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Feasibility of traditional and novel lyocell fibre production concepts

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INTRODUCTION

In the GRETE EU project, concepts for lyocell fibre production using novel solvents and paper grade pulp are developed. This poster presents one promising process concept based on dissolving enzymatically pre-treated eucalyptus paper grade pulp using superbase-based ionic liquid. The techno-economic feasibility of a hypothetical 50 kt/a lyocell fibre production facility is presented and compared to the reference concept, commercial NMMO-Lyocell process plant with same capacity.

APPROACH - Conceptual level techno-economic evaluation

- Definition of the concept and assumptions based on publicly available sources and expert opinions
 - Process block-flow diagram definition and process parameterization
 - Prices and cost factors
- Development of steady-state process simulation and cash flow analysis models
- Calculation of mass & energy balances
- Conducting cash flow analysis including operating and capital expenses of production
- Sensitivity analysis on key process parameter and cost assumptions

ASSUMPTIONS

	REFERENCE	NOVEL CONCEPT (Fig.1)
Raw material	Dried eucalyptus dissolving grade pulp	Never-dried eucalyptus paper grade pulp
Solvent	N-methylmorpholine N-oxide (NMMO)	Ionic liquid
Solvent recovery	Filtration, ion exchange, evaporation, regeneration of degraded NMMO, stabilization of NMMO	Filtration, removal of unregenerated material, evaporation
Pre-treatment	Re-pulping, dewatering	Enzymatic treatment, washing and dewatering
Dope water content	12.25%	2%
Spin bath solvent content	20%	15%
Solvent water cont. after recovery	14%	20%

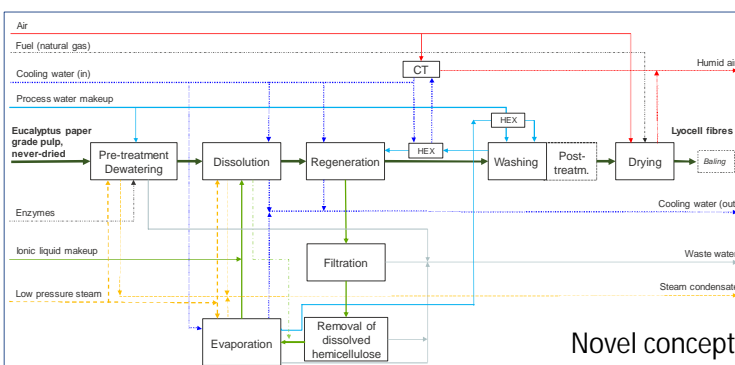


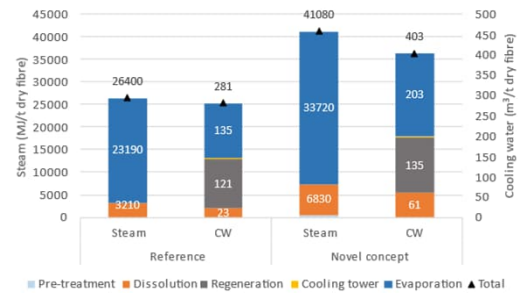
Figure 1. Block-flow diagram of the novel lyocell fibre production concept based on dissolving enzymatically pre-treated eucalyptus paper grade pulp using ionic liquid. (CT=cooling tower, HEX=heat exchanger)

RESULTS

Compared to the reference, in the novel concept

- 2.9% lower product yield due to losses in pre-treatment,
- 19% higher solvent makeup need due to higher dope solvent content,
- 98% higher wastewater amount due to water in the never-dried pulp,
- 43% higher cooling water and 56% higher steam consumption due to higher evaporation capacity requirement in dissolution and solvent recovery (Fig.2).

Figure 2. Steam (MJ/t dry fibre) and cooling water (m³/t dry fibre) consumptions in the reference and novel lyocell fibre production concept.



- Total capital cost estimate for reference and novel concept 290 MEUR and 315 MEUR respectively, calculated using early-stage engineering capital cost estimation routine (Bridgewater's method).
- Total operating costs 2% lower for the novel concept, even though energy and solvent costs are significantly higher (Fig. 3).
- Through technology development, the solvent price and the water removal needs could potentially reach the reference concept level. As a result, the novel concept would have 9% lower operating costs than the reference.

Operating cost breakdown

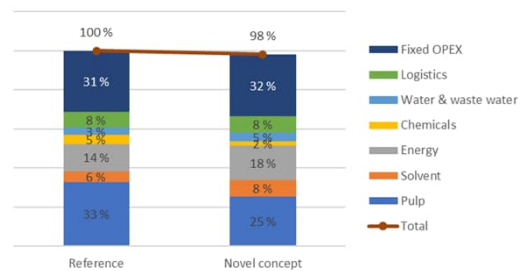


Figure 3. Operating cost breakdown for the reference and novel lyocell fibre production concept.

CONCLUSIONS

- The feasibility of a novel lyocell fibre production plant is compared to traditional NMMO-Lyocell plant.
- The novel concept leads to lower total operating costs (-2%) but higher capital expenses (+8%) than the reference. It benefits from the lower pulp price, but the overall process is more complex due to use of paper grade pulp and needed enzymatic pre-treatment.
- The presented results are results of one fixed process design for both concepts. By optimizing the design and the parameterizations of the novel concept, further benefits could be achieved.