Beneficial Use of Pulp and Paper Industry Manufacturing Residuals

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Outline

• Overview of beneficial use criteria

• Beneficial use applications and opportunities for the pulp and paper industry

• Information resources from NCASI
Project Evaluation Criteria
(the Beneficial Use “Puzzle”)

Several intertwined considerations

- Capital and operating costs
- Regulatory requirements
- Company policies
- Technical feasibility
- Market conditions
- Public acceptance
- Potential liabilities

Who does what: paper company, broker, processor?
Markets for Industrial Byproducts

Three major markets, each *broadly* defined:

- **Agriculture**
- **Construction**
- **Energy**

For paper industry byproducts

- Agriculture and energy (especially onsite) relatively established
- Construction, other than earthen construction, relatively untapped
Pulp and Paper Mill Solid Residuals Composition

US Paper Industry

Ash, 34%
Other, 34%
WWTP Resid, 32%

2012 AF&PA EHS Data
Materials Often Beneficially Used

• Power boiler ash
• Wastewater treatment plant (WWTP) residuals (including deinking solids)
• Woody biomass residuals
• Kraft causticizing residues (lime mud, slaker grits, green liquor dregs)
• Secondary fiber rejects
Management of Power Boiler Ash

US Paper Industry

- Other Beneficial: 35%
- Landfill/Lago: 55%
- Apply To Land: 10%

2012 AF&PA EHS Data
Characteristics of Wood Ash

- High in unburned carbon (char)
- High in calcium
- Source of potassium and phosphorus
- Alkaline (high pH)
- Low in heavy metals
- Low in dioxins

Typical value ranges:

Ca  8 – 33%
K  1 – 4%
P  0.15 – 1.5%
C  3 – 48%
Land Application of Wood Ash

- Wood ash is alkaline, can substitute for traditional liming agent
- Wood ash can be source of nutrients (e.g., Ca, Mg, K, P)
- Wood fly ash most commonly applied, but bottom and combination ashes are, too
- Crop yields with wood ash can be equivalent or better than with CaCO₃ (proper liming effect, nutrients)
- Potential issues with wood ash include
  - Herbicide ineffectiveness
  - Handling (e.g., dustiness)
  - Contaminants (e.g., metals)
Geotechnical Applications of Wood Ash

• Stabilize soil for roads and other structures
• Construct embankments and other structural fills

Wood Ash as Concrete Additive

• Coal fly ash used in concrete
• Wood ash in concrete is subject of research
• Potential issues with wood ash in concrete
  – Material-specific technical standards (coal ash)
  – Requirement for low-carbon ash
Other Uses for Wood Ash

• Manufactured soil component
• Cement kiln ingredient
• Flowable fill component (CLSM)*
• Mortar and grout additive
• Brick additive
• Compost feedstock
• Waste solidification/stabilization
• Landfill cover
• Mine reclamation
• Supplemental fuel

* CLSM = controlled low-strength material
Management of WWTP Residuals

US Paper Industry

Apply To Land 22%
Burned 22%
Other Beneficial 12%
Landfill/Lago on 44%

2012 AF&PA EHS Data
Characteristics of WWTP Residuals

• Primary and deinking solids
  – Wood fiber and fines
  – Mineral matter (e.g., clay, CaCO$_3$, TiO$_2$)
  – Ash content: $<5\% - 70\%$
  – Low in N and P (C:N $\approx 30:1 - 900:1$)

• Secondary solids (waste activated sludge)
  – Microbial biomass
  – Higher in N and P (C:N $\approx 9:1 - 80:1$)

• Either primary/deinking or secondary solids
  – Low in heavy metals
  – Low in dioxins and PCBs
Land Application of WWTP Residuals

- Depending on characteristics, mill WWTP residuals can serve as
  - Soil conditioner (organic matter)
  - Fertilizer (N, P, other plant nutrients)
  - Liming agent (soil pH increase via CaCO₃)
  - Mulch (weed suppression, erosion control)

- Generally improves soil quality and crop yields

- Potential issues with mill WWTP residuals include
  - Nitrogen immobilization (high C:N, particularly with primary solids)
  - Odors (onsite management issue)
  - Contaminants (e.g., metals, organics)
  - Herbicide ineffectiveness
  - Can stimulate weed competition
Other Uses for WWTP Residuals

• Energy (boiler fuel)
• Landfill barrier cover
• Concrete additive
• Brick manufacture
• Papermaking fiber/filler
• Industrial absorbent
• Animal bedding/litter
• Manufactured soil/compost feedstock
• Building board/fixture
• Glass or lightweight aggregate
• Cement kiln feedstock
• Fuel pellet ingredient
• Biorefinery feedstock
Characteristics of Woody Biomass

- Many different types: chips, sawdust, shavings, sanderdust bark, forest residue, etc.
- Wide range of moisture content: 2% - 70%
- HHV approx. 8000 – 9000 Btu/lb (dry)
- Ash ranges from 0.1% to 10%
  - Bark higher than wood
  - Reclaimed wood higher than “virgin” wood
- Approximately 50% carbon (dry)
Burning Woody Biomass for Energy

- Typically burned in industrial boilers and heaters
- Often burned in conjunction with fossil fuels, most commonly coal
- Sometimes co-fired with WWTP residuals
- May be converted to other fuel types
  - Pellets, briquettes, firelogs, pyrolysis products such as bio-oil, etc.
  - Biorefinery products such as lignocellulosic ethanol (pilot stage only)
  - Biogas
Burning Woody Biomass for Energy (cont.)

• Benefits
  – Alternative to disposal/landfill
  – Economically attractive alternative to fossil fuel
  – Low greenhouse gas (GHG) emissions relative to fossil fuels (biogenic CO₂ typically treated favorably relative to fossil CO₂)
Other Uses for Woody Biomass

• Soil amendment
  – Land application
  – Composting
  – Mulch
• Growing medium
• Ground cover
• Landfill cover
• Animal bedding and pet litter
• Wood composite materials (e.g., particleboard)
• Animal feeds and food-related products
• Other…
Characteristics of Causticizing Residues

• **Types**
  – Lime mud
  – Slaker grits
  – Green liquor dregs

• **Characteristics**
  – From kraft pulping recovery cycle
  – Very high in calcium (mostly as $\text{CaCO}_3$
  – Alkaline
  – Fine particle size
Agricultural Land Application of Causticizing Residues

• Possible utility
  – Liming agent (common purpose)
  – Fertilizer (e.g., Ca, P, K)

• Potential concerns
  – High Ca:Mg ratio (Mg deficiency)
  – Contaminants (e.g., metals)

• Application rate as a liming agent typically
  \( \approx 1 \) to 4 tons/acre
Other Possible Uses for Causticizing Residues

- Cement kiln feedstock, cement additive
- Earthen construction, soil stabilization
- Brick additive
- Asphalt additive
- Compost feedstock/additive
- Manufactured soil component
- Acid mine drainage control cover and mine reclamation
- Wastewater neutralization, AOX removal
- Reduced sulfur removal from waste gas
Secondary Fiber Rejects

- Rejects managed separately are most often landfilled
- Known beneficial uses limited to rejects from OCC and poly-coated grades
- Tend to be high in fiber and various plastics
- Low ash content
- Known beneficial uses include
  - Boiler fuel (most common by far)
  - Recovering fiber for papermaking
  - Various land-based (compost, mulch, animal bedding)
  - Molded products
Information from NCASI

Technical Bulletins

• No. 994 (2011). Beneficial Use of Woody Biomass for Energy and Other Purposes
• No. 931 (2007). Beneficial Use of By-product Solids from the Kraft Recovery Cycle
• No. 900. (2005). Compilation of Alternative Landfill Cover Experience Using Wastewater Treatment Plant Residuals
• No. 894 (2005). Composting of By-Product Solids from the Pulp and Paper Industry
Information from NCASI

Technical Bulletins (cont.)

• No. 806 (2000). Beneficial Use of Secondary Fiber Rejects
Information from NCASI

Special Reports

• No. 01-06 (2001). *Proceedings of the NCASI Meeting on By-Products Synergy*
• No. 99-04 (1999). *A Summary of Available Data on the Chemical Composition of Forest Products Industry Solid Wastes*
• No. 97-08 (1997). *Proceedings of the National Bioash Utilization Conference*

Other

• Research Brief No. 9 (2003). *Land Application of Forest Industry Mill By-Product Solids*
Information from NCASI

Published Literature on Land Application


Information from NCASI

Published Literature on Land Application (cont.)


Information from NCASI

Ongoing Work
• Development of Excel™-based guide for beneficial use of materials from pulp and paper and wood products mills

Planned Work
• Beneficial use of wood ash for land applications: A synthesis of the literature and Canadian regulations
• Beneficial use of mixed pulp and paper mill residues for the manufacture of topsoil and potting soil
• Beneficial use of pulp and paper mill sludge - An updated review and extension of work done by NCASI in the 1990s [e.g., TB 655 and TB 793]
Questions?

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