Alphabet Soup Scaleup

GOALS:

1. To teach how Chemical Engineers do Process Design
2. To teach students how to use scientific facts they know
3. To understand scaleup issues in process design

PROGRAM DESCRIPTION:

The students will "design" a process for making Alphabet Soup for 300 from a recipe for one bowl.

MATERIALS NEEDED:

Overhead Projector
Blank transparencies
Enough blank paper for every student
4 or 5 sheets of 'L" sized paper - most likely off of a flipchart
Enough copies of a blank reactor for each student

PROCEDURE:

Introduce yourself as a chemical engineer, and introduce scale-up and what it means.

Explain that today's problem is to design a process that makes Alphabet Soup for 300.

Get out the blank paper and transparencies, and ask students for ideas as to what to put in the soup. Make sure somebody thinks to add water, heat and Alphabets.

Draw up a final recipe from the ideas (Take no more than 10 minutes with this)

Put up a transparency of the blank reactor, and explain that it is a cooking pot for 300 bowls. Discuss how each item of the recipe may be included in the big reactor. Some of the items are easy, and can be put directly on the reactor drawing, like the water, the heat, and the alphabets. Other items, such as vegetables and meat, may need some preliminary processing. Work with the students (on the L sized paper) to draw how these processes might look. (You might want to discuss how to do this with the teacher beforehand). Draw lines from the L sized drawings, and lines into the reactor. Encourage the students to update their own drawings and color them.

Try to leave some time at the end of the exercise for questions. If the students cannot think of any, then you might want to leave them with some closing ideas of other things engineers do, like:

Water Treatment
Making Gasoline
Making Medicine
Making Plastic

Some Ideas for getting the "Design" started:

What color is the soup?

Ask the students what color they think their soup should be. How does it get to be that color? If it is red, most likely someone adds tomatoes. How will we add the tomatoes? Will we get a truckful and chop them up? Will we open a lot of cans? Will we receive drums of tomato sauce? How does their mom make soup? You may find that a lot of moms open a can of soup. The analogue for scaling up would be to get the item in drums or tankers. You probably will end up drawing some type of warehouse or dock.

If the soup is brown, it is likely to come from some beef. How does the beef come? Will be chop up hamburger from the grocery store? Will we just add a boullion cube? How do you add boullion for 300? You could also start the soup with a can of stock. It may be easiest to move away from chopping meat for beef flavor, and thinking about adding boullion or broth. Both can be stored in tanks or hoppers.

What do we taste in the soup?

The answer here should be the vegetables, spices and/or meat.

How are vegetables packaged? Do they come fresh? Frozen? Canned? Dried? The first impulse will be to think of a huge vegetable chopper. If the students seem interested in designing a chopper, go with it. You might also suggest that the vegetable can be bought ready to add to the soup. Consider dried vegetables and reconstituting them. Since we are using water as the soup base, could we add the vegetables directly to the soup? Or, should we have a separate tank to mix them and then add? If we use a separate tank, how are we going to move the reconstituted vegetables to the soup tank?

The spices are usually added in small amounts. Consider when mom just shakes in salt or spices from small spice jars, or uses a small spoon to add something. On a large scale, we probably would open the manway, or fabricate a batch, prepacked small hopper attached to the top of the reactor. Talk about the safety issues of opening a hot pot of soup and putting your face over it to add the spices.

Some students may want to add chicken. How do we get chicken? The answer is a lot like the vegetable problem, except for the dried chicken option. If they have designed a vegetable chopper, consider using the same design for meat. Will the chickens come deboned? Will the chicken be cooked by us, or will we receive it cooked already? The issue here is how to keep the chicken tasting good. Ask them if they have ever eaten

frozen chicken. How do they like the chicken fresh from the oven? What would be the best option for the best taste?

How do we make the soup hot?

Let the children brainstorm about how to heat things up. The students may want to build a large version of a stove burner. Point out the heat transfer, safety and energy waste problems with that option. Consider talking about steam heat. If there are radiators in the room, they might visualize a radiator on the pot. If not, you might want them to think about how steam is made, and to imagine how you would get the steam to the pot. They may come up with a “double boiler” option. This is not far off from a jacketed reactor; the external heater just happens to be on the jacket. Of course, boiling the steam somewhere else, and piping the condensate back would be the traditional way. The conversation should be directed to this solution if possible.