~ glucose consumed, nitrogen consumed, alcohol produced, so...

$$R = [a - q(u_1 + qu_2)]y$$

~~base from before~~

q should actually be related to all

need to re-write

$$R = (-qu_1 - qu_2 + qa)y$$

~~$V_2 = (-qu_2 + qa)y$~~

$$V_2 = (qu_2 - qc_2 + qa)y$$

finally $\frac{da}{dt}$ ...

$$\frac{da}{dt} = -qa + ayV_2 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}$$

— modeled like yeast population

so finally; my new equation system is

$$\frac{dc_1}{dt} = qu_1 - qc_1 - yV_1 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}$$

$$\frac{dc_2}{dt} = qu_2 - qc_2 - yV_2 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}$$

$$\frac{dy}{dt} = yR \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2} - qy$$

$$\frac{da}{dt} = -qa + ayV_2 \frac{c_1}{k_1+c_1} \frac{c_2}{k_2+c_2}$$

$$R = (-qu_1 - qu_2 + qa)y$$

$$V_2 = (qu_2 - qc_2 + qa)y$$