Disposing of

Building outdoor structures such as decks, docks, and playgrounds often signifies the pursuit of a more healthful lifestyle, but the wood used in much of this construction poses potential environmental and health problems when these structures are demolished. The chemicals that preserve the wood, primarily the inorganic waterborne preservative chromated copper arsenate (CCA), are designed to kill or repel biological organisms. As such, disposal of CCA-treated wood raises environmental and health concerns.

In solution, CCA is a potentially hazardous material that may be applied only by certified pest control applicators. The copper in the wood acts as a fungicide, the arsenic protects against insects, and the chromium fixes the copper and arsenic to the wood. Both arsenic and chromium, if released in quantity to the air or soil, are well-known toxicants. However, wood that has been treated with CCA is not classified as hazardous; during the treatment process, the CCA is carried into the wood by water under pressurized conditions, and after drying the CCA remains tightly bonded to the wood.

The average service life of treated wood is 25 years. When that service life is done, the wood is typically put in an unlined landfill, recycled as mulch, or burned for fuel, primarily in cogeneration plants. The quantity of treated wood in the United States is growing quickly. In 1970 the total volume of treated wood products was 248 million cubic feet (ft^3), of which 39 million ft^3 was treated with CCA. The total rose to 591 million ft^3 in 1996, with 467 million ft^3 of it CCA-treated products.

Prior to 1986, creosote was the standard wood preservative. Although it was declared a restricted-use pesticide in 1986, it remains the treatment of choice for railroad ties. In addition to a few other oilborne preservatives, the primary alternatives to CCA are waterborne chemicals such as ammoniacal copper quaternary compounds.

The U.S. Southeast produces and uses a greater percentage of CCA-treated wood than any other region. Wood in this region has a greater potential for deterioration because the warmth and humidity of the area are very conducive to insects and fungi. In addition, with its long coastline, Florida demands treated wood for marine applications. The regional demand is reflected in the fact that of the 491 treatment plants in the United States, 25 are located in Florida and an additional 100 are located just across the state's northern borders.

According to the Florida Center for Solid and Hazardous Waste Management in Gainesville, approximately 5 million ft^3 of CCA-treated wood (or 350 tons of the chemical) was discarded in Florida during 1996. By 2016, that volume is expected to rise to 35 million ft^3 (or 2,500 tons of CCA). In fact, the total amount of arsenic currently in use in CCA-treated wood in Florida is estimated at 26,800 tons—a quantity large enough to substantially contaminate the state's water and soil resources if it is not well managed.

Burning Questions

The prevalence of CCA-treated wood and the continued growth of the construction industry in Florida have led to research projects aimed at determining the best waste

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CCA-Treated Wood

management options. "CCA-treated wood shouldn't be put in unlined landfills because of potential for leaching, and lined landfills are becoming questionable because people are concerned that the leachate may contain a concentration of [toxicants] that will prove too difficult to treat," says John Schert, director of the Florida Center for Solid and Hazardous Waste Management. The result, he says, is that some researchers have their hopes pinned on incineration as an alternative. Already Florida burns at least 70% of its treated wood as fuel.

Helena Solo-Gabriele, an assistant professor in the Department of Civil, Architectural, and Environmental Engineering at Florida's University of Miami, has looked at ash from cogeneration plants that burn wood waste including construction debris. "The ash contained high concentrations of chromium and arsenic, which we determined came from CCA-treated wood that had been inadvertently mixed in," she says. "This is a common and growing problem, with construction and demolition wood waste containing an average concentration of six percent CCA-treated wood." She continues, "We need better sorting methods, and we need to look at alternatives that let the plants keep burning treated wood but extract and concentrate the metals before they are emitted to the environment."

A team of researchers led by Chang-Yu Wu, an assistant professor of environmental engineering at the University of Florida in Gainesville, has developed a new incineration technique that reduces the concentration of arsenic in emissions while binding the metals in the ash so they do not leach when landfilled. According to Wu, past research shows that when CCA-treated wood is burned, the majority of its arsenic may escape into the air. One of the chief challenges with incineration is that arsenic sublimates. In other words, at relatively low temperatures, arsenic goes from a solid directly to a gaseous state. When the gas stream cools, the arsenic forms particles less than 1 micrometer in diameter, which are very difficult to capture in traditional pollution control devices.

Working with a muffle furnace on the University of Florida campus, the researchers decided to handle the two problems of emissions and leaching by introducing mineral sorbents into the airflow-controlled combustion system. They first performed thermodynamic calculations to determine the sorbents that would potentially react with heavy metals within the CCA-treated wood as it burned. Their analyses led them to test limestone powder, alumina, and soda ash. Following the test, the ash was digested to determine the total amount of heavy metal. To determine leaching characteristics of the ash, toxicity characteristic leaching procedure tests were performed.

The research showed that when limestone powder is introduced into the burning process, arsenic is chemically bonded onto the powder surface to form larger particles up to 50 micrometers in diameter. Instead of escaping through the smokestack, the particles wind up in the waste ash. The arsenic–limestone particles form insoluble solid compounds that are much less likely to leach arsenic into the groundwater than unbonded arsenic.

So far, the incinerator technique has been tested only in the laboratory. Power plants already use a similar technique involving injecting limestone into air pollution devices to reduce sulfur dioxide emissions. This suggests that adopting the process for wood incinerators is a distinct possibility.

The Right Sort

The industries that produce CCA and CCA-treated wood generally favor research into ways to handle the wood at the end of its primary application. Robert Gruber, director of regulatory affairs at Arch Wood Protection, which manufactures CCA and other preservatives, says, "The industry supports these kinds of studies and those on the reuse or recycling of treated wood. A number of other incineration techniques have been tried, as have recycling projects."

Gruber cites work under way to use recycled CCA-treated wood in concrete composites and in oriented strandboard (a type of wood panel used for the same purposes as plywood), and to remove hindrances to getting the wood from backyards to proper disposal facilities. He adds that it helps the industry to have other products planned for the wood at the end of its initial use, and that sorting is the key to proper management of the wood.

Solo-Gabriele says that much of the academic research is focused on sorting so that untreated wood can be burned for fuel without concern about releasing arsenic to the environment. The difficulty with sorting is that it's often difficult to distinguish between untreated wood and different types of treated wood. Wood with low concentrations of CCA (0.25 pounds/ft^3) is suitable for interior building use and maintains the general appearance of natural wood. Wood with the highest concentrations (0.8 and 2.5 pounds/ft^3) is used for foundations and saltwater applications, and has a strong green color.

Unfinished wood? The end of the line for CCA-treated wood is currently landfills or burning, but sorting and additives may make for safer disposal.

Simple visual sorting is not good enough to catch much more than 90% of the CCA-treated wood. Applying a stain to mark CCA-treated woods appears to be one reasonable method for sorting small quantities of wood. Capital costs are low, but the work is labor-intensive. Another alternative under development is a demonstration project at the Sarasota County landfill in Sarasota, Florida. It consists of an online sorting technology that will rely on laser-induced breakdown spectroscopy (LIBS), already tested on wood waste in laboratory studies at the University of Florida and the University of Miami.

Initially, two sorting techniques were considered. The first, X-ray fluorescence (XRF), is a well-established technique that places an X-ray source on the surface of a material and, based on the spectral response of the metals in the wood, identifies the chemical composition. The drawbacks with this technique, according to David Hahn, an assistant professor of mechanical engineering at the University of Florida, are twofold. First, XRF requires that the piece being analyzed be stationary while the sample is taken. Second, the XRF equipment needs to be in close contact with the sample, which is difficult because of the many different shapes of the wood. Although this technique could prove useful for spot-checking, the XRF equipment that can overcome these obstacles is expensive—and would still not be as fast as the second technique considered, which uses LIBS.

Hahn says that LIBS is a widely used diagnostic technique for analyzing surfaces and gaseous streams. A high-power neodymium:yttrium-aluminum-garnet laser creates a light-emitting microplasma on the surface of the targeted material, and a spectrometer determines whether chromium is present and thus how the wood should be sorted.

Hahn says that LIBS has been shown to be highly accurate in identifying individual chemical constituents in other experiments, including his work on characterizing toxic metals in aerosols. For the Sarasota project, he and his colleagues first used a laser that put out 50 millijoules of energy per pulse, but found that it did not produce reliable plasma from wet or particularly dense wood. "The wood didn't 'spark,'" he says, "and so we went to a two hundred millijoule laser, and the results have been excellent. The laser is one hundred percent accurate if the wood is placed in front of it."

"We're able to fire two pulses a second from the laser," says Hahn, "and we can tell instantly whether chromium is present." To enable a full-scale testing of this sorting system, he says, the project has proceeded on a two-pronged course: the sorting technique is being finalized while the construction of the sorting facility is completed.

In parallel with the research work, a 30 × 40 ft facility is being built to house the LIBS equipment, piles of sorted and unsorted wood, and the conveyor belt that brings the wood past the detection system. Wood identified as being treated with CCA is pulled from the main conveyor when a buzzer sounds and placed in a special pile, while the untreated wood is piled for removal to a wood-burning power plant. The loading and sorting will be done manually at first, although the project team has plans to automate the separation procedure on the conveyor belt.

There is no predetermined goal for accuracy in separation, says Hahn, but he thinks they should be in the high-nineties percentage range. To monitor the success rate of the test, the unsorted wood first will be stained with chemicals that turn it varying colors in response to the presence of chromium, copper, or arsenic. Hahn believes that this type of sorting system may find other applications such as separating treated from untreated wood at power plants (this would allow operators to create different grades of wood chips that could be used to dilute a mixture to a ratio that is acceptable to burn). The LIBS system could also be used as a tool to certify different grades of mulch that are commonly sold to consumers.

The estimated cost for stockpiling and handling construction and demolition wood is approximately $5.00 per ton. Then, sorting treated from untreated wood with the LIBS system will add an additional $5.20 per ton. Still, this cost is low relative to the tipping fees for municipal Class I solid waste landfills, which charge approximately $42.50 per ton in Florida. A combination of intelligent sorting, burning, and recycling promises to help all users of CCA-treated woods address an issue that is becoming an increasing source of environmental concern.

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Suggested Reading

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