

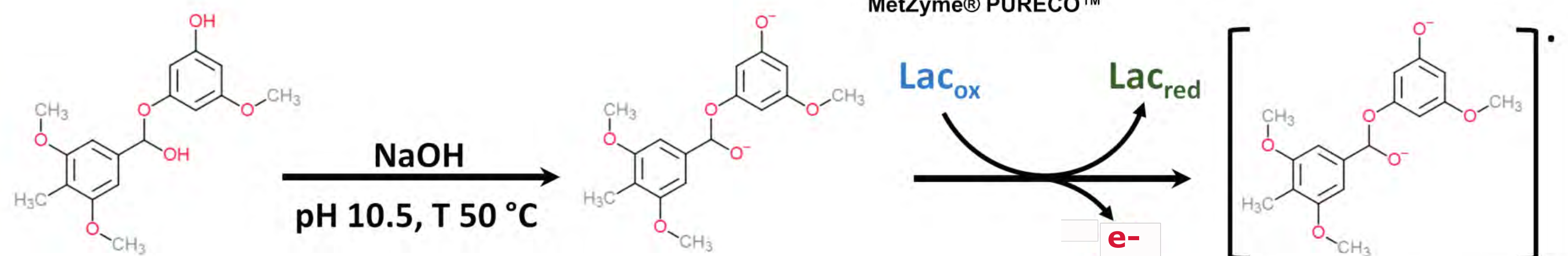
# ENZYMATIC TECHNOLOGY FOR LIGNIN VALORISATION

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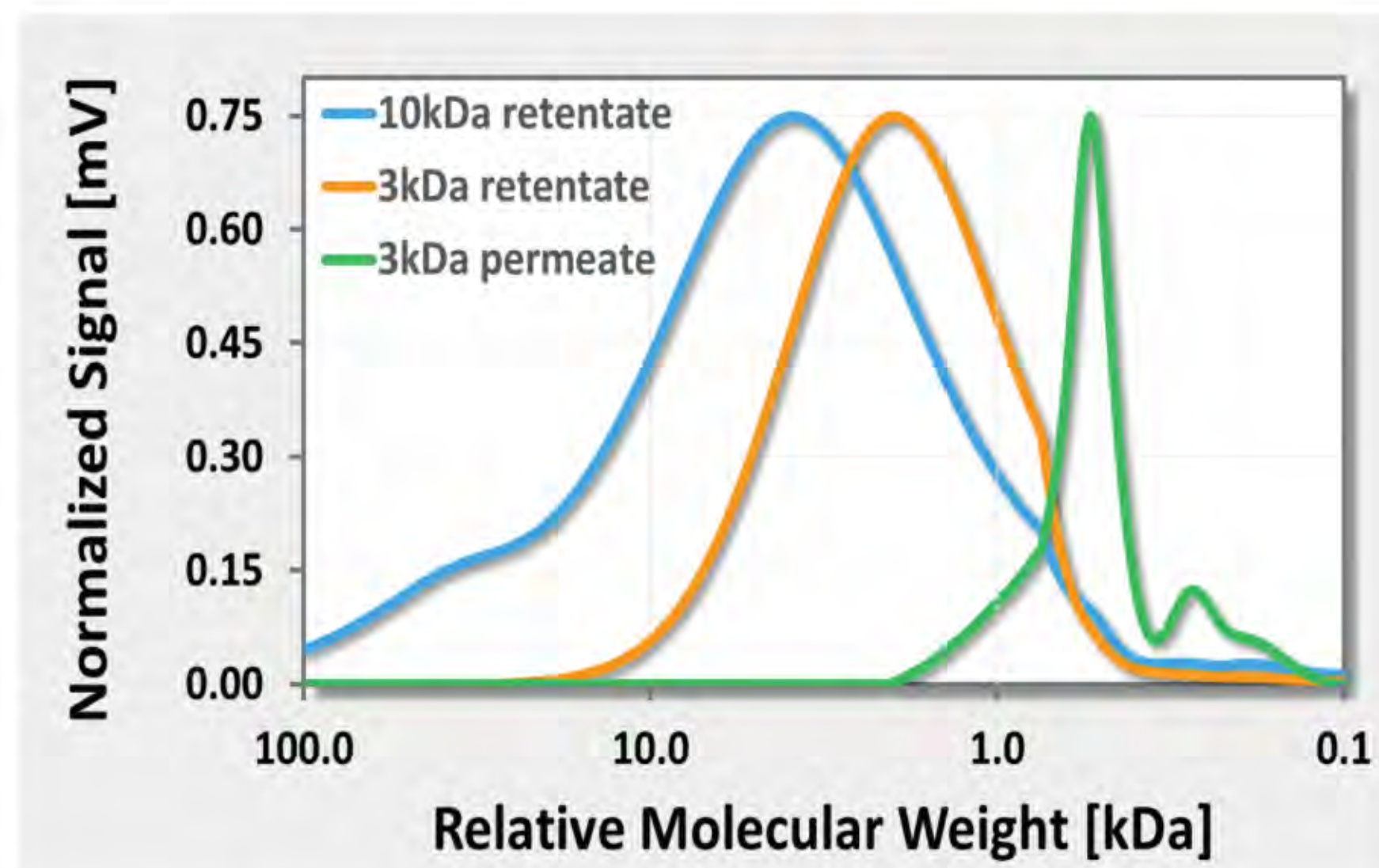
MetGen is a Finnish biotech company developing and supplying industrial enzymes and enzymatic processes. The main focus of the company is to provide enabling enzymatic solution for biomass valorisation and sustainable bio-economy. One of the latest achievements in this area is MetGen's enzyme MetZyme® PURECO™ - an extremely alkaline and thermostable laccase (polyphenol oxidase).



MetZyme® PURECO™ function in a high pH (up to 11) enables more efficient and more specific oxidation of lignin, generating highly active lignin fractions and leading to fractionation, demethylation and functionalization.

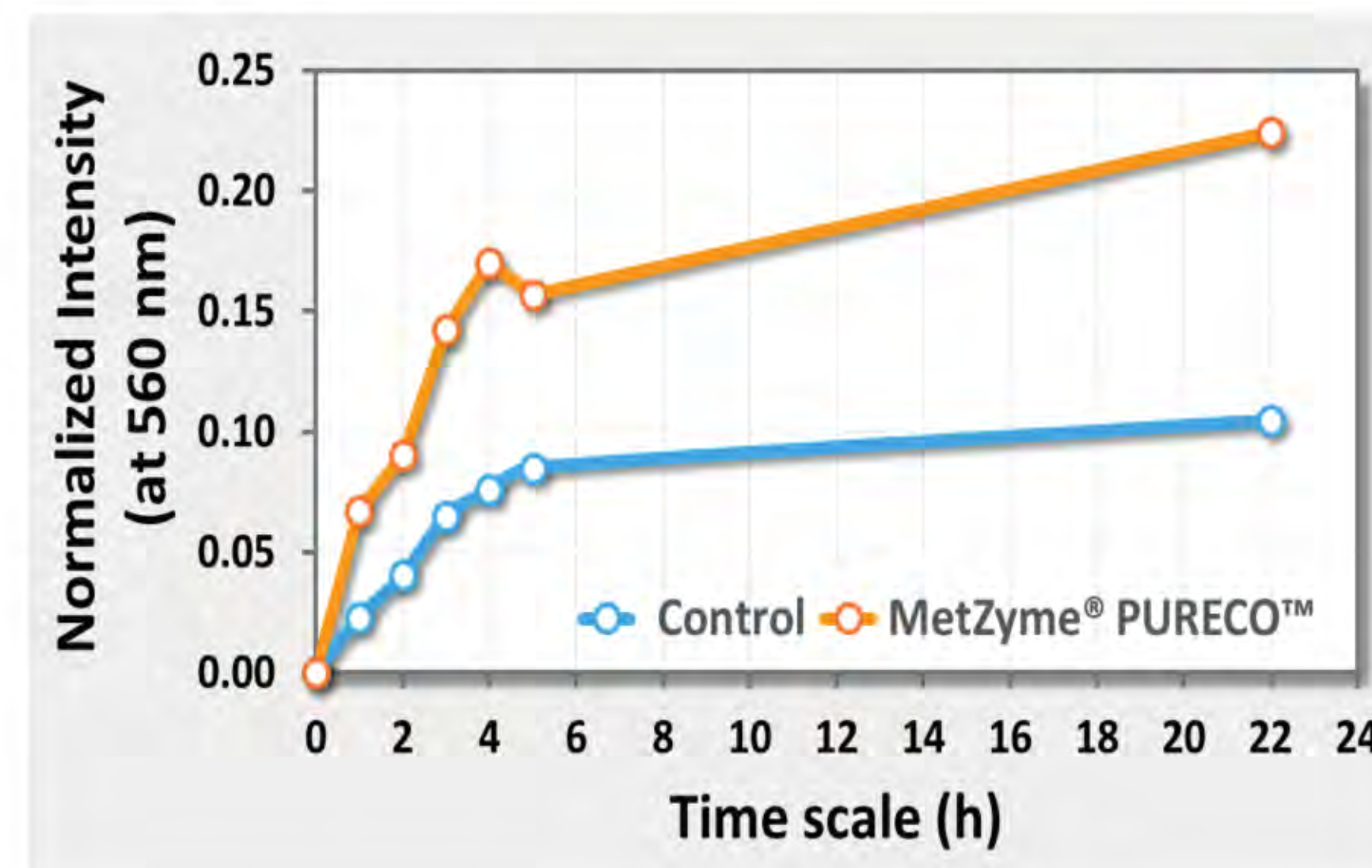


## FRACTIONATION



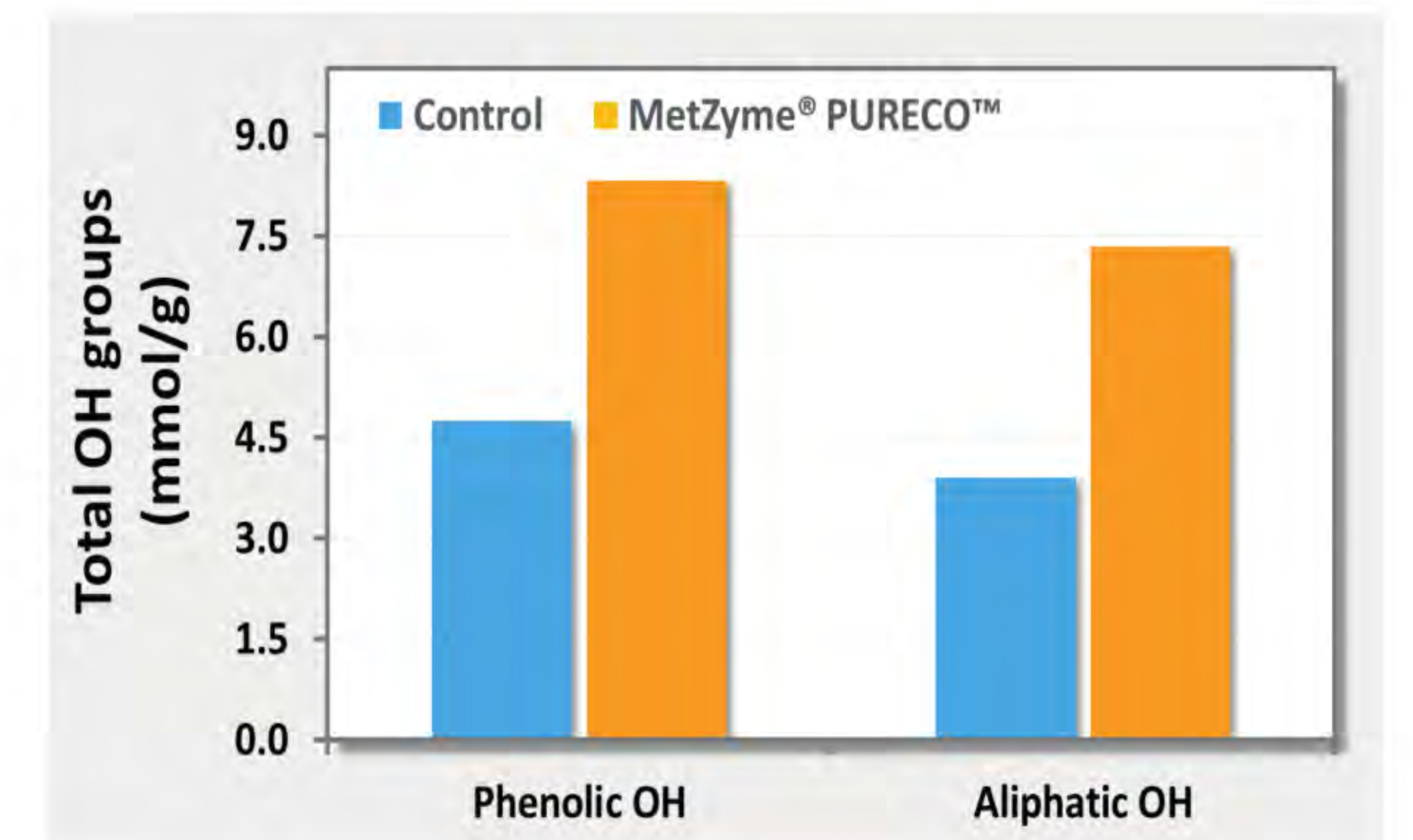
SEC/GPC chromatographs (normalized) showing the different lignin size fraction collected with membrane operations after the application of MetZyme® PURECO™ on the studied lignin.

## DEMETHYLATION



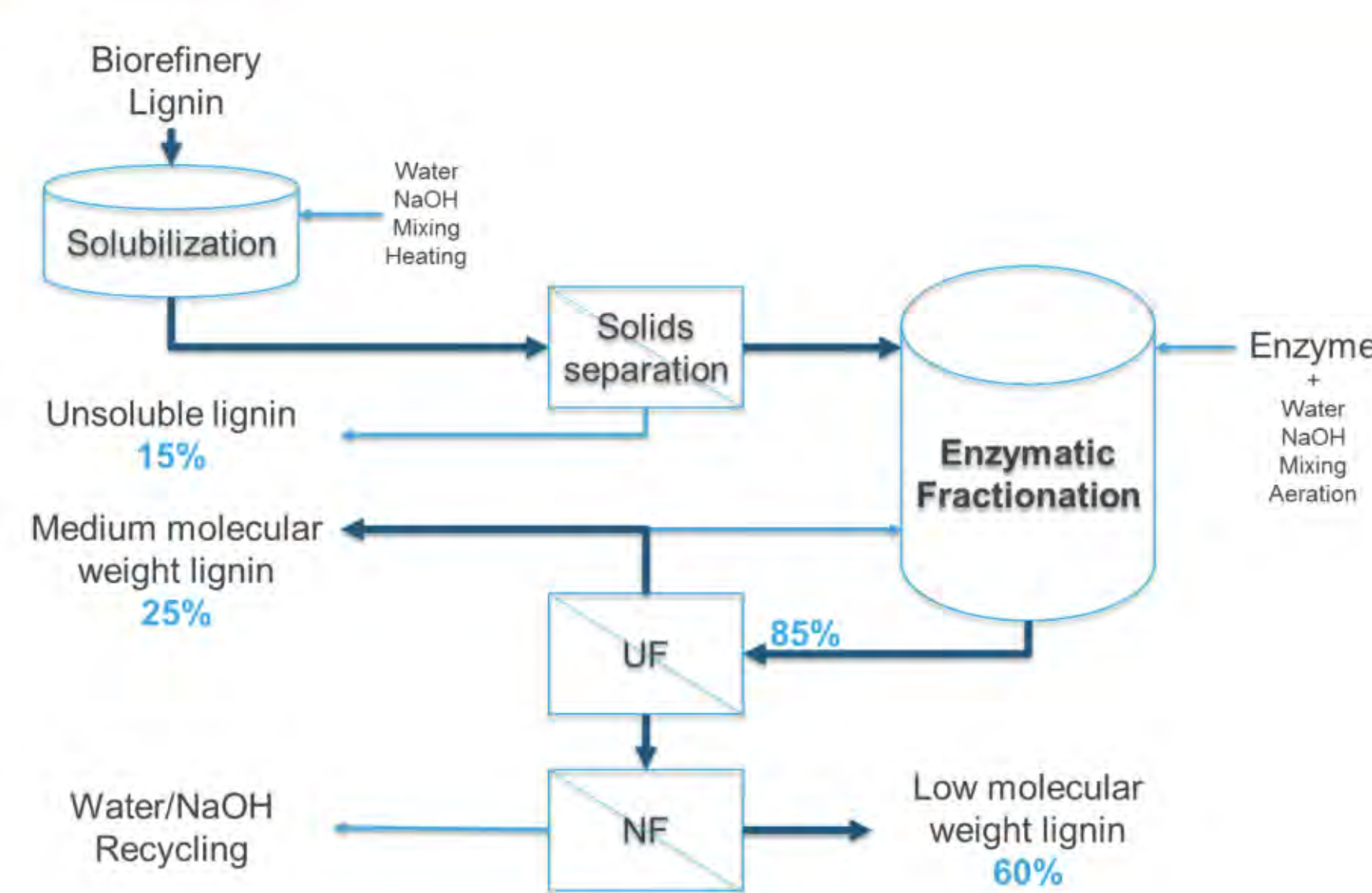
Purpald assay shows a significant increase (>110%) in the release of MeOH during the application of MetZyme® PURECO™, indicating enhanced enzyme assisted demethylation of the tested lignin.

## ACTIVATION



<sup>13</sup>P NMR measurements show clear increase (>75%) in the amount phenolic and aliphatic OH groups after the application of MetZyme® PURECO™ on the studied lignin. Analysis provided by Prof. N. Labbé et al. Department of Forestry, University of Tennessee, USA.

## CONTINUOUS MEMBRANE OPERATIONS FOR LIGNIN FRACTIONATION



Process flow schematics for a continuous membrane fractionation.

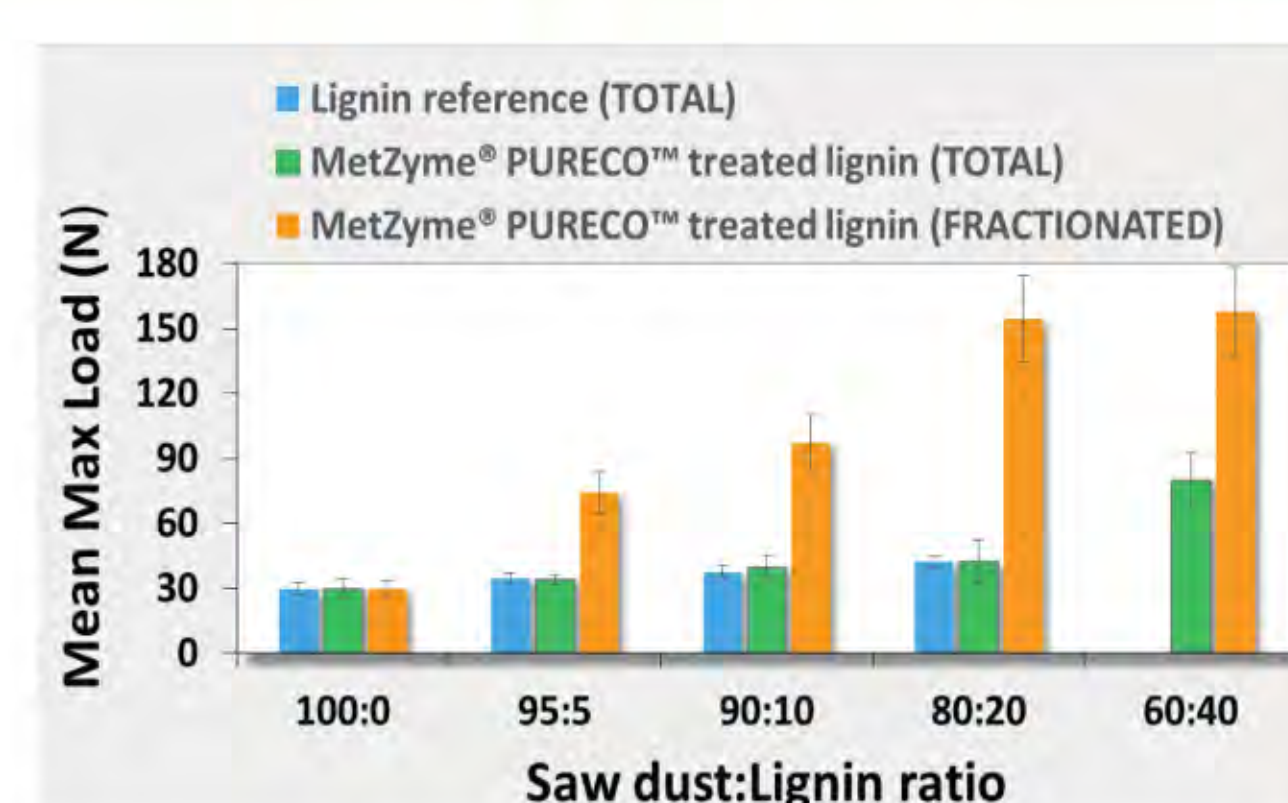
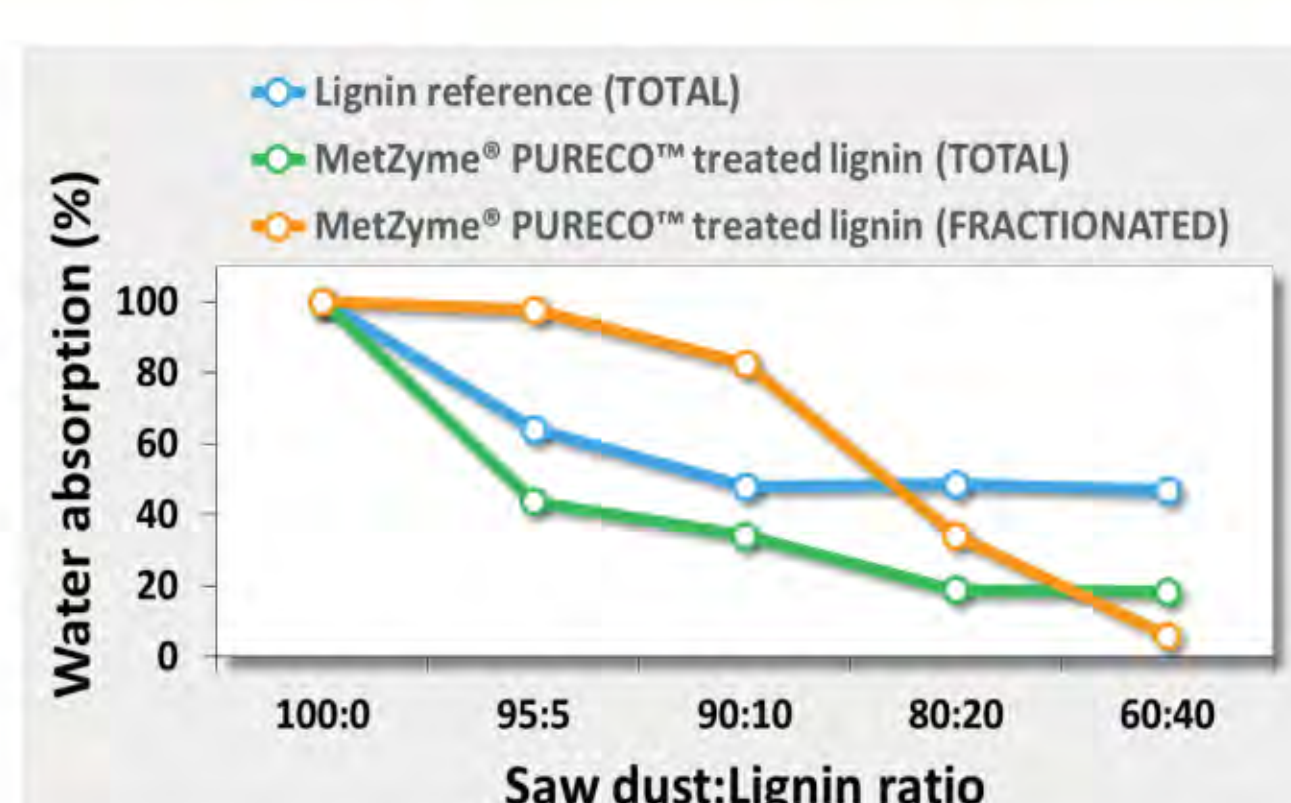
LIGNIN MOLECULAR SIZE BY FRACTION			
Lignin fraction	Mn	Mw	PDI
Alkaline soluble lignin	0.9 kDa	3.6 kDa	4.1
MetZyme® PURECO™ treated lignin, 10 kDa cut-off retentate	1.5 kDa	6.8 kDa	4.4
MetZyme® PURECO™ treated lignin, 3 kDa cut-off retentate	1.2 kDa	2.3 kDa	1.8
MetZyme® PURECO™ treated lignin, 3 kDa cut-off permeate	0.5 kDa	0.6 kDa	1.2

Characteristics of different fractions collected using different membrane cut-offs.

METGEN	Molecular Weight	Reactivity & Solubility	Application	Bio-Equivalent of	Price
Currently available lignin	5-100 kDa	Poor	Burning	Oil / Electricity	50 - 150 €/ton
MetZyme® PURECO™ treated Dissolved lignin	3-50 kDa	Medium	Resins & Adhesives	Formaldehyde	400 - 500 €/ton
MetZyme® PURECO™ treated depolymerized lignin	0.3-2 kDa	Good	Foams & Composites	PVA	1000 - 1500 €/ton
MetZyme® PURECO™ treated depolymerized fractions	0.3 kDa, 0.5 kDa, 0.7 kDa, ... 2 kDa	Very Good	New materials	Specialty Chemicals & Polymers	> 1500 €/ton

Higher value application areas of different lignin fractions, assessed by MetGen.

## A CASE STUDY – LIGNIN AS AN ADHESIVE IN MDF APPLICATION



MetZyme® PURECO™ treated lignin show enhanced properties as an adhesive in the manufacture of medium-density fibreboards (MDF). Using MetZyme® PURECO™ activated lignin clearly improved water retention and maximum load, mean stress and mean flexural modulus (three-point bending test). MDF board was formed by hot pressing at temperature of 200 °C for 5 minutes using a 100 cm<sup>2</sup> mold. Sample preparation and measurements provided by Prof. M. Toivakka et al., Laboratory of Paper Coating and Converting, Åbo Akademi University, Finland.

## ACKNOWLEDGEMENTS

Following EU H2020/BBI JU projects utilizing MetGen's MetZyme® PURECO™ technology for lignin valorization are acknowledged:



RIA projects (792070, 720918, 792004) with several different lignin applications, including MDF, insulating material, bitum, foams, marine fuel, octane boosters



Flagship project (792061) – MetGen's role focusing on industrialisation and commercialisation of MetZyme® PURECO™

