paperChain

Guidelines for the implementation of the Circular Economy models.

FACTSHEET CC4

Fiber sludge-based chemicals production

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Keywords

Guidelines	Construction material	Pulp & Paper Industry (PPI)	Circular Economy Model (CEM)	Fact sheet
assessment	requirement	standard	Waste	performance
Rejected Fibers	ethanol	hydrolysis	reactor	Bermocoll®

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CC4 Circular Model Guidelines: fiber sludge-based chemicals production.

CC4: Chemicals production based on fiber sludge: CC4 demonstrates the transformation of an industrial waste from the PPI to a functional chemical used as an additive in paint and for applications within the construction sector. Improved cellulose, ethanol derivates and ethyl chloride can be obtained by several chemical processes transforming the PPI rejected fibre sludge waste. These can be employed in several applications, as additives for painting products as Bermocoll®. DOMSJÖ FABRIKER (pulp mill), produces dissolving pulp for viscose applications, ethanol from fiber reject and improved pulp quality suitable for production of cellulose ethers; SEKAB (chemicals), produces ethanol derivatives such as acetic aldehyde and ethyl acetate starting from ethanol, and in addition, ethyl chloride production; NOURYON chemicals (Former AKZONOVEL facility), produces cellulose ether, Bermocoll®, using cellulose and ethyl chloride as raw materials; RISE PROCESSUM (research institute), coordinates the circular case and support scientifically the project. Case achieved user quality requirements for the products. Challenges: scalability requires high investment, safety and environmental constrains for big plants. Environmental benefits avoiding fossil based raw materials and lower CO_2 footprint by novel process are high. CC4 process is highly specific. Figure 1 shows the CC4 Circular Case in Sweden. Production chemicals from PPI fiber sludges, Figures 2 to 4 show the industrial scale pilot demonstration, and Tables 1 and 2 the CC Main Items, Key Factos and Lessons learnt.

CC4 chemicals production based on rejected fiber sludge, short Guidelines:

- CC4 aims producing improved cellulose, ethanol derivates, ethyl chloride, and Bermocoll® derived from the fiber sludge developed in PAPERCHAIN, as a greener alternative to fossil-based chemicals. Challenges: achieving high purity chemicals, reactions optimization and safe and economically feasible production. High investment required for industrial scalable production, but large-scale market opportunity for bio EtCl production is unique, representing an alternative lower CO_2 footprint process, that reduces transportation footprint and costs, resulting in an increased competitiveness.

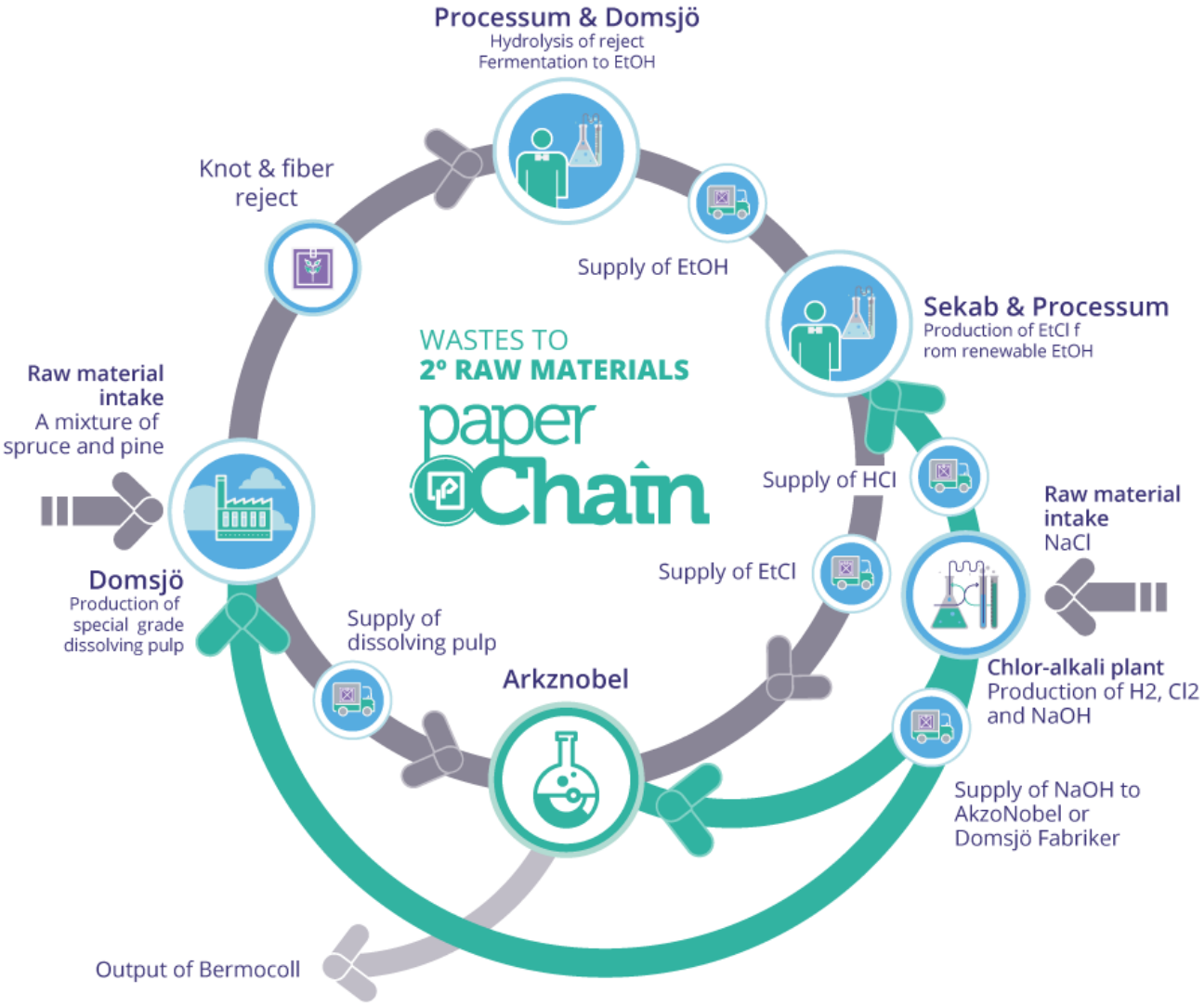

FIGURE 1 – CC4 CIRCULAR CASE (SWEDEN)–CHEMICALS FROM FIBER SLUDGE.

FIGURE 2 – WASTES: FIBER SLUDGE.

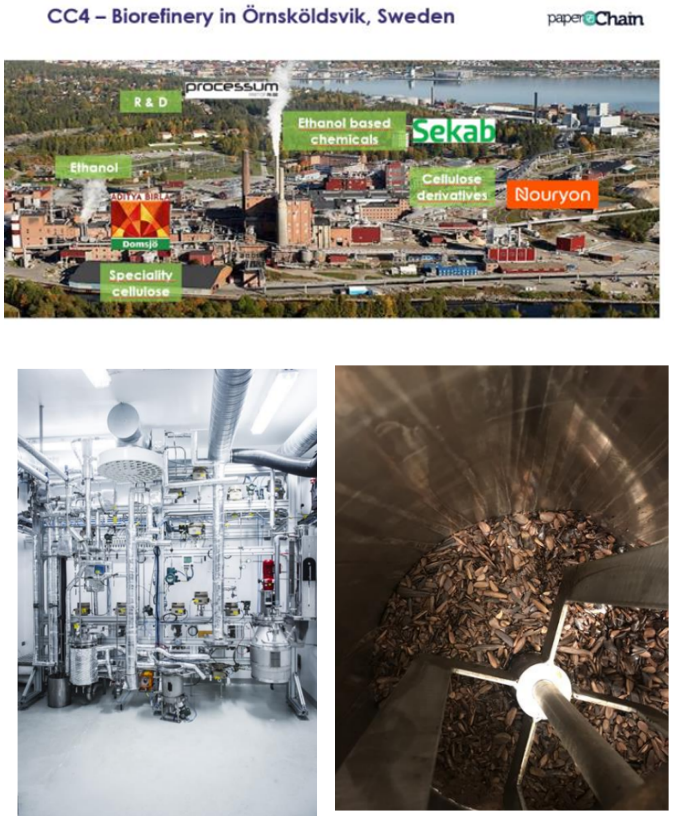

FIGURE 3 – WASTES: FIBER SLUDGE.

FIGURE 4 – APPLICATION. CHEMICALS: IMPROVED CELLULOSE, BIOETHANOL DERIVATIVES, ETHYL CHLORIDE, BERMOCOLL®.

TABLE 1 PAPERCHAIN CIRCULAR CASE 4: CHEMICALS; MAIN ITEMS

item	*Description*
PAPERCHAIN STAKEHOLDERS	ADIYA BIRLA Domsjö Fabriker (DOMJSO); SEKAB; NOURYON (Former AKZONOVEL facility); SP Processum (SP).
LOCATION	Örnsköldsviks, Sweden.
WASTE	Fiber sludge
PRODUCT	Chemicals: improved cellulose, bioethanol derivatives, Ethyl chloride, Bermocoll®.
APPLICATION	Chemical industry: additives for paintings, coverings, etc.

TABLE 2 CC4 FIBER SLUDGE BASED CHEMICALS. KEY FACTORS AND LESSONS LEARNT

Key Factor	*Fact*	*Lessons learnt*
Waste (Fiber sludge)	Fiber sludge comprises cellulose and hemicellulose as main constituents. Waste fiber sludge is produced as a side product at most pulp mills and is usually used for internal energy production. Fibers are short and do not qualify to make paper. Usually fiber reject is incinerated for steam production Composition differs between mills.	Two different types of fiber rejects identified as potential raw materials for sugar production: fines and knot reject. Residual sugars obtained from the fiber sludge generated by DOMSJÖ FABRIKER were used for the ethanol production.
Regulatory framework	Constrains focuses on the product required quality-purity achievement and environmental performance, ruled by REACH.	Important changes in the quality/purity levels for the ethyl chloride may affect dramatically the viability of the new production, and therefore, major efforts are put in the process optimization.

	Obtaining all the environmental permits from authorities, and fulfilling all requirements about safety for the implementation at industrial scale can be challenge and time-consuming (2-3 years approx.). Fossil based chemical productions can be affected by future constrining regulations.	Environmental barriers regarding to production wastewater must be considered, where effluents must be properly monitored and managed. New policies and regulatory framework fostering green chemicals and constrain long distance trading of such chemicals can help boost CC4 products.
Proceedings	Providing a regular SRM quality requires an important effort on quality assuring for the full process. REACH and Quality standards must be granted in all the production steps.	A clear and open fibre sludge traceability is relevant. Therefore, the waste quality control is critical, that implies a solid SRM providing networking. Specific technologies/processes must be developed and upscaled the Electrolysis technology, the transformation of Fiber reject to ethanol via enzymatic hydrolysis, the production of new cellulose quality, the production of Ethyl Chloride.
Barriers	Obtaining high purity chemicals in a feasible way is in fact a big challenge.	To develop these processes, resulting in a high purity production supposes a large investment.
Enablers	Fibre sludge landfilling not allowed in some countries. EtCl availability will be very close, supposing an advantage (neighbours), on costs and environmental footprint.	Solid SRM providing networking is necessary to stablish a stable market framework.
LCA/CO2 footprint	The circular model will replace another no bio product (EtCl) imported by train from Germany. Positive environmental impact is foreseen. All the stakeholders are neighbours so no transport of Ethyl chloride will be required, reduction of carbon footprint.	By this CC4 the overall environmental impact and CO_2 footprint is minimized, making this novel product more atractive than standard fossil-based products.

Exploitation	Domsjö Fabriker will have an increase in the ethanol production and a more versatile cellulose product. A 2000 t/year of high quality ethanol is foreseen by upscaling the process. Sekab have the potential to expand their product portfolio with ethyl chloride which will include the construction of a new chemical plant. Nouryon will be able to produce a more sustainable product while also securing the raw material supply of ethyl chloride.	Competitive new product ethyl chloride prices can be obtained but CC4 implementation costs are high. Increased product and sub-products analyses and purification costs may affect negatively to the margin. Process (ACL) requiring salts storage needs mean higher investment costs. Higher environmental monitoring and safety providing costs will reduce profitability. No other large-scale market opportunity for bio EtCl than Nouryon in EU.
Replicability potential	Ethanol is a global commodity that is a part of the transition to a bioeconomy in Europe and all sources of raw material for ethanol production have to be considered. Wood based fibres are a highly interesting substitution of cotton linter due to problems with irrigation and use of pesticides in cotton production. Bermocoll® and other cellulose ethers are produced at several locations worldwide and could replace fossil based products in additional applications with further development.	No other large-scale market opportunity for bio EtCl than Nouryon in EU. This CC4 process is highly specific and dependent on the new target chemicals envisaged for the replication of the circular economy model.