Drying and recycling of primary sludge at Champion International

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ABSTRACT: Champion International Corp.'s Hamilton, OH, mill uses a triple pass rotary dryer to dry primary sludge to a nominal 85% total solids content. The sludge can be recycled and used in the manufacture of such products as paperboard or portland cement.

KEYWORDS: Dryers, drying, end use, Ohio, paper boards, paper mills, portland cement, recycling, rotary machines, sludge.

Champion International Corp.'s Hamilton, OH, mill produces 425 metric tons/day (470 tons/day) of premium coated and uncoated printing papers. As a by-product of this manufacturing, 100 wet metric tons/day (110 tons/day) of primary wastewater treatment plant sludge at a nominal 55% solids content is generated. From late 1970 until early 1989, the sludge (papermaking waste) and coal-fired boiler ash were deposited in the mill's Hodapp Landfill. The Hamilton Mill began recycling a portion of the papermaking waste into cement in 1989. Also in 1989, 100% of the ash from the coal-fired boilers began to be recycled into portland cement. In September 1991, the recycling project began consistent 100% recycle of the papermaking waste generated. This project was discussed in a paper presented at the 1991 TAPPI Environmental Conference.[1,2]

The mill has continued to explore ways to optimize the recycling of the papermaking waste into cement and to seek alternate markets for the waste. This article looks at refinements Champion has made to the earlier project.

Project background

Sanitary wastes from the paper mill are piped to the City of Hamilton Sewage Treatment Plant (STP) via a dedicated sanitary sewer system. Process wastewater is piped separately by gravity approximately 4 km (2.5 miles) to the Champion primary wastewater treatment plant for treatment. Effluent from the primary plant is pumped to the City of Hamilton STP and mixes with the sanitary wastes immediately before the secondary treatment facility. The Champion primary wastewater treatment plant sludge is pumped from the clarifier at 10–15% total solids into one of three screw presses. The screw press produces press cake (papermaking waste) at 50–65% total solids. The papermaking waste is held in a storage bay of the screw press building for up to three days awaiting transport to a recycling operation. A diagram of Champion's Hamilton Mill Wastewater Treatment Plant (WWTP) can be found in **Fig. 1.**

A state of the art landfill was constructed in Reily Township in 1990. This landfill is licensed to receive the papermaking waste and boiler ash from the mill. It is the goal of the environmental department of the mill only to use this facility as an absolute emergency backup to the recycling options available to the mill for these two waste streams. At the time of the writing of this article, no waste had been taken to this new landfill.

The Hamilton Mill Primary Wastewater Treatment Plant sludge has a nominal 55% solids content and a general composition as listed in **Table I.**

Sludge drying

The first step to optimization of the cement recycle project was to dry the waste to 85% solids. This produced a material that was easier to handle and store and was virtually free of odor problems. Trials were performed with two different design dryers. The first dryer, a ring dryer, produced a fluffy product that was difficult to manage. The final product resembled mattress stuffing or cellulose insulation. This

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[1]Huston, B., Beer, E. H., and Hardesty, K. L., TAPPI 1991 Environmental Conference Proceedings, TAPPI PRESS, Atlanta, Book 2, p. 657.

[2]Huston, B., Hardesty, K. L., and Beer, E. H., Pollution Prevention Review 2(4): 453(1992).

fluffy consistency was unsuitable for the cement manufacturer's current storage and raw material feed equipment.

The second dryer under trial was a rotary dryer, illustrated in **Fig. 2.** It was more successful and was selected for full-scale operation. The rotary dryer chosen is currently marketed for use in drying or dehydrating materials such as foods, grains, waste products, wood chips, and wood wastes. It is a triple pass unit that can utilize solid, liquid, or gaseous fuels.

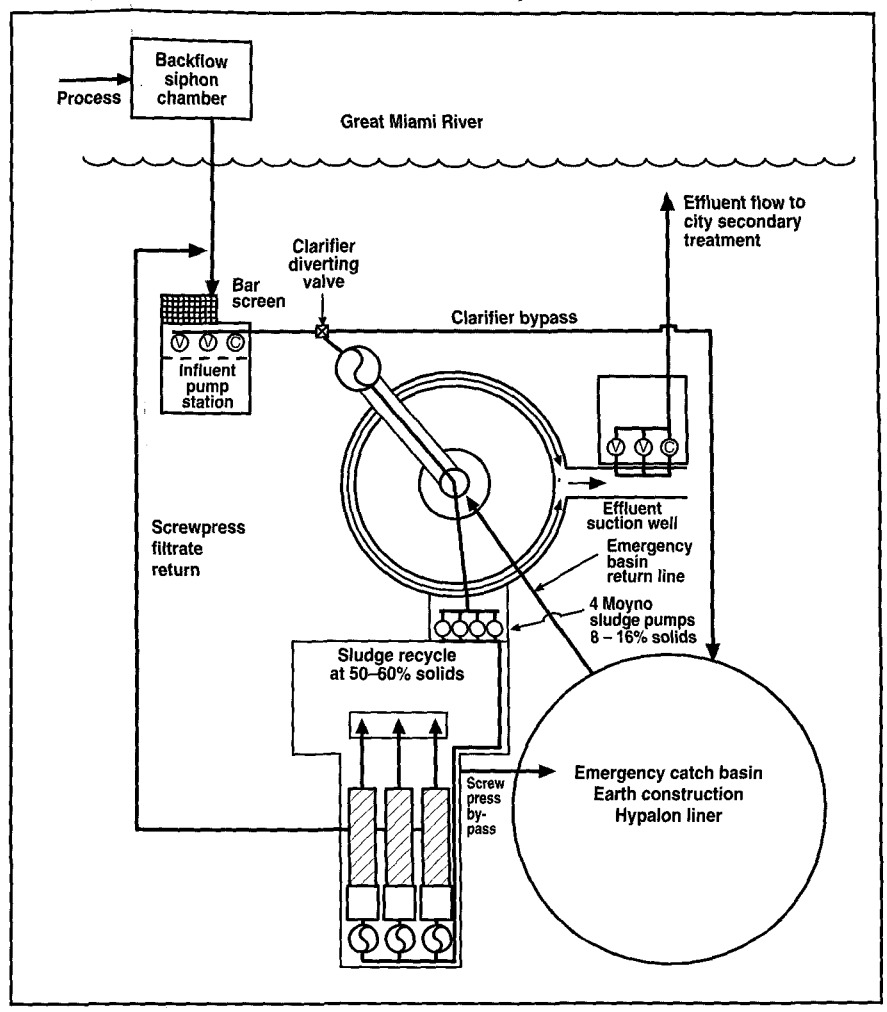
The flue gases from the heat source are part of a hot gas stream which comes into direct contact with the material being dried. The triple pass system consists of three concentric cylinders mechanically interlocked. This design enables the material to move through the unit in the hot gas stream from the hottest inner cylinder to the last and coolest outer cylinder before being discharged. The product can be moved through the dryer either by a fan located at the discharge of the dryer or by a fan located after the first cyclone. The dry material is then conveyed from the cyclone to a storage facility. **Figure 3** is a process diagram of the rotary dryer system.

The gas phase continues from the exhaust of the first cyclone either to the atmosphere or to a secondary particulate removal device.

Full scale operation

The "wet" (50-65% solids) sludge from Champion's wastewater treatment plant is transported offsite by truck to the rotary dryer. The drying operations currently used by Champion's Hamilton Mill are located approximately 240 km (150 miles) from the mill site. These installations also dry alfalfa for local farmers. Champion has contracted their services to dry the papermaking waste. The rotary dryer dries the material to a nominal 85% (85-95%) total solids content. Separate storage facilities have been built to handle the papermaking waste and isolate it from the farm products.

1. Champion Hamilton Mill wastewater treatment facility



The dry sludge is now ready for recycle into another useful product such as portland cement.

Permitting

Champion is pursuing installation of a dryer at its wastewater treatment plant site via a third party. Installation of a drying unit for wastewater treatment plant sludge requires several permitting issues to be resolved.

Air permitting issues

Stationary sources that dry wastewater treatment plant sludge must comply with United States Environmental Protection Agency (USEPA) rules under Title 40 CFR Part 61, Subpart E—National Emission Standard for Mercury.

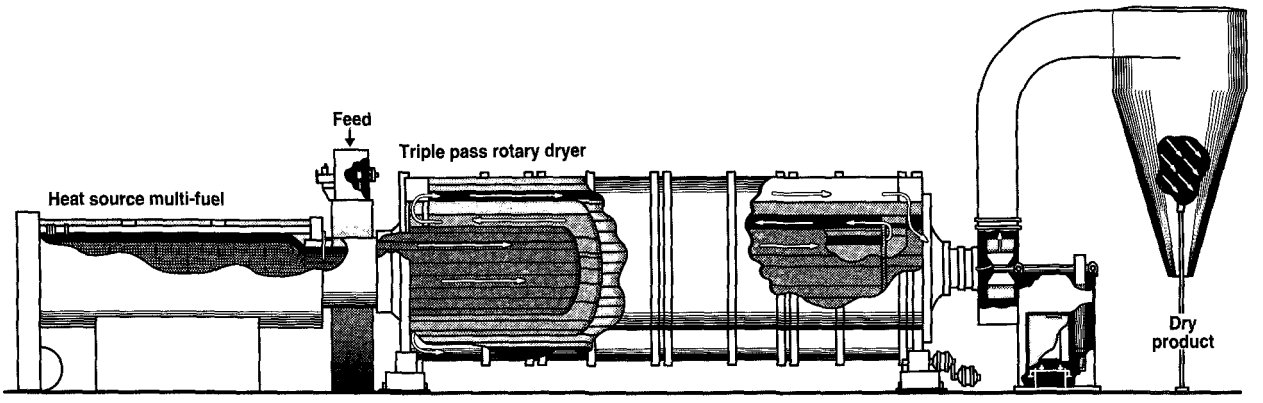
1. Champion Hamilton Mill dry primary sludge composition

Clay	40%
Fiber	30%
Limestone	19%
Latex, dye, defoamer	4%
Casein, soy protein	4%
Starch	2%
Titanium dioxide	1%

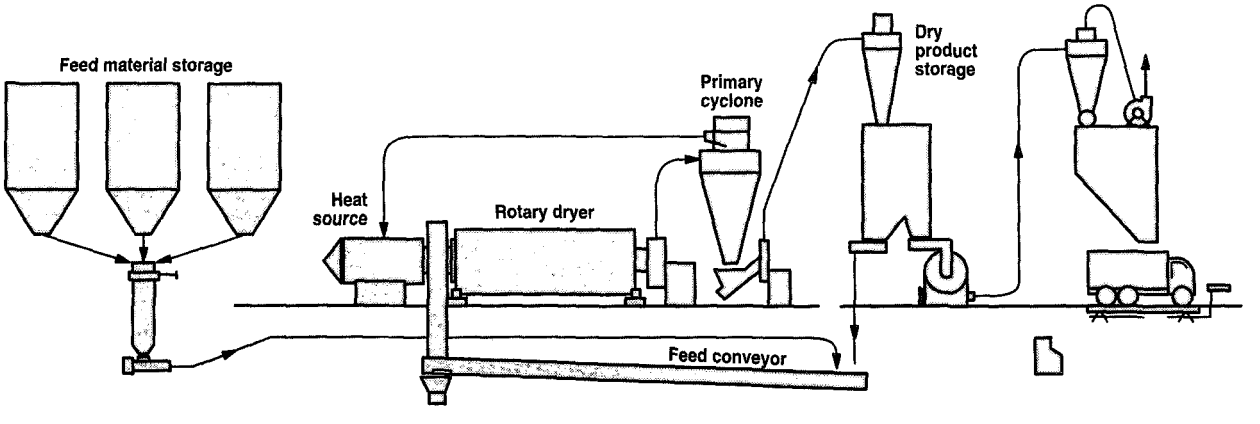
Title 40 CFR 61.51 defines a sludge dryer in this way: "'Sludge dryer' means a device used to reduce the moisture content of sludge by heating to temperatures above 65°C (ca. 150°F) directly with combustion gases."

Therefore an air permit for a direct contact dryer as described above will require compliance with NESHAPS Subpart E for mercury emissions. The applicability of this rule to the source

2. Cutaway view of triple pass rotary dryer



3. Process diagram of rotary dryer system



is simply due to the flue gas coming into direct contact with the sludge from an industrial or municipal wastewater treatment plant at higher than 65°C. Use of materials containing mercury or test results revealing measured amounts of mercury in the sludge are not part of the determination of applicability of this regulation. This is an example of "permit by rule."

Compliance with this rule requires a performance test of the dryer unit within the first 90 days of operation. The performance test can be either a USEPA Method 101A performed on the stack gas of the unit or a USEPA Method 105 test performed on the sludge after dewatering with the screw press. The latter method requires obtaining a 0.94 L (1 quart) sample every 30 min over an 8 h period and compositing it into a 15 L sludge sample for testing. If the performance test indicates an emission level of greater than 1,600 g/year (3.5 lb/year) of mercury, the source must be monitored annually by one of the above mentioned test procedures.

Primary sludge with a high inorganic content such as that generated by Champion's Hamilton facility also creates concern for potential emissions of particulate matter less than 10 μm in size (PM_{10}). Champion had a full-scale dryer, utilizing only a primary cyclone for particulate control, tested for PM_{10} emissions. The test method used an in-stack cascade impactor. The PM_{10} emission rate when drying the papermaking waste from Champion's Hamilton Mill was determined to be 65% of the remaining particulate.

Volatile Organic Compound (VOC) emissions were tested on a trial size unit and extrapolated to be less than one metric ton/year for the approximately 33,000 metric tons/year of waste to be dried.

Other air permitting issues may arise, depending on the fuel used for the dryer unit.

NPDES and pretreatment issues

Other permitting issues arise based on where the dryer is to be installed. If the unit is installed at the site of the WWTP, a modification to the facility's NPDES or pretreatment permit may be needed. This is usually triggered by the need to connect process drainage or air pollution scrubber water discharge to the WWTP. State regulations may require the NPDES or pretreatment permit to be revised, since the dryer is physically located at the WWTP.

Storm water runoff issues also must be considered. These issues may be able to be combined with the existing wastewater permits for the WWTP.

Benefits of sludge drying

Although drying the papermaking waste increases the costs, there are several advantages that must be considered. The dried papermaking waste is much easier to handle and store. The dried material can be transported via blower trucks, allowing the waste to be air conveyed into storage silos.

Previous problems of odor during storage and handling at the recycling location are virtually eliminated. This enables both the producer and the consumer of the waste to increase inventories without fear of odor complaints from employees or neighbors.

Freeze problems that were encountered sporadically when a load of wet waste would freeze to the bed of a truck have been eliminated by the reduced moisture content.

The dryer operation can be adjusted to produce a customer-specific moisture level. A 95% solids content waste is easier to handle in an air-conveyed unloading system filling silos than is 85% solids. In the case of outside storage piles, an 85% solids content takes advantage of dry material but reduces the potential for dust problems.

A volume reduction is achieved through the drying process. This reduced volume lowers the transportation costs to deliver the product to the recycling operation.

WWTP upset conditions that create wetter sludge can be overcome for the recycler with the dryer. The dryer can produce the same 85% nominal solids level material regardless of whether the feed is at 45% solids or 65% solids. This enables the final customer to receive a more consistent product.

II. Comparison of paperboard manufactured with and without Champion Hamilton Mill primary sludge

	Inorganic, %	*Fiber,* %	*Other Organics,* %
Paperboard w/sludge	9.41	76.27	14.32
Paperboard w/o sludge	6.98	81.19	11.83
Champion primary sludge	60.00	30.00	10.00

The dried primary sludge makes other potential uses feasible. A few of those opportunities are:

- Part of the furnish for paperboard manufacturing
- Dry-process manufacture of portland cement
- Volume reduction via burning in a coal-fired boiler prior to processing into portland cement.

Champion's Hamilton Mill has investigated on a full scale the use of the papermaking waste as a secondary fiber source for paperboard manufacturing, and investigation of burning the waste in one of the coal-fired boilers has begun.

Paperboard furnish

The latest opportunity implemented by Champion's Hamilton mill is utilization of papermaking waste as a part of the furnish for a paperboard machine. The machine utilized is a cylinder board machine manufacturing boxboard. The facility is located near the Champion facility and uses many secondary fiber sources in its furnish.

In February 1992, preliminary evaluation of the papermaking waste began at a nearby paperboard manufacturer. Several trials have been run to evaluate both the wet papermaking

waste (50-55% solids) and the dry waste (85-95% solids). These trials indicated the most suitable form is dry material, and a maximum of 25% of the furnish for one ply should be papermaking waste. An 85% solids content appears to be the optimum for this application. This solids content virtually eliminates the odor issue for storage of the waste and minimizes the dusting that can occur at higher levels of dryness.

A basic comparison of paperboard manufactured with and without papermaking waste in the furnish and the Champion Hamilton typical sludge composition is shown in **Table II.** The basic differences between the two paperboard products are the inorganic and fiber concentrations. The "other organics" are very close to the typical Hamilton mill sludge concentration.

Analyses were done to evaluate the impact of papermaking waste in the finished paperboard. The analysis of dioxins and furans gave nondetect values as did PCBs. The metals analysis showed a minimum impact.

Operational problems

The trials determined a maximum of 25% of the furnish could be substituted with the papermaking waste. Over this limit, breaks in the sheet and odors near the machine were a problem.

The paperboard facility does not have a waste treatment plant or a pretreatment facility. The facility's pretreatment permit with the Publicly Owned Treatment Works (POTW) limits the amount of BOD and TSS that can be discharged to the POTW. The effluent quality to the POTW is limited to 350 ppm BOD. The papermaking waste is high in BOD, creating higher BOD levels in the paperboard facility's wastewater. When the paperboard furnish contains 25% papermaking waste, the BOD rises to 500 ppm. The paperboard manufacturer has decided to maintain a 12% addition rate of papermaking waste to the furnish. This represents approximately 16-18 metric tons/day of dry papermaking waste and maintains the BOD levels in the 350 ppm range.

The increase in the ash content in the paperboard that could result in customer complaints for high-density sheets is another potential problem with papermaking waste addition to the paperboard, as fewer cut sheets are obtained per metric ton.

A third potential problem with the use of papermaking waste is the necessity to increase retention aid in the operation. This problem is considered typical for this particular mill and this papermaking waste and may not be typical of this recycle process.

Summary

Primary wastewater treatment plant sludge from a premium printing paper mill can economically be recycled into a variety of products. Drying the sludge to improve storage and handling conditions opens additional potential markets for the product. ■

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