

PROCESS and DESIGN

Prausnitz and Cairns

Describe your senior design project. I designed a methanol production plant. Basically I felt that I could have talked about it for as long as I wanted but I got nervous after having talked for so long without any comments from them so I stopped and let them rip into my design. You should know what your product is used for. They asked what methanol was used for and I said "for making formaldehyde." Then they asked what formaldehyde was used for and I said for "biology lab experiments" and they LAUGHED at me. Apparently, you should know that formaldehyde is used for polymers.

How do you make nickel? Cairns will most likely ask you about making metals like Ni, Na, Cu, Mg, Al, etc. Unfortunately I didn't study nickel but they led (dragged) me through the process. You should have a general understanding of general and organic chemistry or their attempts at helping you won't help very much. I had to figure out where we find copper in nature, the chemical formula, and how to convert it into the salt used in an electrochemical cell. Cairns kept sighing and Prausnitz kept yawning so I felt like they were disappointed with my performance. Somehow I passed.

Prausnitz and Cairns

1. What was your senior design project?

I just drew the process flowsheet and described the streams. They didn't care that much about my design project.

2. Let's say we want to separate low concentration organics from water. How would you do that?

Liquid-liquid extraction, but you would introduce another organic compound into water.

Activated carbon.

- a. How would you set up the activated carbon system?

Need to run two systems in parallel, so steam can be run through one activated carbon tank to reactivate the carbon.

- b. What do you do with the concentrated organic solution (from running steam through a tank)?
use aerobic microorganisms to decompose the organic material

You could burn it for fuel, or you could use bacteria to decompose the organics.

solid may be buried, or get fertilizer

6. Draw the bacteria wastewater treatment reactor. What else do you need?

Oxygen in excess. This led to a whole series of questions asking me to regurgitate how to make all these different compounds.

reactor, may be flooded

3. How do you make oxygen? Draw flowsheet.

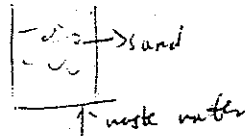
4. What do you do with the nitrogen?

Haber process. I had to draw the Haber process, but I couldn't remember what to do besides throttle it. They did help me through it.

5. How do you make hydrogen?

6. How do you make silicon?

I knew Cairns would ask something like this, but I had focused more on zinc, lithium, and real metals. All I could remember was that silicon comes from SiO_2 , which comes from sand, and then you need to reduce it with carbon. But Cairns led me through the problem.



If too high in nitrogen, anaerobic fermentation

Lynn and Wallman

Lynn

So, tell me about your senior design project...

My project was the synthesis of MTBE (Methyl t-Butyl Ether) from n-butane. I drew a flowsheet up, and he asked me some basic questions about how I handled/separated byproducts and also about the reactive distillation column.

Moving on with MTBE, he asked me if I had ever heard about the MTBE problem that was recently in the news. I told him that I had--MTBE was a fuel additive (oxygenator) that helps the combustion process of gasoline so that it is cleaner-burning. Unfortunately, while it has done wonders for the air pollution in California, it is being found in the water.

Why is it being found in the groundwater, and why isn't gasoline? Well, I reasoned that it was probably due to leaks in the underground storage tanks at gasoline stations. Since MTBE is fairly soluble in water (and hard to separate out from water), I said that it was probably because of the mass transfer characteristics of the MTBE and gasoline. Basically, the MTBE would easily be carried off by water flow in the soil, which would lead to MTBE getting in the groundwater.

Can you think of some other substance that could be used to oxygenate fuel? I couldn't, so he said that ethanol is used today. He asked if I thought that it would be a problem, and I said probably not (to which Wallman and Lynn shared some joke about "some people probably wouldn't mind having some ethanol in their water"--ha ha).

Wallman

By then, thankfully, we had to move on to controls. Wallman asked me to draw up a flash drum. He asked some general questions--basically getting at the fact that I'd have to have a pump and a throttling valve in the picture, too. The controls questions were basic (what variables do you think I would have to control?). I said temperature, pressure, and the liquid level. He made me draw a feedback controller for controlling the inlet feed temperature.

The flash drum had k components in the feed. I had to do some degree of freedom analysis to justify the fact that I could control/specify the system (think about overall mass balance, component mass balance, energy balance, etc.)

Blanch and Vorhis

Vorhis

You are at a refinery where the gasoline/C4 splitter overhead drum is having level control problems. The drum is nearly empty, the vent valve off the drum is wide open, and the tower pressure is rising. What do you do to keep the safety valve on the tower from releasing? (This is probably not a question that Vorhis would ask unless you have some industrial experience. He gave some additional details along the way, which allowed me to get to the right answer: you have to increase the reboiler duty. This is counter-intuitive, because you might think that vaporizing more liquid in the tower would raise the tower pressure even further. However, since the tower is taking a propane/butane stream overhead, if the reboiler duty is insufficient, mostly propane will go overhead. The propane could not condense at the conditions he gave, so reflux to the tower was limited as the overhead drum went dry. Increasing the duty to the reboiler will send more butane and heavier components overhead, which will condense, lower the vapor pressure in the drum, and provide additional reflux/cooling to the tower.)

Blanch

Design a tower to absorb dilute HCl from an air stream. (The main thing he wanted to hear was perform an energy balance and make sure you use enough water to control the exothermic absorption without boiling off the water.)

Lynn and Wallman

Lynn

Lynn started off asking the usual -- senior design project. I did the design of a Dinitrotoluene plant and there wasn't much to say. He asked me about process chemistry, extent of reaction, reactants needed and in what quantities, and some process control. At one point I screwed up and said my organics were soluble in water, but they didn't fail me!

Wallman asked me about the control strategy for a flash vaporization chamber. He wanted to know what the relative T and P's were inside and outside of the vessel, where to place controllers and why, and type of controllers (feed back). He helped me whenever I got stuck and always gave useful hints. He also wanted to know how I would solve for the compositions of the outlet streams.

So overall, they were pretty fair with me, but I think that Lynn takes into account if you are confident or not at the board. Wallman seemed to be more helpful.