III International Scientific Conference "**Sustainable and efficient use of energy, water and natural resources – SEWAN-2021**"

Improving the water resistance of phenol-formaldehyde resin using biophenols obtained from liquid pyrolysis products of wood waste

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Title

Improving the water resistance of phenol-formaldehyde resin using biophenols obtained from liquid pyrolysis products of wood waste

Keywords: Phenol-formaldehyde resin . Resol resin . Wood pyrolysis . Pyrolysis liquid . Bio-oil . Phenol substitution .Biophenol . Water resistance coefficient

According to some researchers, about 35.5 million m3 of wood waste is generated annually in the Russian Federation.

These waste lignocellulosic biomass can serve as a source of energy and chemical components.

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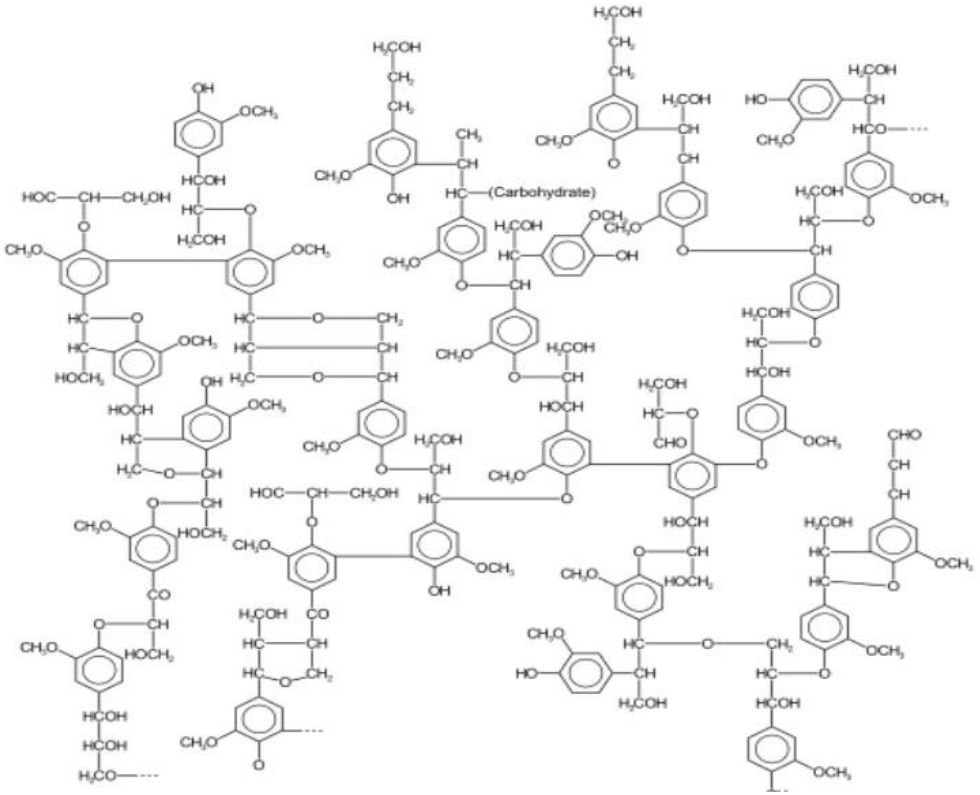
Phenol in plants

An example of a possible structure of lignin



Phenolic compounds are produced by plants and microorganisms, and during growth they accumulate in cell vacuoles or polymerize into lignin.

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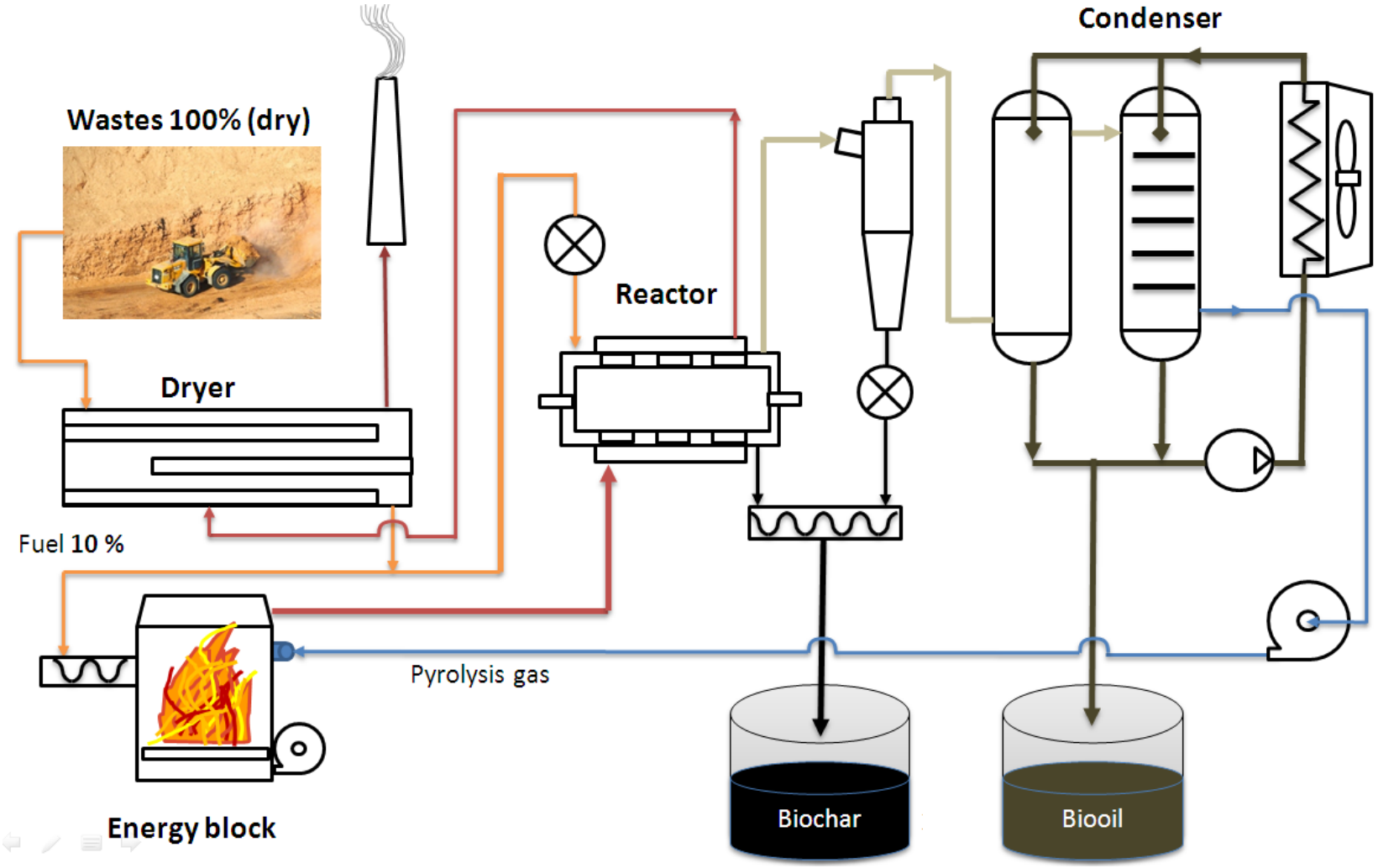
Fast ablative pyrolysis



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Yield of pyrolysis products at the FPP02 production complex, %	
1. Charcoal	22
2. Pyrolysis liquid	56
3. Gas	22

1

2

3

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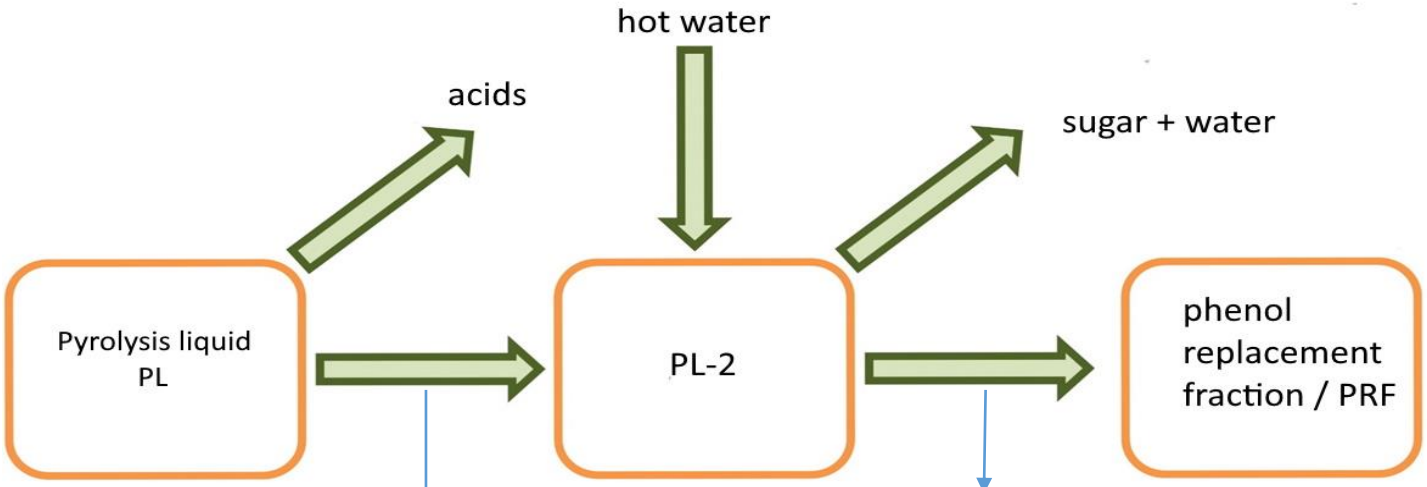
Separation of the phenol-substituting fraction



distillation

water extraction

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Yield of fractionation products (PL-2, PRF) from the pyrolysis liquid

Yield, %	Pyrolysis liquid (100%)
Condensate obtained during distillation	55,08
PL-2	40,43
PRF	14,77

Yield of the phenol replacement fraction (PRF) from dry wood

Yield, %	Weight of absolutely dry wood (100%)
PRF	8,27

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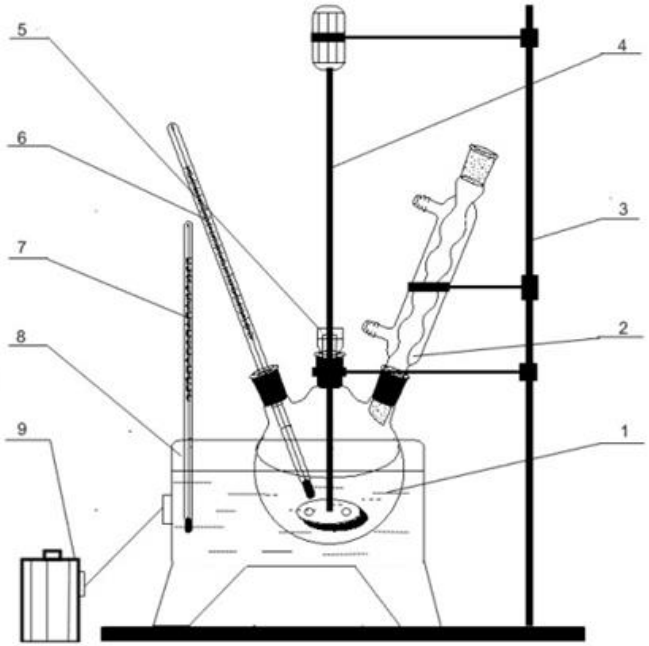
Laboratory plant for the synthesis of phenol-formaldehyde resins:

photo

scheme



1 - three-necked flask; 2 - reflux condenser; 3 - tripod; 4 - mechanical mixer; 5 - shutter; 6.7 - thermometer; 8 - water bath; 9 - thermostat

Resin with PRF

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	Modified resin with	Control resin without
color		
smell	Distinct smoke odor characteristic of pyrolysis liquid	Weak, sweet taste
consistency	Heterogeneous with small inclusions	Homogeneous

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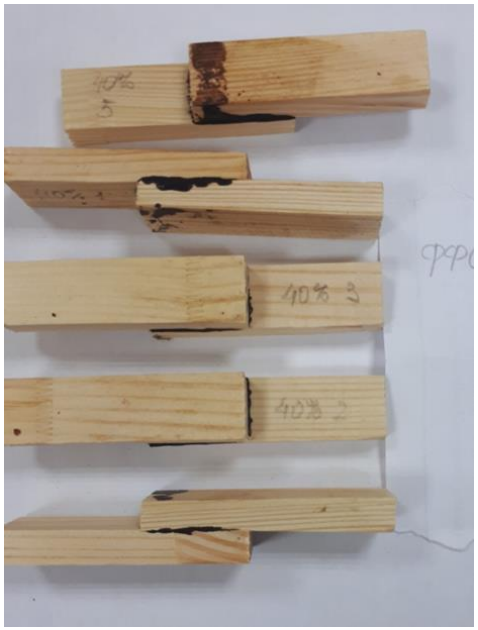
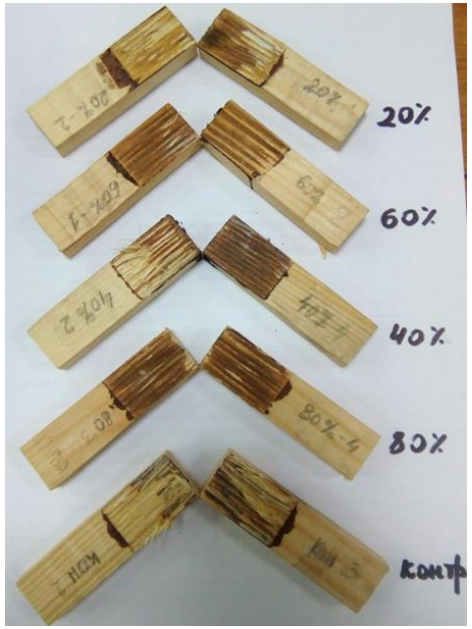
Samples for testing shear strength



Before the break



After the break

Title

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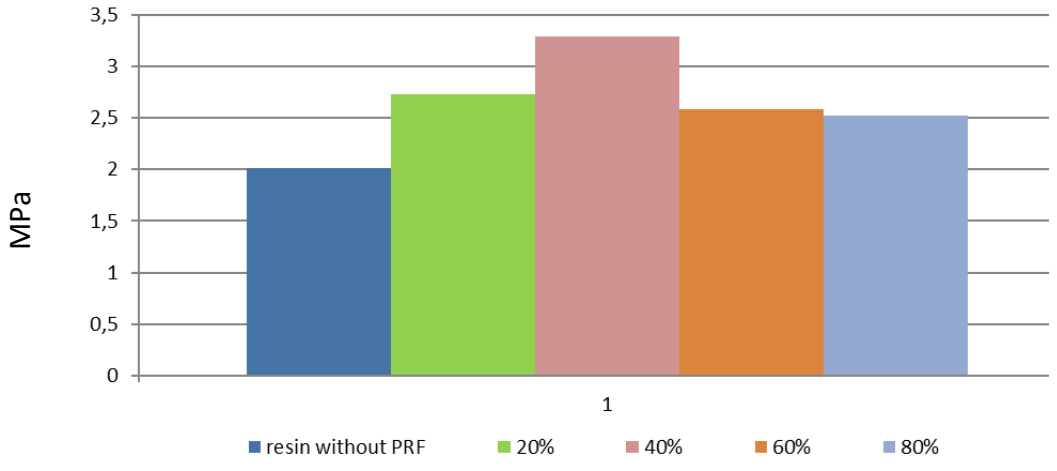
Keywords: Phenol-formaldehyde resin . Resol resin . Wood pyrolysis . Pyrolysis liquid . Bio-oil . Phenol substitution .Biophenol . Water resistance coefficient

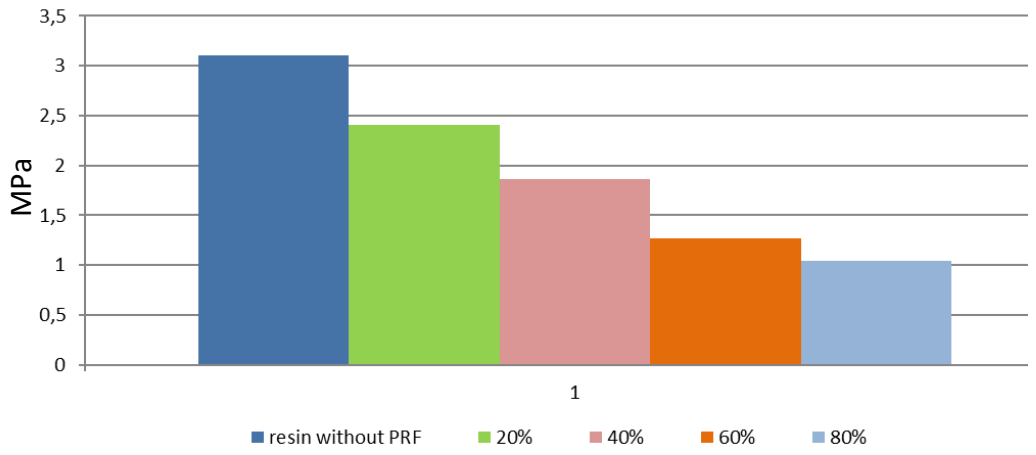
Dependence of the resin strength on the degree of substitution of phenol with pyrolysis liquid

before boiling



Percentage of substitution of synthetic phenol by phenol replacement fraction (PRF)

after boiling



Percentage of substitution of synthetic phenol by phenol replacement fraction (PRF)

The ultimate strength when chipping on the adhesive layer according to the state standard 20907-2016 is not less than 1.47 MPa

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Treatment of modified resin with PRF solvents

Two solvents were used for extraction: benzene and n-hexane

Stirring for 1 hour

Settling in the dividing funnel for 3 hours

benzene

hexane

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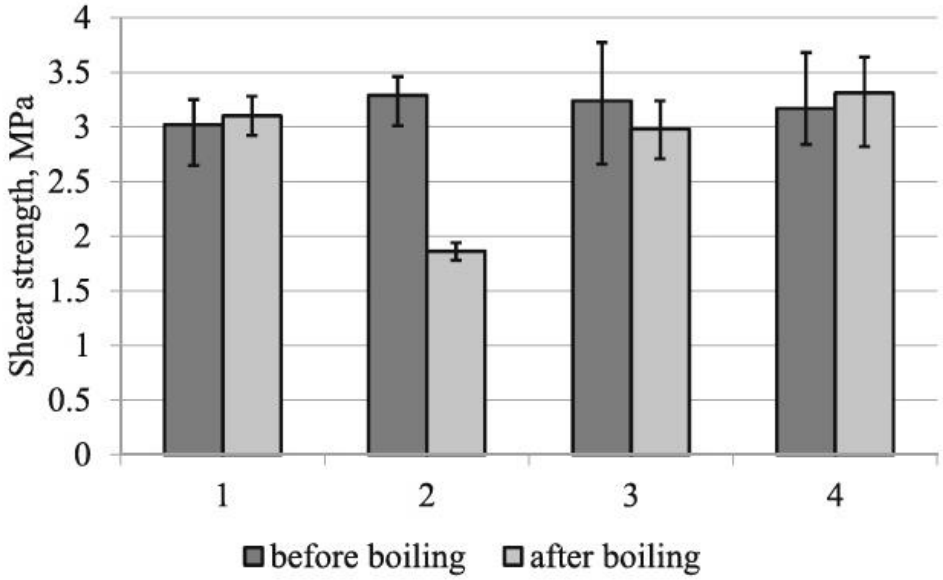
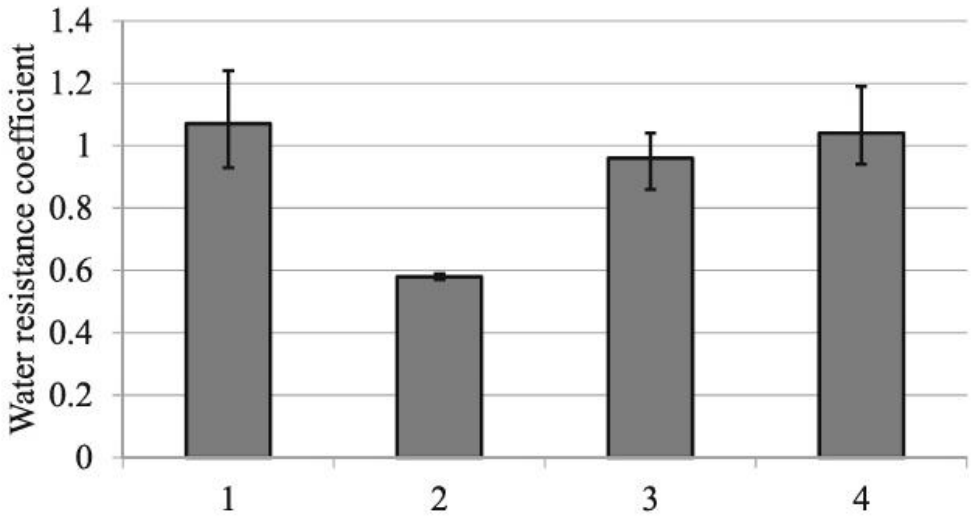
Shear strength before and after boiling and water resistance coefficients





1-control resin without PRF, 2-resin modified with PRF, 3- resin with PRF and cleaned with benzene, 4-resin with PRF and cleaned with hexane

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Conclusions

- The results of the study indicate a significant influence of neutral substances in the composition of liquid products of rapid pyrolysis on the quality indicators of the resol phenol-formaldehyde resin.
- The release of neutral substances increased the water resistance coefficient for the resin with PRF purified hexane to 0.91 MPa, for the resin purified with benzene to 1.04 MPa.
- Benzene as an organic solvent copes more efficiently, the mass content of substances dissolved in benzene is 3.2%, in hexane 2.5%. The strength values of the resin purified with benzene remain stable before and after boiling (3.17 MPa before boiling, 3.31 MPa after boiling), and the water resistance coefficient is comparable to the water resistance coefficients of the control sample.

References

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3 - Zabelkin S., Valeeva A., Sabirzyanova A. et al. // Biomass Conversion and Biorefinery. 2020. DOI: 10.1007/s13399-020-01025-0

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Thank you for your attention!

Authors: **Valeeva A.R., Valiullina A. I., Grachev A.N., Zabelkin S.A., Bikbulatova G.M.**

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