Recycling and Reuse Technology Transfer Center

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Cedar River Paper Company and Pulper Tails

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Randy Read

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My internship was with the Cedar River Paper Company in Cedar Rapids. This company uses old corrugated cardboard (OCC) and other mixed paper to make recycled paperboard. This is used to make new boxes, paper grocery bags, and the cardboard rounds under pizzas. Bales of OCC and paper are wrapped with wire at the recycling centers to hold them together. These are bought from the recycling centers and stored in a warehouse at the recycling mill until needed.

The bales are then placed on a conveyor belt, the wires clipped, and then dumped into a pulping vat. All of the trash such as plastics, tapes, Styrofoam packaging, rags, and many other unexpected contaminants that is mixed with the bale is dumped into the vat also. The cardboard and paper are broken down by the repulping process and agitation to yield pulp fibers. These pulp fibers can be used to make recycled paperboard. The trash must be removed from the vat somehow, and this is when the pulper tail is formed.

The pulper tail is a mixed waste stream that consists of the baling wires, plastics, tapes, rags, and other trash materials. It is made as a way to clean the trash from the vat. The wires that are around the bales are dumped into the vat with the bales. The vat has a swirling motion that causes the wire to become entangled. The plastics and other junk get caught up in the wire. Then a rope with a hood on it is placed into the vat. The wire and trash start to wrap around the rope and hook, and the rope is then pulled out of the vat. The wires hooked on the rope come out also, with the other trash entangled also. As it is pulled out, it is twisted by the swirling of the vat, and forms a very compact tailing (pulper tail), about 8 - 10 inches in diameter. This removes the trash from the vat, which allows the repulping process to continue. This tail is then placed in dumpsters and cut off in about 12 foot lengths and taken to the landfill. This tail is not dried before it is taken to the landfill which adds extra weight.

The Cedar River Paper Company produces 142 tons of pulper tails per month. This is 1704 tons per year that is placed in the landfill, and this was before the second plant came on line in April. This new plant is almost twice the size of the original plant, so soon the amount of waste being landfilled will be about 2.5 times the current amount. This is nearly 4000 tons per year. This tail takes up much space in a landfill ever decreasing in capacity. In Cedar Rapids the amount of material landfilled must be cut in half by the year 2000.

This is where my internship came in. I was to find options for reuse or recycling of the pulper tails. This was very hard to do because very little information was known about the waste tail, and it is a mixed waste stream that is very hard to work with. In order to explore these recycling options, the concentrations of the materials making up the tail need to be known. Since these concentrations were not known, much of my time was spent sorting through a 14.125 lbs sample of a pulper tail separating the wire, the plastics, and the pulp material. First the wire was removed and weighed.

Sample weight = 14.125 lbs

Wire weight = 6.25 lbs

Then the plastics and pulp materials were separated.

Plastics weight = 2.9 lbs

Pulp weight = 3.25 lbs

Added together, these do not add up to the 14.125 lbs sample, and it was concluded that some of the water weight must have been lost. This happened during the sorting process which took many hours, some of the water evaporated off the pulp material. In order to compensate for this loss three small samples were rehydrated to the approximate original water content. These three samples were then dried in a drying oven for 24 hours at 65 degrees Celsius weighed, and redried for 72 hours at 65 degrees Celsius in order to find a constant weight of the dried pulp material. This new weight was used to calculate the % weight lost as water and the % weight of each

sample that was pulp material. These percentages were then used to extrapolate the weights of the pulp and water in the original sample. The following are the calculations and final concentrations of the original 14.125 lbs sample.

Three sample of approximately the same weight were used to find the average water loss.

Sample #	original weight	weight after 1st drying	weight after 2nd drying	water weight lost
#1	15.00 grams	4.96 grams	4.95 grams	10.04 grams
#2	15.00 grams	4.92 grams	4.91 grams	10.08 grams
#3	15.50 grams	5.02 grams	5.01 grams	10.48 grams

Sample #	calculations for % pulp	% pulp	Calculations for % water	% water
#1	4.95 / 15.00	33.0 %	10.05 / 15.00	70.0 %
#2	4.91 / 15.00	32.7 %	10.09 / 15.00	67.3 %
#3	5.01 / 15.50	32.3 %	10.49 / 15.50	67.7%
averages		32.7%		67.3%

These percentages were then used to find the water weight and pulp weight in the sample. 14.125 lbs sample - 6.25 lbs of wire - 2.90 lbs of plastics = 4.98 lbs of pulp and water weight.. Therefore:

4.98 lbs of pulp and water X 32.7 % pulp = 1.63 lbs of pulp material / sample

4.98 lbs of pulp and water X 67.3 % water = 3.35 lbs of water per sample

These numbers were then used to calculate the concentrations of components in a 1 ton sample (2000 lbs).

6.25 lbs of wire / 14.125 lbs sample = 44.2 % X 2000 lbs = 884 lbs of wire per ton of pulper tails

2.90 lbs of plastics / 14.125 lbs sample = 20.5 % X 2000 lbs = 410 lbs of plastics per ton of pulper tails

1.63 lbs of pulp material / 14.125 lbs sample = 11.5 % X 2000 lbs = 230 lbs of pulp material per ton of pulper tails

3.34 lbs of water / 14.125 lbs sample = 23.7 % X 2000 lbs = 474 lbs of water per ton of pulper tails.

Using the tonnage of waste land filled per year before the new plant opened, 1704 tons, one can calculate the amount of each component of the pulper tails that is being land filled. The land filling of waste costs the Cedar River Paper Company $35 per ton. This is a total of $59,640 per year, and with the additional plant coming online, the amount of waste land filled will increase greatly. The total to landfill the pulper tails from both plants could reach $150,000 per year, and no one even knew the concentrations of the components of the pulper tails. Since the new plant is now operational, I will now estimate the amount that is paid to landfill each of the components of the pulper tails.

44.2 % wire X $150,000 = $66,300 to landfill the wire, a reusable commodity

20.5 % plastics X $150,000 = $30,750 to landfill plastics and non pulp material

11.5 % pulp material X $150,000 = $17,250 to landfill a product lost in the repulping process

This material is lost profit, because they already paid for it, and are now paying to get rid of it when it is their primary resource used to produce paperboard products.

23.7% water X $150,000 = $35,550 to landfill water

Each of these components of the mixed waste stream of pulper tails could be reused or recycled, but since they are commingled, the handling costs to separate

them would be extremely high. This waste stream being mixed seems to cause the largest problem. If they were separated, it would be easier to recycle them.

I have been in contact with many other recycling mills around the country, and they just landfill their pulper tails also. Some time has been spent by these mills trying to find ways to reduce the pulper tails, but as of yet nothing has been worked out. Most of the mills say that it is cheaper to landfill the waste instead of trying to reuse or recycle it. In many areas there is no limit to the amount of waste that is landfilled, and so the mills will continue to landfill the waste until they have an economic incentive to discover alternative methods of disposal.

I have been looking into the possibility of salvaging the wire from the tail. Most scrap metal salvaging will not accept the tail because it is hard to handle, and it is not very economically worthwhile. They claim that the steel (wire) concentrations are not high enough for them to go through the work of separating the wire from the other wastes in the stream.

Trying to find a use for the tail seemed backwards to me, but it is the direction the industry wanted to go. To me it would make more sense to eliminate the mixed waste stream before it is made. The waste stream would be much easier to handle if it did not contain so many different components. The wire would be much easier to salvage, and there are possible uses for the remainder of the tail. One such use for the plastics and the pulp material is pelletization for use as burning fuel. Industrial paper waste is bought, pelletized, and sold by General Fuels Corporation in Neenah, Wisconsin. This fuel can be used to heat buildings or burnt instead of coal in electrical power plants.

There are a few problems with removing the wire before repulping though. The wire is what allows the pulper tail to form, which is the cleaning process that removes the trash from the pulping vat. Without this tail, a new process must be created. One possible solution to this is a pulper scavenger. It is a new type of vat that can separate

the wastes from the pulp fibers without a tail. These vats are in the developmental stages now, but it would cost the industry large amounts of money to install these new vats, and remove the old ones. The mills operating today would most likely be against a complete shift to these pulper scavenger vats because of these tremendous costs.

This new vat also brings about another problem. If the wire is not needed to form the tail, how does one remove it from the bales before it enters the vats. The industry is developing prototypes of a bale dewirer to solve this problem. There are still glitches in the process though, and the prototype misses wires, which is unacceptable to the mills. Each prototype also costs $250,000 to make, and the upkeep would be large.

I also investigated other methods of wire removal, including a magnetized conveyor belt. Since the wires are cut, a magnetized conveyor belt could separate the wire and cardboard and paper as it fell into the vat. This solution has its flaws also. One is that a magnetized conveyor belt has not been developed to this scale. Another problem is that the bales are so heavy and bulky that they would just pull the wires into the vat even if a magnet was holding them.

There are many other possible solutions to removing the wires, even it is with workers pulling the wires off individually as the bale moved up the conveyor belt. If the belt was made in a way that it did not rest on the wires, the bale would not be holding the wires, and they could be removed easily. This would increase labor costs, but the money save by reduced landfill charges, and selling the wire to salvage companies could pay the workers, and even be profitable. The pulp and plastics could also be sold to become burning fuel, and also increase profits.

Another possible use for the pulper tail, or at least the pulp and plastics incorporated in it is as a food source, for fungus or bacteria. After the sample was sorted, small portions of the pulp material was placed on Tryptic Soy Agar (TSA) media and Malt agar to see what micro-organisms were growing on it. Within 1 day

there were large bacterial colony growths on the TSA, and within 2 days there was fungal growth on the Malt agar. These colonies were then isolated so that identifications could be made. A variety of test were ran on each of the bacterial colonies, including: gram staining, oxidase, catalase, and a series of tests included in an Enterotube. The Enterotube reactions and a key indicated what species each bacteria was, and after further testing the following results were found.

Sample #	description	Identification
#1	gram + rod, spore former can be pleomorphic	Bacillus species
#2	gram + rod, spore former, bipolar	Bacillus species
#3 (culture #5)	gram - possible enterobacter or pseudomonas	Enterobacter agglomerans

The fungus was also isolated, and identified using a wet mount, lacto phenol cotton blue stain, and a key of fungus species. Under the microscope, the septa and conidiophores (or fruiting body) were located, and classified to identify the fungal colonies. The following are the results:

Fungal colony #1 = a penecillium species

Fungal colony #2 = a Aspirigillus species

I do not know if the pulper tails could serve as a food source for these bacteria and fungus for those who grow them or not, but it could be investigated further. There are many possible solutions of ways to handle or dispose of the pulper tails, with only the imagination as the limiting factor. If continued work is done on this problem a solution the land filling of this waste may be found.

To me it seems that it would be best to remove the wire before it enters the repulping vat, but until industry must do it, or it has economic incentives to do it, it will not because it is cheaper to landfill. They wanted to sell the tail instead of eliminating it because they would not have to alter their operation. There many possible solutions to the problem, it just depends if someone will be willing to try them.

This internship has been very interesting and valuable to me, and I would like to thank you for the opportunity to do it. I hope that I was of some value to your RRTTC program, and that some good will come out of my research. I have learned a lot about the recycling business, and also how to deal with business people over the phone. I also learned that even recycling plants produce waste, which is something I had never thought about before. This project taught me much about the problems and benefits associated with this type of job, and I am grateful for this learning opportunity.

A complete list of my contacts and findings are included in the notes and computer disk that are attached to this paper. Pleas note that the paper was typed on a Macintosh, and on the Clarisworks program.

CEDAR RIVER PAPER COMPANY

Material to be reused or recycled: pulper tail or ragger tails

current disposal method: landfill

pulper tail = contaminated with plastics - material forms a roll or tail as it is pulled from the pulp vat it is chopped off every so often and a new tail forms

potential chop and recycle

Quantity 142 tons per month 1704 tons per year

Physical state solid packaging dumpsters

Cost of land filling the tails

142 tons X $35 per ton = $59,640

Process that creates the pulper tail:

The large bails of mixed paper and old corrugated cardboard are placed on the conveyor and dropped into the pulper vat. The wires that hold the bales together goes into the vat also. The contents of the vat are spun, and the wires begin to wrap around each other. Other contaminants such as plastics, tapes, and box packaging are incorporated into this wire tail and removed from the pulper. This leaves a complicated problem, what to do with it? Common sense says to eliminate the problem before it starts, so take the wire off before it enters the pulper. This would allow recycling of the wire, and lower the amount of waste land filled. Other possible uses for the wastes are to pelletize and burn it. This removal of the wire before pulping brings up a variety of problems.

What does the ragger tail from around?

If no ragger tail exists, how do the other contaminants get removed?

How to remove the wires completely? So far technology is incapable of doing this.

CONTACTS MADE

Cedar River Paper Company in Cedar Rapids IA

phone # 319-365-9785

contact Michele Roddey

was my contact at CRPC, answered any questions I had about the operation, and gave a tour of the plant to Cathy and me

Workplace Development Services

By-product and Waste Search Service

phone # 319-398-5623

contact Stacie R. Johnson (program coordinator)

She is involved in trying to find ways to reuse of recycle many waste streams of industries around the region.

Packing Corporation of America in Tama, Iowa (formerly Tenaco)

phone # 515-484-2884

Contact Jerry Brink 2/12/96

2/20/96 Ask about balers

Wire sent to Gervich Steel in Marshalltown, PCA pays them to take it. the rest of the stuff is sent to landfill in Tama. Call Gervich.

Weyerhauser Tacoma, WA

phone # 206-924-3605

Contact Manfred Boreder e-mail BorederMK at WDNI

Thought maybe could chop and separate metal, leaves fuel stream to pelletize can mix.

My thought, maybe possible to to magnetize a conveyor, cut wires, and have the conveyor hold the wires as the paper falls into the pulper. Manfred gave Dick Spangenburg as possible contact. wanted to keep in touch

Weyerhauser

Contact Dick Spangerburg engineer, industry practice

phone # 206-924-6501

$250,000 for a bale dewirer, prototype not yet completely dewiring the bales.

Brought up the pulper scavenger idea, don't need rag-rope maybe

Wires put on by the recycling centers bales low density 500-700 lbs high density bales 1500 lbs

VIM corporation Glenn Ellyn Illinois

Contact Mark

phone # 708-858-5180

Ask tolerances of metals and glues, ask who could handle the waste stream. Mark was very interested, wanted to know tons/day. The companies he works for accept the small fibers that can't be used to make paper because to small. They recycle them. Made mistake, he thought I was trying to get rid of these fibers, no the ragger tail, misunderstanding, wasted his time and mine.

North Star Steel

contact: Tim Bourcier

phone # 319-732-4554

Have been unable to contact, get machine with a different name

Allied Scrap Metal

contact: Barry Cowhen

phone # 312-225-2800

2/20/96, Barry Cowhen stated that he didn't know what to do with it, they don't handle, he suggested I contact the Institute of Scrap Recycling Industry (ISRI). Suggested Evelyn Haught, public relations, as a contact. phone # 202-737-1770.

Evelyn Haught at ISRI suggested I talk to Kimberly Harris also at ISRI

ISRI

contact Kimberly Harris

phone # 202-662-8535

She said that she did not know anyone who was recycling the pulper tails. She suggested I contact Peter Bunten or Dana Blanton at the American Forest and Paper Association, who are members of the Recycling Group.

Recycling Group

Peter Bunten and Dana Blanton

phone # 202-463-2700

Talked to Peter Bunten, and he said he knew of no one working with the pulper tails.

Chemetco Inc

contact Greg Cotter

phone # 1-800-444-5564 extension 219 Fax # 618-254-0138

address Route 3 Chemetco Lane

Hartford, Illinois 62048

Greg wanted a sample from Cedar River, told Michele Roddey to send him one. She hadn't got this done, even after numerous reminders. Made this contact of 2/20/96, and as of 4/1/96 no sample sent. Chemetco was going to analyze the sample to see if they could use it. Greg would not reveal any of the process that they use.

Gervich Steel, of Marshalltown Iowa

phone # 1-800-622-8833 or 515-753-3359

contact Doug

He said that PCA pays them to take the pulper tails. Every couple of years, they do a study to see if it was profitable. They have to change the handling price to keep up with the costs to them. After they scrap it, they send it to North Star Steel or similar companies. They mix wires with other metals to bring the concentration and quality up. They are not sure how much money they make on the deal.

Ace Iron and Metals Inc

phone# 1-800-640-0223 or 815-723-2612

Said will have to continue to dump it, no market for it

Chicago Paperboard Company

phone # 312-997-3131

Said they landfill all of their wastes. It does not seem to be hurting their profits any. Said could not recycle even if wire was not in it because still a mixed waste stream. Suggested I contact a firm in Appelton Wisconsin that pelletized paper and plastics and sold for heating or electrical power generation.

Called Wisconsin DNR and asked for recycling rep. They directed me to a man named John Brand at the Lake Michigan office I believe.

WDNR

contact John Brand

phone # 414-492-5867

He told me that the company was based in Neenah, Wisconsin, and named General Fuels Corporation. They pelletize the paper and sell it. Gave me the names of two possible contacts Lee Jesse, and Harlan Medders.

General Fuels Corporation

P.O. Box 732

Neenah WI, 54957-0732

contact Lee Jesse

phone # 414-738-7878

Talked to Lee, said that they sell pelletized paper and plastics to companies to burn as fuel. Also used in power plants.

Contacted by Melanie O'Donnell who works at Resource Recovery Agency in Syracuse, New York. She had talked to Stacie Johnson, and wanted to know what I knew about the ragger tail recycling possibilities.

Melanie O'Donnell

phone # 315-453-2866

Also called the following conveyor belt manufacturers and asked about magnetic conveyor belts, of which none are made.

Van Gorp Corporation phone # 515-628-9212

Stern's Magnetic or Ohio Stern's Magnetics phone # 216-662-8484

or 414-543-2177

Received a sample from the Cedar River Paper Company on 3/11/96, and began analysis. The sample and the bucket weighed 16.25 pounds..

bucket and sample	16.25 lbs
bucket	2.125 lbs
sample	14.125 lbs

It took 4.5 hours to remove the wire from this sample with wire cutters and pliers.

wire in sample	6.25 lbs

Then separated the plastics and the pulp material. Took nearly 20 hours.

plastics in sample	2.9 lbs
pulp material and water weight	4.975 lbs
pulp weight dry (calculated)	1.63 lbs
water weight (calculated)	3.34 lbs

Calculated the percent water weight in the pulp material.

Three samples of wetted pulp material were dried to remove the water weight and to find the actual pulp weight. The pulp was rehydrated to approximate water content, because the pulp dried somewhat while I was sorting the plastics out. Therefore the percentages are not exact. The samples was dried for 24 hours weighed, and dried again for 72 hours at 65 degrees Celsius.

Weights before and after drying # 1 and # 2				% pulp	% water
Sample # 1	15.00 g	4.96 g	4.95 g	33.1	66.9
Sample # 2	15.00 g	4.92 g	4.91 g	32.8	67.2
Sample # 3	15.50 g	5.02 g	5.01 g	32.4	67.6
			averages	32.8	67.2

14.125 lbs sample - 6.25 lbs wire - 2.9 lbs plastics = 4.975 lbs of pulp and water

4.975 X 32.8 % = 1.63 lbs of pulp per 14.125 lbs sample

4.975 X 67.2 % = 3.34 lbs of water per 14.125 lbs sample

These percentages for a 2000 lbs (1 ton) sample 2000/ 14.125 = 141.6 portions weighing 14.125 lbs.

141.6 X 6.25 lbs of wire = 885 lbs of wire per ton

141.6 X 2.9 lbs of plastic = 410 lbs of plastic per ton

141.6 X 1.63 lbs of pulp = 230.8 lbs of pulp per ton

141.6 X 3.34 lbs of water = 472.9 lbs of water per ton

Find out if they dry sample at all before land filling, and write about the fungus and bacteria.

Found out that they do no dry the tail before land filling. It is placed in a dumpster type container with holes in the bottom, so that some liquid does drip out, but no substantial drying takes place.

I tried growing any bacteria or fungus from the pulp material. Small amounts of pulp material were plated on TSA and malt agar. The TSA plates grew different types of bacteria, while the malt agar allows growth of fungus. There was lots of growth within one day

On the TSA plates:

much growth, large round circles light in color and another growth dark in color

On the malt agar

had growth of fungus after of 2 days. 8 colonies on one plate and 11 on the other

Then I isolated the colonies on malt and TSA agar. Had three different bacterial growths and two different fungal growths. Then did gram stains of the 3 bacterial colonies. #1 was gram - #2 was gram + #3 was gram -

Then ran many more tests to identify using the enterotube tests. Should be done only for gram - but accidentally did gram + also. Results:

#1 20020 or 20060

#2 20000 or 30000

#5 20001 or 30001

These numbers correspond to bacteria listed in the enterotube direction book and key. These bacterial species were then looked up in Bergey's manual to identify the bugs. Additional tests were done to help with the identification including oxidase and catalase tests.

#1 = a Bacillus species

#2 = a Bacillus species

#3 (plate #5) = Enterobacter agglomerans

The fungus were also identified using different techniques and keys. A wet mount and a lacto phenol cotton blue stain test was done to determine the septa and fruiting bodies used for identification. The fungus appear to be:

#1 Penecillium species

#2 Aspirigillus species