



Production of bio-oil from forest residue

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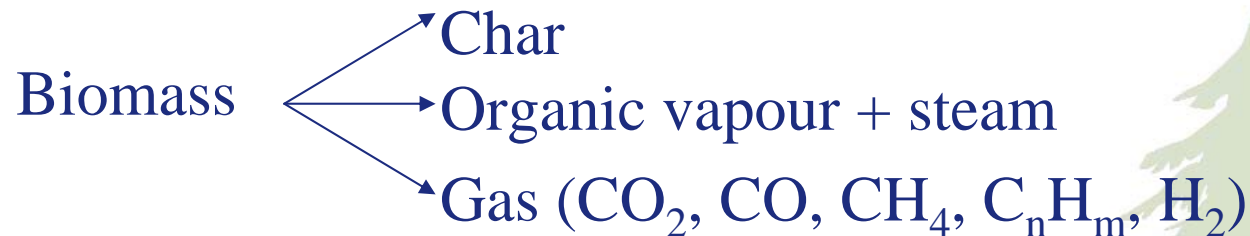
•VTT



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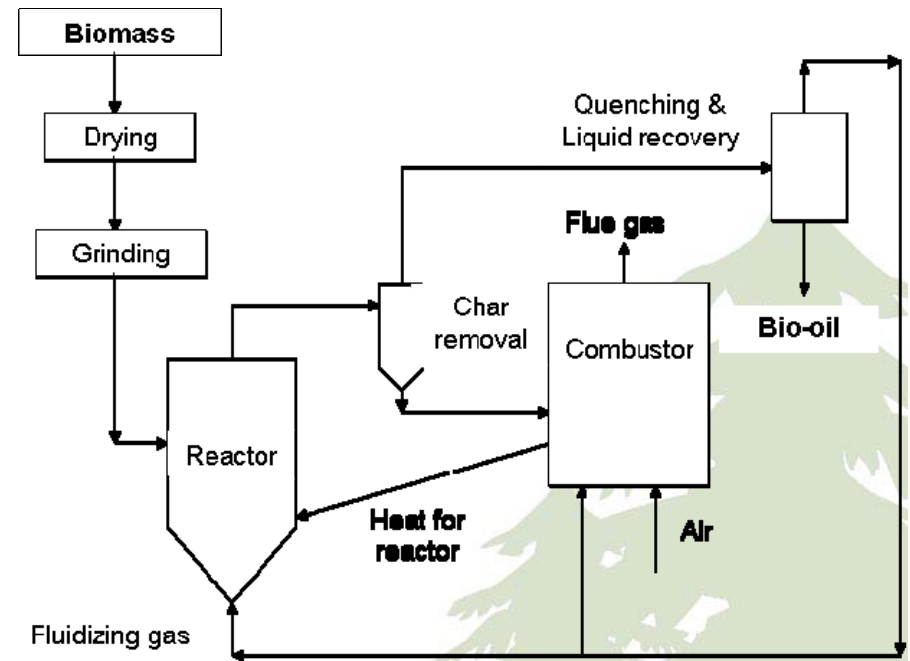
- Fast pyrolysis
- Forest residue as a feedstock in fast pyrolysis
- Composition and behaviour of bio-oil from forest residue
- Bio-oil properties from forest residue
- Quality improvement of bio-oil
- Conclusions

- Fast pyrolysis is a low cost and high efficiency process to produce liquid fuels from biomass.
- During fast pyrolysis the biomass is heated up rapidly to around 500 °C in the absence of oxygen.



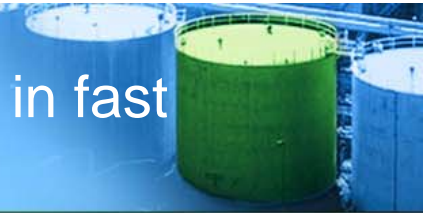
•The highest liquid yield is obtained with

- Dry feedstock moisture below 10 wt- %
- Small particle size of the raw material typically 2-6 mm in fluidized bed reactors
- Moderate temperature (500 °C)
- Short residence time (0,5 - 2 s) at moderate temperature
- Rapid quenching of the liquid products

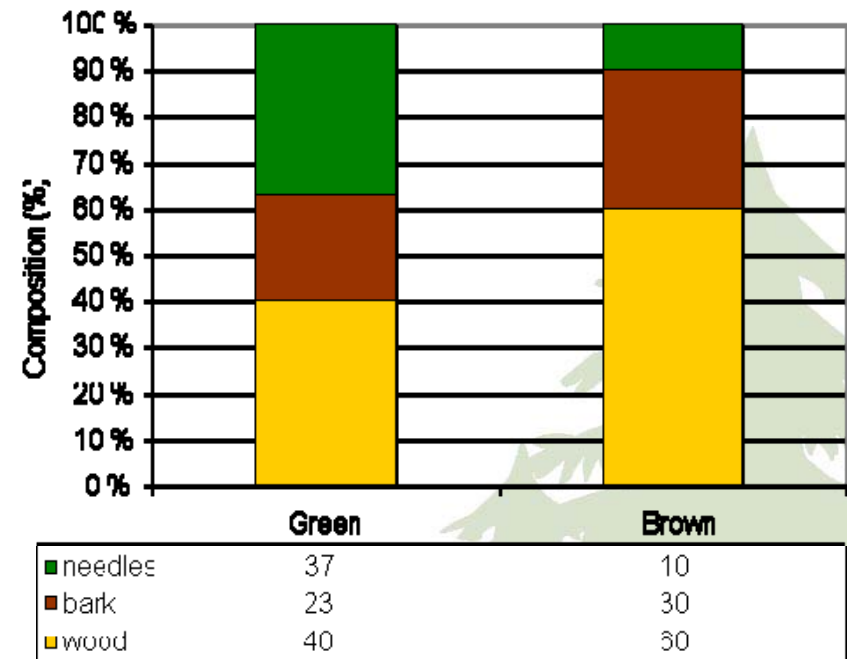


- Forest residue is the most potential raw material for fast pyrolysis in Finland
- The chemical composition of forest residue is very dependent on
 - wood species
 - amount of branches, tree tops and stumps
 - extent of decay

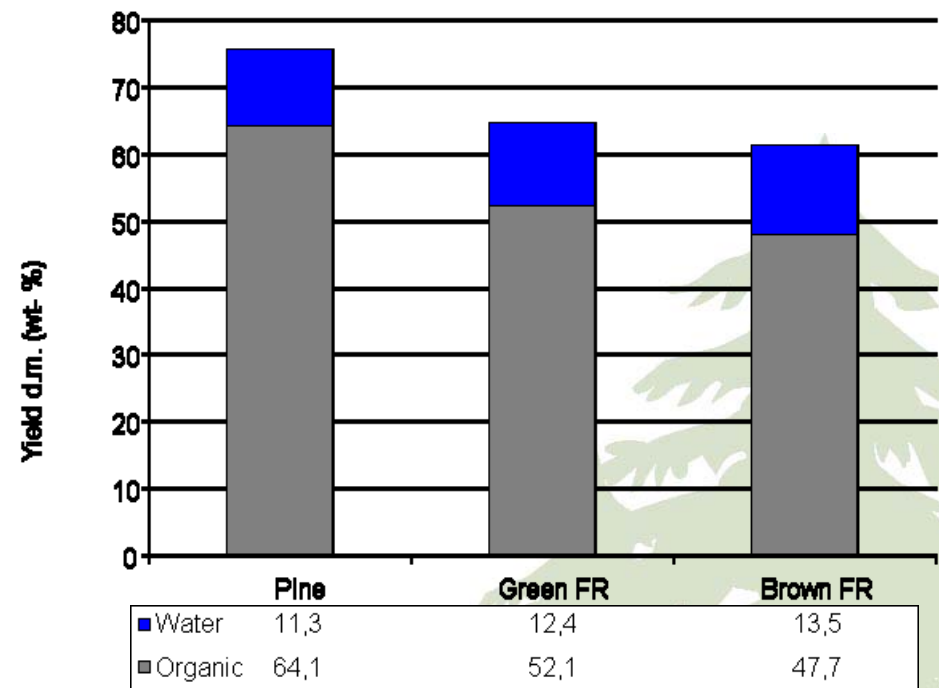
	Unit	Pine stem wood	Spruce needles	Spruce bark
Ash, d.m	wt- %	0,2	6,65	2,3
Carbon, d.m.	wt- %	50,3	48,4	49,9
Hydrogen, d.m.	wt- %	6,0	6,1	5,9
Nitrogen, d.m.	wt- %	<0,1	0,6	0,4
Oxygen, d.m.	wt- %	43,5	38,3	41,4
Extractives, d.m.	wt- %	5,9	20,3	21-24



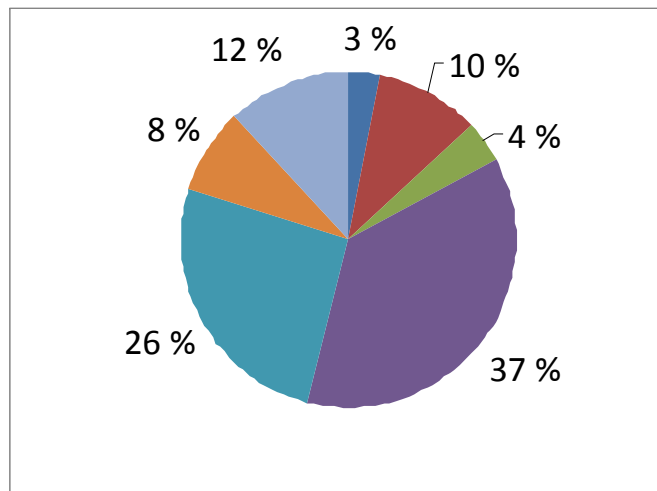
- Forest residue can be harvested either as
 - green (moisture about 55 wt- %) with needles
 - brown (moisture about 35 wt- %) after seasoning



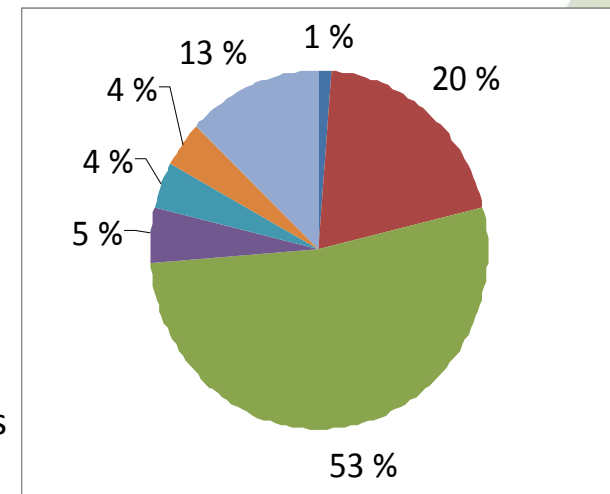
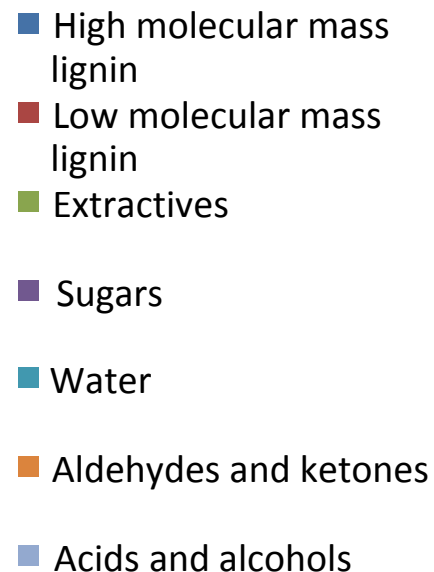
- The organic liquid yield is lower for forest residue than for bark free wood.
- Forest residue liquid separates spontaneously after condensation to polar fluid bottom phase and a hydrophobic viscous top phase.
- The amount of top phase is typically 10-20 wt- % depending on the feedstock.



- Forest residue bottom phase is similar to bio-oil recovered from bark free wood
- Top phase differs significantly from the bark free wood due to the high amount of extractives



Bottom phase
(80-90 %)



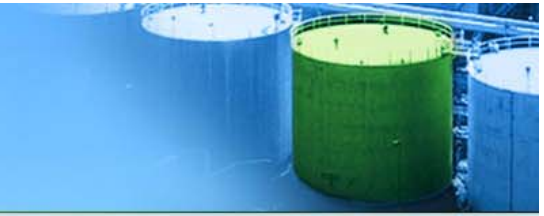
Top phase
(10-20 %)

- Contains 45-50 wt- % oxygen
- Contains 20-30 wt- % water
- Low heating value (40-45 % of mineral oil)
- Low pH (2-3)
- Contain a lot of different compounds
- Non homogeneous liquid
- Unstable during first 6 months of storage



- The quality of bio-oil can be improved already in the pyrolysis process by removing water and low molecular weight compounds from the oil during the liquid recovery.
- These compounds are believed to contribute to the instability of bio-oil.
- The removal of these compounds can be done by raising the temperature of the condensers and then evaporate the light compounds out of the liquid

- The composition of bio-oil formed during fast pyrolysis is very dependent on the quality of the raw material
- The quality of bio-oil has to be improved before it can be used as a traffic fuel or combusted in boilers
- The quality of the bio-oil can be improved by
 - modification of the harvesting process of forest residue
 - improving the pyrolysis process and liquid recovery system (removing solids and fractionation of compound groups in recovery)
 - upgrading the bio-oil after pyrolysis



Thank you for your attention!

