Optimizing an experimental system for assessing the amounts and forms of copper released into aquatic systems from commercially available liquid and micronized pressure treated lumber

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The fate and effects of pristine engineered metal nanomaterials (ENMs) in simplified systems have been widely studied; however, little is known about the potential release and impact of metal ENMs from consumer goods, especially lumber which has been treated with micronized copper. Micronized copper treatment solutions contain copper complexes that range in size from nano- to micro-particles, and are used in lumber to prevent microbial degradation and fouling. In this work, the goal was to design and optimize experimental conditions to determine the rate, concentration, and form of copper released from several commercially-available pressure-treated lumber samples exposed to an aqueous system. Lumber tested included untreated Southern Yellow Pine (SYP) as the control, SYP treated with micronized copper azole (MCA) at 0.06 and 0.15 pounds per cubic foot (pcf), alkaline copper quaternary (ACQ) at 0.019 and 0.6 pcf, and chromated copper arsenate (CCA) at 2.5 pcf. Of the different chemical treatments, only MCA included micronized copper complexes which are expected to minimize or reduce the release of copper into the environment over time. In contrast, older treatments like ACQ and CCA are expected to release copper more readily. Other experimental parameters tested included salinity (0, 1, 10, and 30 ppt filtered seawater), lumber form (sawdust versus wood blocks), and lumber orientation (e.g., minimally agitated sawdust, vigorously agitated sawdust, floating blocks, and submerged blocks). The optimal experimental system included 2 cm wood cubes cut from the outer surface of the lumber

submerged in 230 mL of media (0, 1, 10, and 30 ppt filtered seawater) in high density polyethylene bottles, and mixed on a shaker table at 110 rpm for a minimum of 28 days. Water samples were taken at eight hours, one day, two days, seven days, fourteen days, and twenty-eight days. Subsamples included unfiltered water, and water filtered through a 0.45 µm polyethersulfone (PES) syringe filter and a 0.1 µm PES syringe filter, which were analyzed using ICP-AES to determine the total, colloidal (< 0.45 µm subsample), and nano+ionic copper (< 0.1 µm subsample). Unfiltered water samples were also analyzed using a copper-selective electrode. This experimental system will allow for the conduct of comparative studies to determine the relative risk to aquatic systems associated with each type of copper treated lumber.