TBP01x - 2.7 - banana 3

Welcome to banana number 3. And the topic of this banana is that the broth is not the same as filtrate. Suppose that you have the following steady state experiment. There's a feed of 1.8 liters per hour, and there is a broth outflow of 2 liters per hour. In the fermenter there is a biomass concentration which is 75 grams per liter, which is a very high biomass concentration, which we call a high cell density fermentation process. Also, because this is about product, the product concentration is analyzed and that is 10 grams per liter. The point is, you should reflect now a little bit about how do you analyze a product concentration in broth. What happens usually is that people take a sample from the broth, and then they remove the biomass from the broth because they want to avoid that the microorganism does additional things in the sample. So it's always a quick removal of biomass from the broth, and then you calculate product concentration, and that is in grams per liter. The point of interest is that you now reflect: what liter is this? So this is liter broth? No, this is basically liters of filtrate, because you removed the biomass. So the biomass concentration is in grams per liter filtrate. And now comes the interesting story, that when you have a high cell density, the biomass concentration, then the biomass concentration can also be calculated as 300 grams of wet biomass, because this is dry matter. And because, think about the biomass composition story in unit 2, 75% water in biomass means essentially that 75 gram dry matter is the same as 300 grams of wet biomass per liter broth, because biomass is determined in broth. So this tells you that 1 liter broth, contains 0.7 liter filtrate. So, thinking about it then the question is: what is now Rp in grams per hour? The standard approach is that you then of course make the product balance, there's no product going in, so everything that is produced in grams per hour can be found back in the outflow. So the rate of product formation is then Fout multiplied by cp,out, so in the outflow. The traditional banana is that people don't realize this filtrate and broth thing, so they just multiply 2 L/h by this concentration, 10 g/L, and they say it's 20 g/h. And of course then, you won't be surprised, this is wrong. Because the correct thing is that Rp is still FoutCp , but you should now realize that Cp is in grams per liter filtrate, and that tells you that Fout should be in liter filtrate per hour. We have 2 liter broth per hour, 1 liter contains 0.7 liter filtrate because of the presence of biomass, so Fout in liter filtrate is 2 multiplied by 0.7 and then of course multiplied by cp, which was analyzed at 10 g/L, but now realize this is filtrate. And then we say this is 13 g/h. Now in industrial fermentations, you usually have a lot of biomass and so that means that this distinction between filtrate and broth is extremely important. So when people do not recognize it, they basically claim that the production process makes much more product than it is doing in reality. And that gives of course very weird effects, because for example the downstream processing people will never be able to make their recovery percentage above 70%, and they are always complaining, but the simple truth is: this is an error by the fermentation people, this is not incapabilities of the downstream processing people. I hope you realize to make these distinctions: never confuse broth and filtrate and especially when the biomass concentration is high this is a big effect. Thank you very much.