

# Continuous Pilot-Scale Steam Explosion of Softwood Bark Residues



Andreas Averheim<sup>a</sup>, Mikael Thyrel<sup>b</sup>, Olof Melander<sup>a</sup>, Sylvia H Larsson<sup>b</sup>

<sup>a</sup>Valmet AB, Fiber Technology Center, Sweden

<sup>b</sup>Swedish University of Agricultural Sciences, Department of Forest Biomaterials and Technology, Sweden

## Introduction

### Softwood bark

Softwood bark is traditionally combusted for energy. However, improved energy efficiency and recent increases in pulp mill capacities in the Nordic countries highlight softwood bark as a low-cost resource for conversion into higher value, renewable end-products.

### Carbocation scavengers

Wayman and Lora (1978) discovered that some aromatic compounds, especially 2-Naphthol, prevented the self-condensation of lignin under acidic conditions. Later, Pielhop et al (2015) showed that carbocation scavenger addition to pretreatment could benefit the enzymatic digestibility of pretreated substrates.

### Research objective

In commercially scalable pretreatment equipment and at industrially relevant steam explosion settings, systematically explore the effects of treatment temperature and 2-Naphthol addition on the carbohydrate composition of softwood bark.

## Materials and methods

**Raw material**

Softwood bark pulp mill residue harvested in North-West Sweden.

- Dry matter content 38-40%
- Norway spruce – 50%\*
- Scots pine – 46%\*
- Contorta pine – 1%\*
- Reject wood – 3%\*

\*Month of February, 2019

**Shredding**

- Lindner Micromat shredder
- 30 mm hole screen
- Downsizing of raw material

**Screening**

- Mogensen screen
- 14 mm mesh
- Separation of oversized material

**Centrifugal separation**

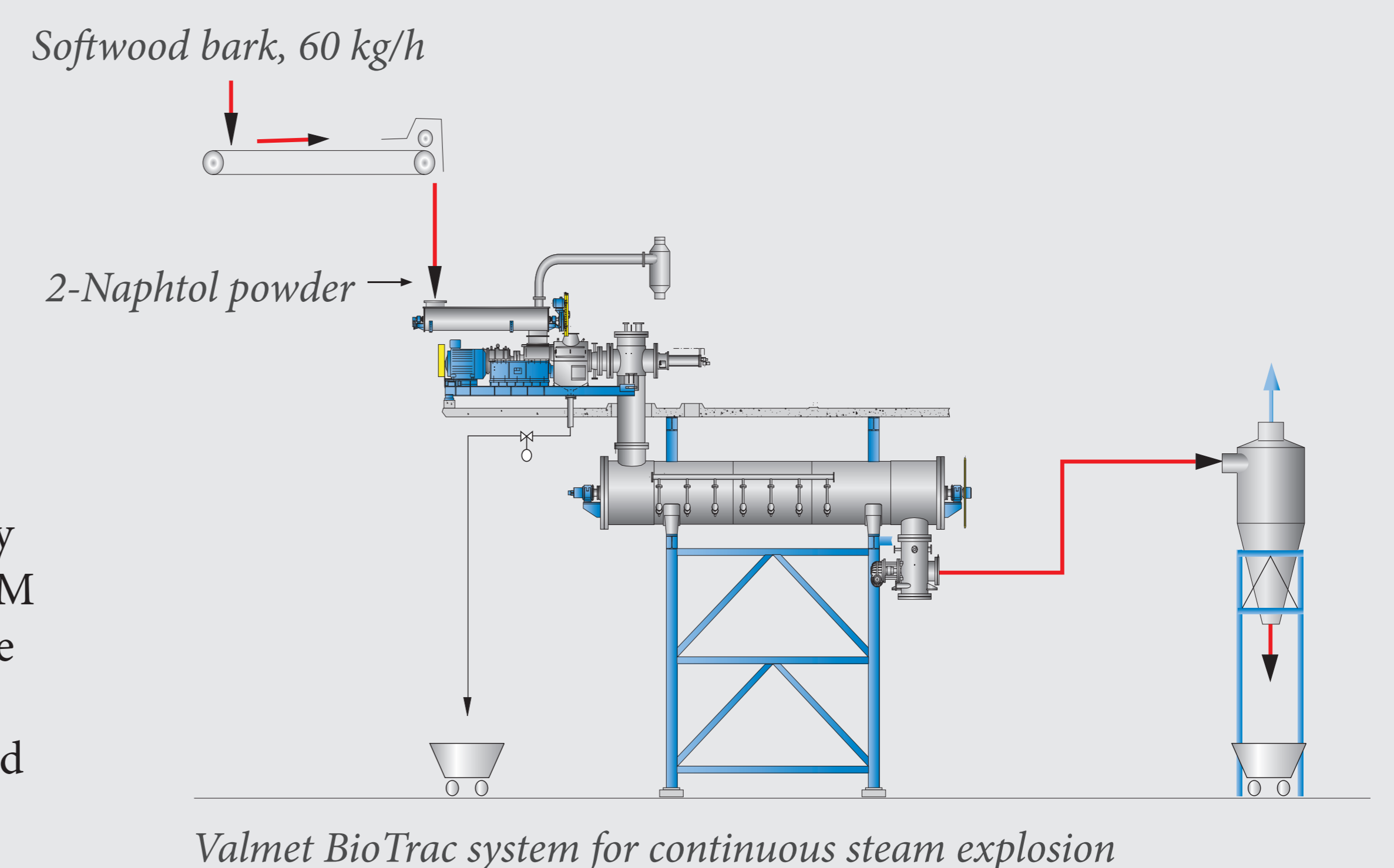
- Junk trap on pneumatic conveying line
- Separation of stones

## Steam explosion conditions

Temperature (°C)	Residence time (min)	Severity factor	2-Naphthol
180	10	3.4	YES/NO
190	10	3.6	YES/NO
200	10	3.9	YES/NO
205	10	4.1	NO

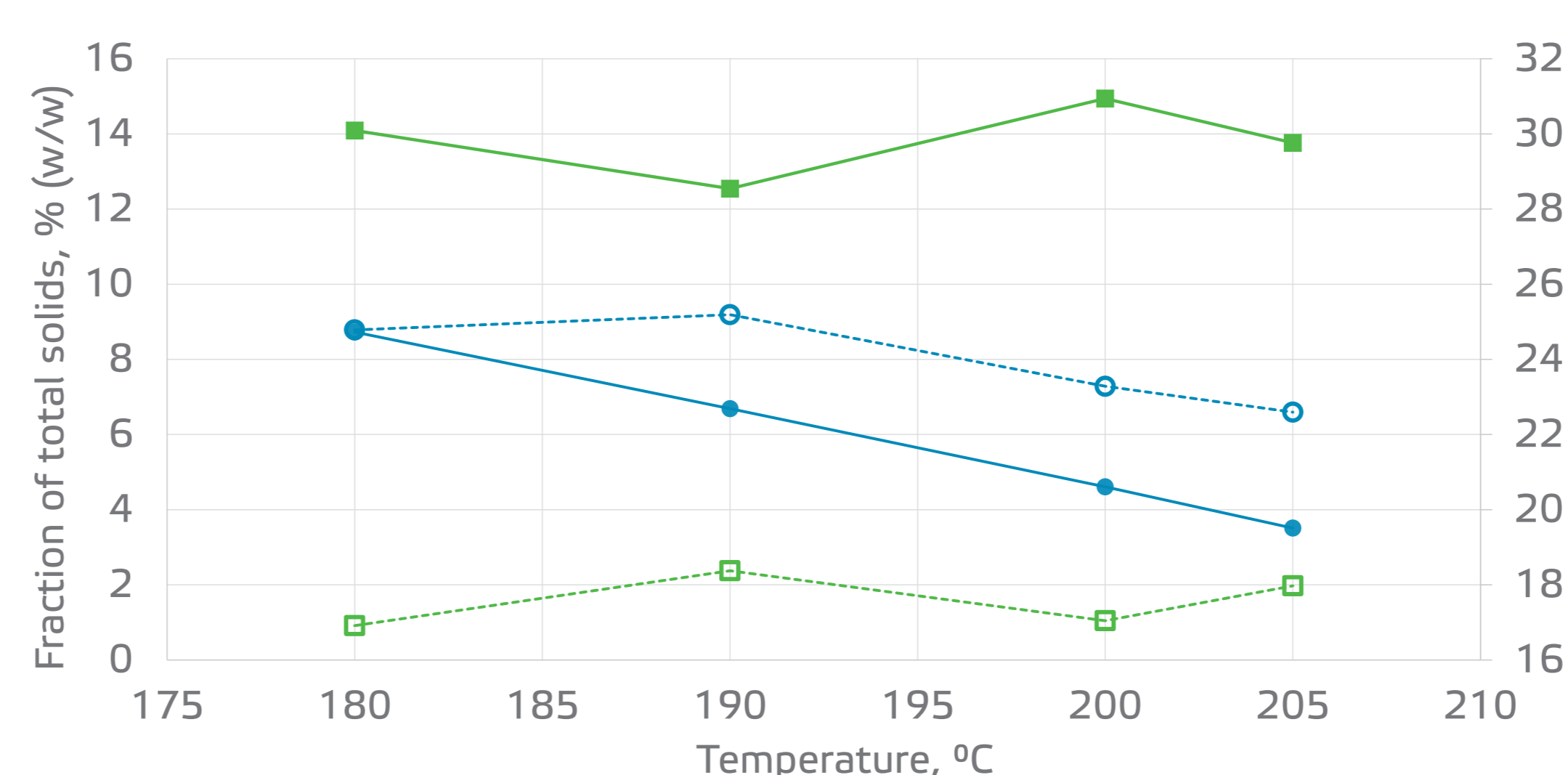
## Analyses

Total solids and water insoluble solids concentration of the steam exploded biomass were analyzed and the fractions were prepared for compositional analysis according to NREL laboratory analytical procedures. Carbohydrate compositions were determined with ion chromatography (Dionex ICS-3000) according to SCAN CM 71:09 applying the IC-PAD analyzing route and the acid insoluble and acid soluble lignin according to TAPPI T222 om-02 and TAPPI UM 250, respectively.



## Results

Temperature	(°C)	180	190	200
ASL, ref	(%)	1.3	1.5	1.7
ASL, 2-Naphthol	(%)	1.5	1.6	3.2
AIL, ref	(%)	40.4	41.3	44.9
AIL, 2-Naphthol	(%)	41.0	43.6	46.3



\*\*Arabinose, Galactose, Mannose, Rahmnose, Xylose

## Conclusions

- A weak optimum in dissolved carbohydrates was found at 190 °C.
- 2-Naphthol addition increased the ASL and AIL contents, with a more pronounced effect at higher severities.

## Future work

- Enzymatic digestibility of the pretreated substrates.

**Andreas Averheim**  
Senior Research Engineer  
Valmet AB  
Mobile +46 70 339 84 05  
andreas.averheim@valmet.com

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