Energetic Recovery of Celulose Wastes

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Abstract

Energy Efficiency and Renewable Energy (EERE) has an Industrial Technologies Program (ITP) that specifically works with the pulp and paper mill industry to enhance their energy usage efficiencies and other industrial environmental improvements. Example of the EERE project relevant to the reduction of waste in pulp and paper mills as outlined in the paper. Solid Recovery Fuel production on the base of pulp and paper production in International paper Kwidzyń is described.

Keywords: paper industry wastes, pulp and paper sludge, energetic utilization of waste, solid recovery fuel

Introduction

Eleven million tons of waste are produced yearly by the European pulp and paper industry, of which 70% originates from the production of deinked recycled paper. The pulp and paper industry is one of the most forward-looking branches of industry, with a good environmental record. Its production is based on renewable raw materials (wood mass) and secondary raw materials (waste and scrap paper). Its products are used in all the other branches of the manufacturing industry, particularly printing. The industry's high energy consumption is partly offset by its use of renewable sources (mainly biomass). Currently this environmentally friendly method of biomass incineration covers approximately one-fourth of total gross energy consumption for paper production. According to the international NACE [1] classification, the branch is divided into two sectors: 21.1 Manufacturing of pulp and paper and 21.2 Manufacturing of articles of paper and paperboard (Monte, 2014).

Recycling of Used Paper and Paperboard

The pulp and paper industry is the second largest branch worldwide, after the food industry, using recoverable raw material sources. In addition, its immense advantage, unlike the food industry, is that the used products can be recycled. Recycling is a natural attribute of this branch, and looking back into history we shall see that the industry came into being actually by "recycling" rags. Paper mills have always behaved, and will continue to behave, strictly economically, while at the same time being friendly to the environment. Different ratios of basic raw materials are used to make new paper and paperboard, i.e. new pulp (groundwood pulp and cellulose), waste and scrap paper and non-fibrous components (fillers, sizing agents, etc.). The usual composition in the pulp and paper industry is about 51% new pulp, 43% waste paper, and 6% other components. Paper and paperboard consumption is continuously growing, which is confirmed not only by the growing performance of the economy, but also by the rising standard of living of the population. This goes hand in hand with growing consumption of waste paper in the manufacture of new paper and paperboard. The main asset of using waste paper is its contribution to environmental protection and lower consumption of primary raw materials – new fibres. All this is being done despite the fact that new fibres are made from domestic renewable raw materials (The Czech, 2007).

The aim of the project

Wastes from pulp and paper industry are very diverse in composition and consist of rejects, different types of sludges and ashes in mills having on-site incineration treatment. The production of pulp and paper from virgin pulp generates less waste but the waste has similar properties to waste from the production of deinked pulp, although with less inorganics. Due to legislation and increased taxes, landfills are quickly being eliminated as a final destination for wastes in Europe, and incineration with energy recovery is becoming the main waste recovery method. Other options such

as pyrolysis, gasification, land spreading, composting and reuse as building material are being applied.

The aim of the presented project was to establish the ecofriendly, ecosafety technology of energetic recovery of the waste produced in pulp and paper company International Paper Kwidzyn.

Production profile of International Paper Kwidzyn

International Paper Company is an American pulp and paper company, the largest such company in the world. It has approximately 65,000 employees, and it is headquartered in Memphis, Tennessee. The company was incorporated January 31, 1898, upon the merger of 18 pulp and paper mills in the northeastern United States. The company is the largest producer of plastic lids and paper cups, manufacturing for the fast-food giants McDonald's, Wendy's, Subway.

In 1992, the company acquired the "Zakłady Celulozowo-Papiernicze w budowie" w Kwidzynie. This plant started at 1972. Now International Paper Kwidzyn sp. z o.o is one of the biggest European pulp and paper companies. It is located in 40-thousand Kwidzyń town, on the Liwa River, Wisła river flows approx. 5 km far away to the east of the Mill. Except for wood and chemical agents consumed, water is a basic raw material for pulp and paper production. Water consumption reached the level of appr. 40 m^3/ton of unbleached pulp output.

Across Europe, Middle East & Africa, International Paper focuses on the production of office and uncoated woodfree papers, industrial and consumer packaging, containerboard as well as coated and uncoated paperboard.

Waste generation in International Paper Kwidzyn

The main types of solid waste generated in pulp and paper mills are briefly described below (IPPC, 2001; CANMET, 2005):

From pulp mills:

• Rejects: The rejects from virgin pulps consist of sand, bark and wood residues from wood handling, which are undesirable for papermaking. Rejects typically have a relatively low moisture content, significant heating values, are easily dewatered and are, generally, burned in the mill's bark boiler for energy recovery.

• Green liquor sludge, dregs and lime mud: These are inorganic sludges separated from the chemical recovery cycle. These sludges are normally landfilled, after dewatering and drying.

• Wastewater treatment sludge: It comes from two sources: primary sludge and biological sludge generated in the second clarifier. These sludges are generally blended together, a polymer added and dewatered together to a 25–40% dry solid content.

• Chemical flocculation sludge: It arises from water treatment and is often transported to the landfill site due to the high content of inorganic matter and water.

From paper mills:

• Rejects: The rejects from recovered paper are impurities and consist of lumps of fibres, staples and metals from ring binders, sand, glass and plastics and paper constituents as fillers, sizing agents and other chemicals. Rejects also have a relatively low moisture content, significant heating values, are easily dewatered and are, generally, incinerated or disposed of in landfills.

• Deinking sludge: This residue contains mainly short fibres or fines, coatings, fillers, ink particles (a potential source of heavy metals), extractive substances and deinking additives. It is normallyreused in other industries (e.g. cement, ceramics), or is incinerated, even though it has a poor heating value.

• Primary sludge: This sludge is generated in the clarification of process water by kidney treatments, e.g.dissolved air flotation. The sludge consists of mostly fines and fillers depending on the recovered paper being processed and it is relatively easy to dewater. This sludge can be reincorporated into the process for board industry, but for high grade products can be incinerated, dumped or, otherwise, mixed with deinking or secondary sludge.

• Secondary or biological sludge: This sludge is generated in the clarifier of the biological units of the wastewater treatment, and itis either recycled to the product (board industry) or thickened, dewatered and then incinerated or disposed of in landfill. Secondary sludge volumes are lower than those corresponding to the primary sludge, since most of the heavy, fibrous or inorganic solids are removed in the primary clarifier.

Remark:

– "slaker grits": lime mud that pebbled in the kilnbut did not calcine, from chemicals used in Kraft pulp mills.

– "dregs": in general, are defined as the sediments that have settled at the bottom of a liquid. In the case of pulp mills, these sediments consist of the matter which does not decant in green liquor clarifier)

Tab. 1. The amounts of waste from the paper production in the IP Kwidzyn

Tab. 1. Ilości odpadów powstających w IP Kwidzyń

Waste	Code	Quantity	Moisture	Quantity	Energetic value	
		Operation state Ton/year	%	Dry mass Ton/year	Operation state [MJ/kg]	Dry state [MJ/kg]
bark	03 03 01	200 000	51,0	98 000	8,0	16,5
Belmer	03 03 10	25 000	52,3	6 695	5,3	11,2
Sludge	03 03 11	50 000	60,9	19 550	3,9	10,0
Krofta	03 03 07	35 000	45,2	12 400		5,8
total		*310 000*		*136 645*		

Waste code according to Ustawa o odpadach, 2012

Tab. 2.Waste balance in operational state

Tab. 2. Bilans odpadów w stanie roboczym

Waste	Yield
	[%]
bark	72,7
belmer	9,1
sludge	18,2
total	100

Tab. 3. Waste balance in dry state

Tab. 3. Bilans odpadów w stanie suchym

Waste	Yield of dry phase
	[%]
bark	78,9
belmer	5,4
sludge	15,7
total	100

The paper industry produces a lot of pre-consumer waste that can easily be put to use in various ways. A group of scientists at AGH have come up with a way to turn paper industry by products into eco-friendly solid recovery fuel.

Important residual waste streams from pulp and paper mill in International Paper Kwidzyn include wastewater treatement sludges, lime mud, lime slaker grits, green liquor dregs, boiler nad furnance ash, scrubber sludges, wood processing residuals. For the investigation combustible waste were choosen. Table 1 shows the balance of the wastes which was the base of investigation, table 2 includes the morphology of the waste (operationg state) and table 3 the same in dry state.

Toal amount of waste produced by IP is appr. 275 000 ton/year, average moisture appr. 55%.

Technology of energetic recovery of wastes

Technology of Solid Recovery Fuel production technology was developed at AGH with cooperation with IP , technology is described in (Tora et all 2013).

Production of alternative fuel is carried out in the following stages:

– Mixing of all components (wastes with addition of shredded bark),

– Drying,

– Forming (pelletising, briquetting).

The average composition of tge alternative fuel is:

– Bark 72.7%

– Belmer - 9.1%

– Sludge 18.2%

Parameters of alternative fuel:

– Moisture 10%

– Net calorific value 13.7 MJ/kg

In general, solid wastes from pulp production and paper mill operations are humid and contain some organic compounds in the form of wood or recycled paper fibres, chlorinated organic compounds and pathogens, significant amounts of ash and trace quantities of heavy metals.

Conclusions

The technology of alternative fuel production involves waste management in pulp and paper industry.

Technology consists of stage of mixing the sludge from the de-inking of waste paper (which contains cellulose fibers, inks, adhesives, fillers, waste fiber, sludges fibers, fillers and coatings from the mechanical separation of waste from water treatment plants, with paper mills. In the second stage mixture (alternative fuel) is dewatered and pelletized.

The fuel has the following characteristics:

- calorific value 9–15 MJ/kg;
- high combustion efficiency;
- low emission of dust and noxious gases;
- reduction of mycotoxins emission;
- low cost and ease of production;
- facility of transport and storage.

Thanks to specially selected additives (waste water descaling) combustion of biomass fuel does not cause known phenomena through the combustion of biomass, such as corrosion and Chloride slag of heating surface of boilers.

The use of technology provides the following benefits:

- development of all kinds of local biomass, which its suppliers provide fixed income;
- possibility to use in the power industry (power, CHP), which is required to produce energy from renewable sources;
- the creation of new job place;
- obtaining cheap fuel.

Minimization of waste generation

According to the IPPC (IPPC 2001), installations (ex. of waste recycling) must be operated in such a way as to meet six prime objectives:

– Application of best available techniques (BAT) to prevent pollution.

– No significant pollution.

– Waste minimization and the recovery of unavoidable waste.

– Efficient use of energy.

– Prevention of accidental releases.

– Remediation of the plant site back to its original state after plant closure.

Due to the large volumes of waste generated from pulp and paper industry, the high moisture content of the waste recovery methods are usually expensive and their environmental impact is still uncertain. For this reason, it is necessary to continue research on different applications of wastes, while taking into account the environmental and economical factors of these waste treatments.

The most important achievements of the project are:

– production of alternative fuel that will be used in the power industry,

– the use of waste, which has so far been directed solely to the disposal by landfilling,

– reducing the pollution generated to environment by replacing conventional energy sources, such as coal, by ecological fuel

– reducing the amount of waste directed to landfill,

– getting a "green energy" produced in a cogeneration process from municipal waste incineration.

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Odzysk energetyczny odpadów z przemysłu papierniczo-celulozowego

W ramach programu Efektywność energetyczna i odnawialne źródła energii (EERE) opracowano program Technologie Przemysłowe (ITP), w którym dokonano specyfikacji działań podejmowanych w przemysle celulozowo-papierniczym w celu zwiększenia efektywności użytkowania energii i poprawy stanu środowiska. Przykład realizacji projektu EERE w celu zmniejszenia ilości odpadów z zakładu celulozowo papierniczego opisano w artykule. Przedstawiono możliwości produkcji stałego paliwa wtórnego (SRF) na bazie odpadów powstających w firmie International Paper Kwidzyn.

Słowa kluczowe: odpady z przemysłu papierniczego, szlamy z przemysłu papierniczo-celulozowego, odzysk energetyczny odpadów, stałe paliwo wórne