

## Electron Beam Irradiation & Cellulose Depolymerization

According to the US Postmaster General's preparedness plan, the US Postal Service now has eight electron beam accelerators to treat mail. Remarkably, this is a concern for fine paper producers, as a dosage sufficient to destroy Anthrax (50 kGy, a level similar to the one used in hospitals for sterilization) is also strong enough to darken *and* weaken the paper in postal envelopes. This report focuses on the effect of electron beam irradiation on the cellulose degradation in fine papers.

We selected two bleached kraft papers (one hardwood and one softwood) from the National Institute of Standards and Technology.

Papers were sorted into postal envelopes and exposed to either 4.5 MeV or 10 MeV electrons through a range of dosages from 20 kGy to 240 kGy. A dosage of 1 kGy corresponds to the absorption of 1 Joule of energy per gram of material.

Carbanilated cellulose solutions were injected in a size exclusion chromatography system, connected to a DAWN.

At a fixed energy, the cellulose distribution shifted towards the *lower* molecular weight as the dosage *increased* (Figure 1). Lowering the energy of the electron beam from 10 MeV to 4.5 MeV—at a constant dosage—increased the damage to the cellulose (Figure 2). The cellulose degradation related to the beam energy was present at all irradiation dosages studied. Because cellulose depolymerization is responsible for paper strength loss, irradiation of mail should be performed at high electron beam energy.

Electron beam irradiation at the dosage used to treat mail by the US Postal Service *depolymerizes* the cellulose in *all* the paper tested, with a higher energy electron beam being less damaging than a lower energy electron beam. Resistance to these effects could become a positive market attribute for paper producers.

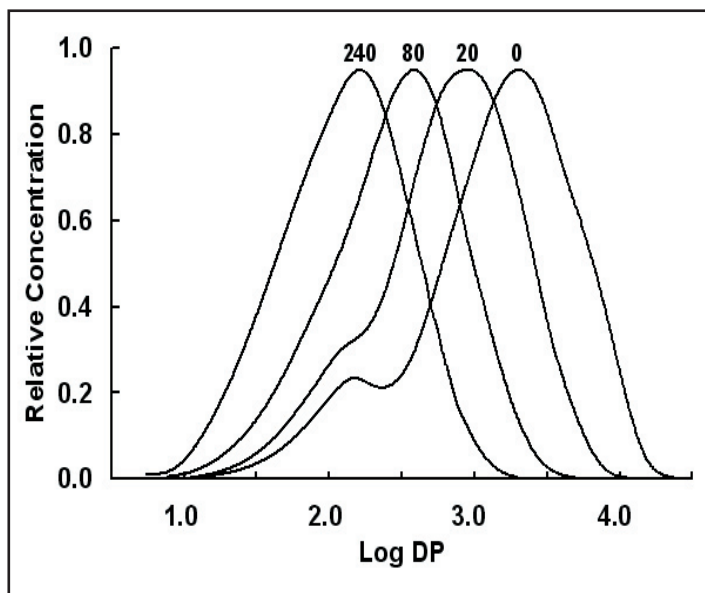


Figure 1: Cellulose DP distribution of a softwood bleached kraft pulp. The dosage of irradiation applied (kGy) is indicated on top of each DPD. The energy of the electron beam was 10 MeV. The average DPw, were, from right to left, 2300, 990, 410 and 180.

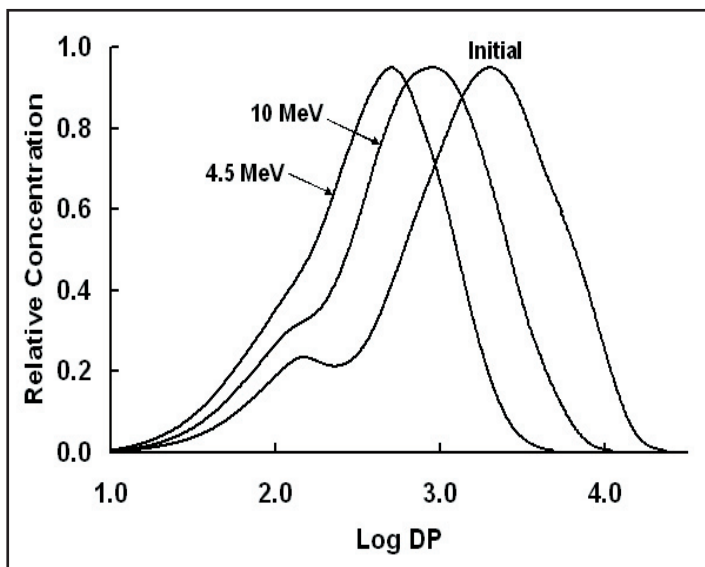


Figure 2: Effect of varying the electron beam energy (4.5 and 10 MeV) at constant dosage (20 kGy) on cellulose DP distribution of softwood kraft pulp. The average DPw, were, from right to left, 2300, 990, and 530.

