Optimization of Alpha and N-cellulose in sodium hydroxide using ionizing radiation

Elizabeth McDaniel[1], Richard List[1], Ileana Pazos[2], Mark Driscoll[1]

[1]State University of New York, College of Environmental Science and Forestry (SUNY ESF)
[2]National Institute of Standards and Technology (NIST)

Purpose: This study proposes a more environmentally friendly method to improve the solubility of cellulose using ionizing radiation and sodium hydroxide.

Methods: Gamma irradiation was conducted on the ^{60}Co source at the National Institute of Standards and Technology (NIST). The cellulose samples received 17 kGy per hour for doses totaling 100, 250, 500, 750, and 1000 kGy. Irradiation was done under atmospheric conditions with dry cellulose.

Cellulose was dried for 24 hours at 102 ºC ± 0.5 ºC, weighted to 0.5 g, then soaked in 30 mL of NaOH that included 10%, 18%, 22%, and 25% by weight for three hours under constant stirring with a magnetic stir plate. Cellulose solutions were made at ambient lab temperature (ranging from 10 to 38 ºC). After stirring, the remaining insoluble cellulose was spun down with a centrifuge. The soluble and insoluble portions were separated by decanting. Solutions of cellulose were made for non-irradiated cellulose (0 kGy), 100, 250, 500, 750, and 1000 kGy. Separate 0.5 g samples of each dose and type of cellulose were dissolved in 10%, 18%, 22% and 25% NaOH solutions to assess how the solubility changed from non-irradiated to 1000 kGy.

The carbon content of the soluble cellulose solutions was analyzed by adding 1 mL of the solution to a ceramic boat that had been packed with ceramic fiber to prevent splashing. The Shimadzu SSM was set to 900 ºC and the samples were oxidized to CO_2. Using oxygen as a carrier gas, the CO_2 from the cellulose oxidation was moved to a non-dispersive infrared detector (NDIR). As the cellulose was oxidizing, the Shimadzu SSM would generate a peak from the detected CO_2. The area under this peak was then used to determine the mass of carbon from cellulose present in the NaOH solution using potassium hydrogen phthalate ($C_8H_5O_4K$, KHP) as the standard.

Results: Shown in the figures below.

Conclusions: Applying gamma irradiation up to 750 kGy and dissolving cellulose in 18-22 wt% sodium hydroxide overcomes some of the solubility problems with cellulose.

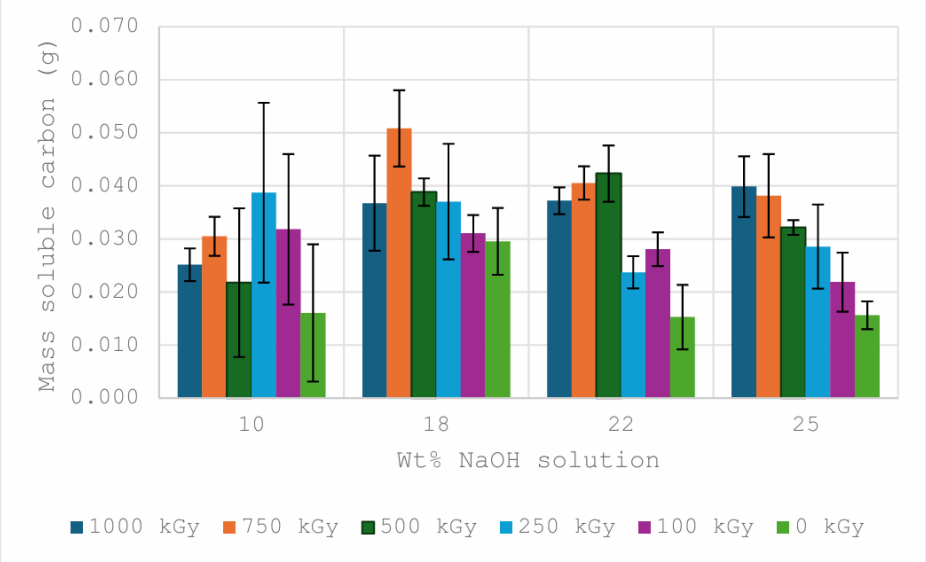

Figure 1. Graph showing the changes in solubility of alpha cellulose with ionizing radiation dose and NaOH concentration.

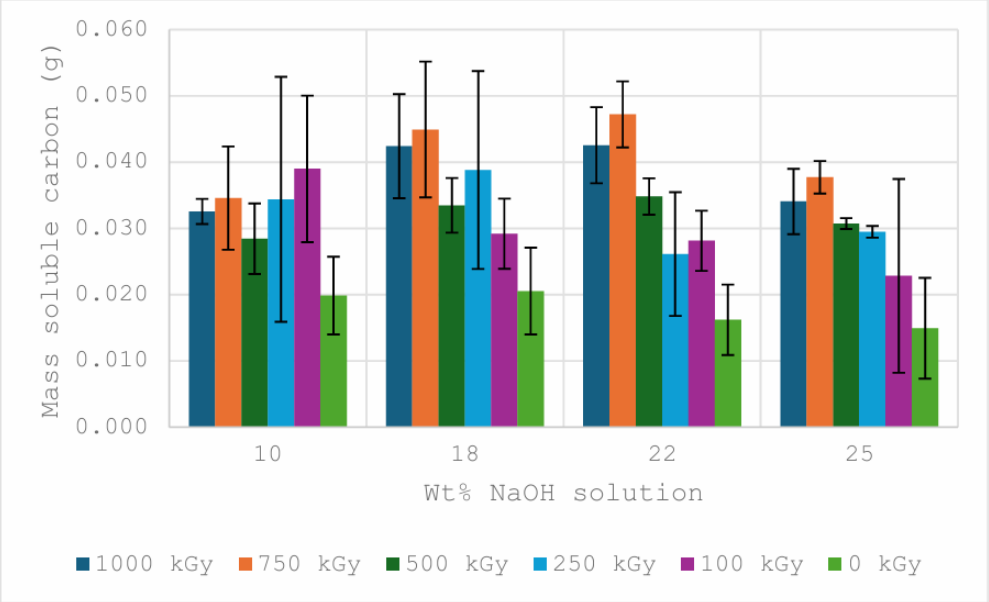

Figure 2. Graph showing the changes in solubility of n cellulose with ionizing radiation dose and NaOH concentration.