Life Cycle Dialogue

Mr. H: Okay, so it's obvious that the major raw material for a paper cup is wood, and the major raw material for polyfoam cups is hydrocarbons, or oil and gas. The raw extraction of both of these materials involves some well- known impacts. In the first case, the clear cutting of extensive areas of watersheds increases the likelihood of flood and drought. In the second case, we are all familiar with the name Exxon Valdez, not to mention the daily leakage of oil from coastal refineries and from delivery systems.

Interestingly enough, according to my Canadian data, the production of the average 10.1g paper cup requires as much hydrocarbon fuel as that of a polyfoam cup. The table I provided you shows the petroleum needed per paper cup to be between 2.8 and 5.5g, for an average of 4.1g, versus 3.2g for polyfoam.

Ms. W: That is interesting. But I think your data is either incorrect or outdated because my own research has led me to a much lower value for oil use in paper cups. I know that in the United States today 56% of the energy used in paper production (this is an average for all grades of paper) comes from waste biomass. Of the other 44%, only about 8% comes form oil. Only 15% comes from natural gas. The 8% oil amounts to around 1.7g per cup.

Mr. M: Well, I'd personally agree with those figures for a modern integrated paper mill. But I know that lightboard paper from nonintegrated mills requires a bit more fuel, something like 2 to 3 grams per 10-gram paper cup. Also, only half the petroleum used to make polyfoam cups is burned, leaving half still available within the finished cup if recycled. In the end, paper and polyfoam cups probably leave the same amount of net nonrecycled petroleum.

Ms. O: Yeah, *if* the polystyrene is recycled to reuse that other half of fuel. . .

Mr. H: Well, I had relied on older reference material which was more readable, although admittedly less up to date. I wouldn't be surprised if the fuel use has decreased over the years, especially in the United States.

Mr. J: Let's move on, then. Could you explain your comparison of the chemicals used in the raw materials category, Mr. H?

Mr. H: Yes, the inorganic chemicals used for paper cups include sodium hydroxide, sodium sulfate, sodium chlorate, sulfuric acid, sulfur dioxide, and calcium dioxide—most of which are used only one time around, without being recycled.

The chemical requirements for the polystyrene foam cup are much smaller. One reason is that in some of the chemical reactions solid-phase catalysts are used that can react many thousands of times over before they have to be replaced.

Ms. O: Now, for the rest of your table, Mr. H, you show "per metric ton" figures rather than "per cup" figures. How do we compare these?

Mr. H: If you notice at the top of the table, I've listed 10.1g as the average paper cup weight, and 1.5g as the average polyfoam cup weight. So the mass of a paper cup is 6.73 times larger. For the data under utilities, water effluent, and air emissions, you must multiply the numbers for paper by 6.7 to compare the two on a per-cup basis.

So, looking at the amount of cooling water used per metric ton of material, we see $50m^3$ of water for paper cups and $154m^3$ of water for polyfoam cups. To compare them, multiply $50m^3$ by 6.7, which gives us $335m^3$ for paper cups. Thus, a paper cup use about 2.2 times the cooling water of a polyfoam cup.

Following the same logic, we'd find that the paper cups use 14 times the steam, 44 times the electricity, 43 times the waste water effluent, and so on, on a per-cup basis.

Mr. M: About that effluent data -- there are a few things that trouble me. I noticed your references are based on kraft mills in the 1970s which did not treat their effluent then at all. Today, any US mill would discharge only about 5kg of biochemical oxygen demand (BOD) per metric ton, not 30 to 50 kg. I also think your 5 to 7kg of organochlorides should be closer to 3kg.

Mr. H: Actually, at least some of the Canadian mills had effluent discharges between 1985 and 1989 in the amounts I listed. But I would agree that the American experience in reducing BOD, organochlorides, and the like, has to be much better to meet EPA standards.

Ms. O: Let's talk about recycling capability for a moment. I've been hearing that paper cups can't be recycled because the adhesive resin used to hold the paper fibers together is unable to be removed in the repulping process.

Mr. J: That goes for cups with plastic or wax films as well.

Ms. O: And as far as polystyrene goes, its recycled resin can't legally be reused in food applications. Food applications includes disposable cups!

Ms. W: Well now, hold on. Polyfoam can be reused as products other than just food and drink containers. We've got standard packing materials, insulation, flotation billets, patio furniture, etc. All the technical problems with polystyrene recycling are pretty much taken care of now. What remains is the expansion of recycling programs. As for paper cups, they in fact can and are being recycled as part of mixed office waste—resin and all. Actually, one of the biggest technical barriers to its recyclability is contamination with styrofoam!

Mr. J: The biggest plus I see for paper is that its major raw material, wood, is renewable, whereas oil for polystyrene is not -- at least not on human time scales. And polyfoam cups are basically inert, so they won't biodegrade, where paper will.

Mr. H: Actually, there's increasing evidence that paper does not degrade fully in landfill conditions, especially in dry climates. And when it does degrade, it releases methane and carbon dioxide in a 2:1 ratio of methane to CO_2. And a methane molecule has from 5 to 20 times the greenhouse warming effect of a CO_2 molecule.

Ms. O: But wouldn't the fixing of carbon dioxide by new tree growth compensate for anyCO_2 emissions from degrading paper?

Mr. H: Well, I don't know about that…..

And now your turn*.....*