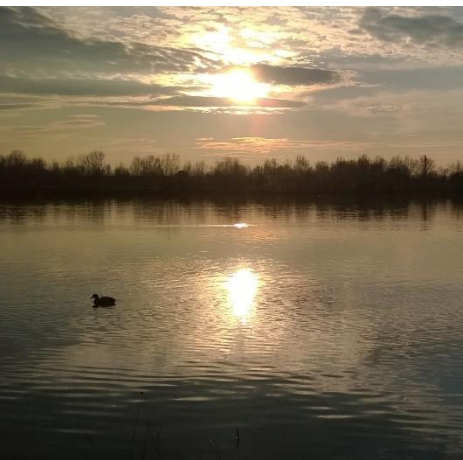


TERMOCONVERSIONE DEI RESIDUI FLUVIALI: GASSIFICAZIONE DELLA FRAZIONE LEGNOSA

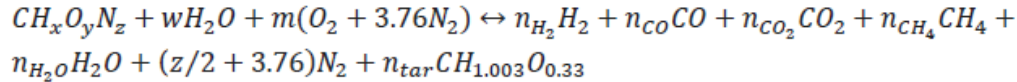
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REBAF: WP2 – Gasification modeling

- Modeling of gasification reaction on a small scale gasifier APL PP20



$$\left\{ \begin{array}{l} n_{CO} + n_{CO_2} + n_{CH_4} + n_{tar} = n_{C_{bio}} = 1 \\ 2n_{H_2} + 2n_{H_2O} + 4n_{CH_4} + 1.033n_{tar} = x + 2y \\ n_{CO} + 2n_{CO_2} + n_{H_2O} + 0.33n_{tar} = w + 2m + y \\ K_1 = \frac{n_{CO_2}n_{H_2}}{n_{CO}n_{H_2O}} \\ K_2 = \frac{n_{CH_4}n_{tot,syngas}}{(n_{H_2})^2} \\ K_3 = \frac{n_{CO}(n_{H_2})^3}{n_{CH_4}n_{H_2O}(n_{tot,syngas})^2} \end{array} \right.$$



REBAF: WP2 – Gasification modeling

- Considering a biomass drying to **10%** of moisture, from one hectare of riverbanks maintenance made every 3 years it is possible to obtain about **27.8 tons** of wood chips.
- This biomass can be used to produce about **23 MWh** of electrical power and **31 MWh** of thermal power.
- Considering a **biochar of 5%** in weight, about **1.4 tons** of biochar is disposed from the char vessel of the plant.

REBAF: WP2 – Gasification experimental

**Biomass sample from Boschiva F.lli Valentini
(about 250 kg at 35% of moisture)**

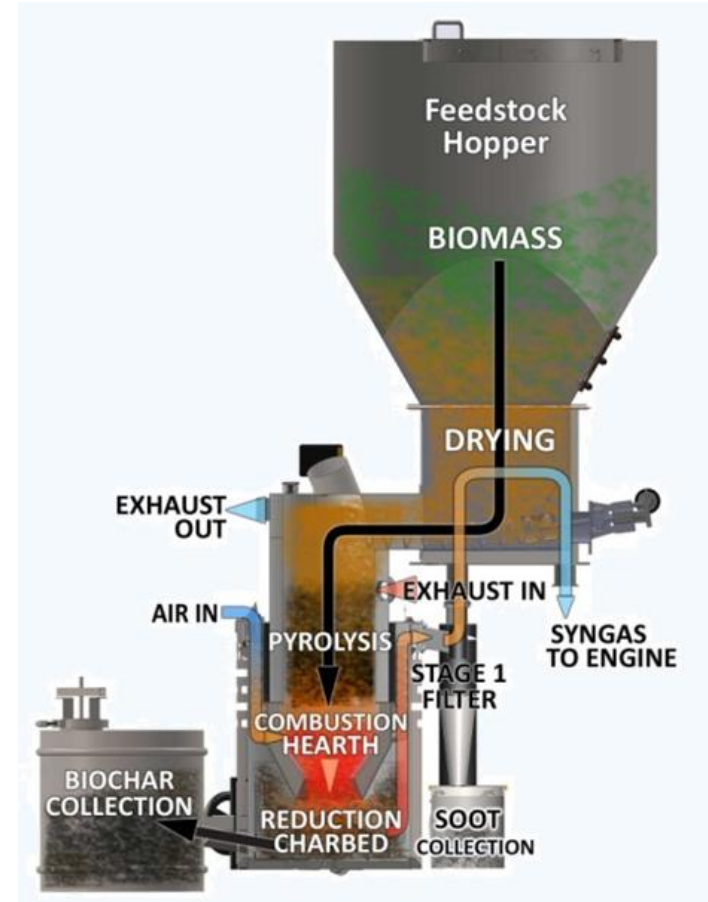


Biomass analysis (dry)

Variable	Value
Carbon content C [wt.]	46.58
Hydrogen content H [wt.]	5.99
Sulphur content S [wt.]	0
Oxygen content O [wt.]	45.31
Nitrogen content N [wt.]	0.22
Ash content ASH [wt.]	1.9
Higher heating value HHV [MJ/kg]	18.59

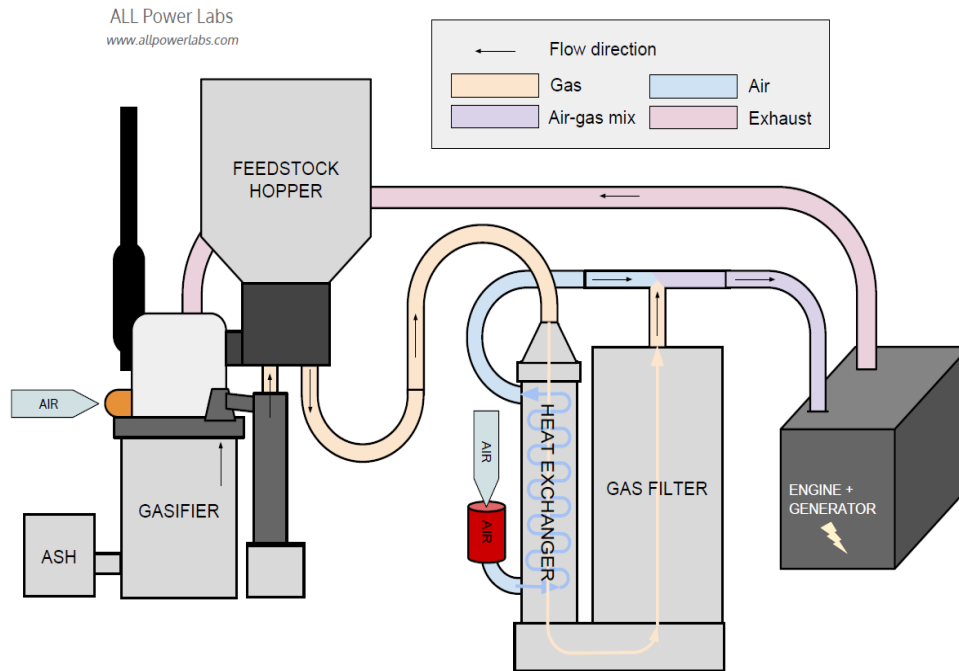
REBAF: WP2 – Gasification experimental

Testing facility: All Power Labs PP20 CHP



REBAF: WP2 – Gasification experimental

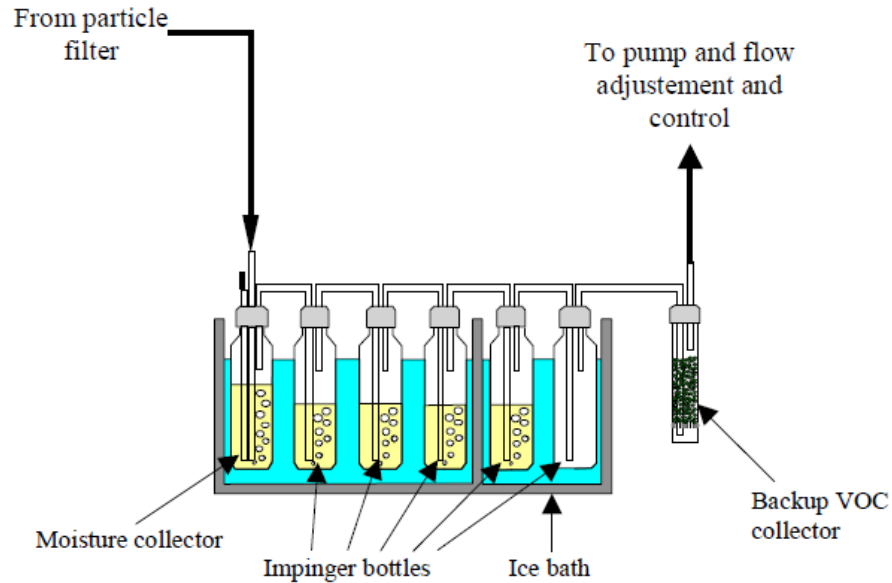
Testing facility: All Power Labs PP20



Continuous electrical power rating	15 kW _{el} @50 Hz
Continuous thermal power rating	20 kW _{th} at 15 kW _{el}
Biomass P16 W10 consumption	1.2 kg/ kW _{el}
Biomass moisture content	5-30% dry basis
Electrical efficiency with P16 W10	18.5 %
Thermal efficiency with P16 W10	24.6 %
Installed foot print	1.36 x 1.36 m
Run time with hopper fill	3 hours at 15 kW _{el}

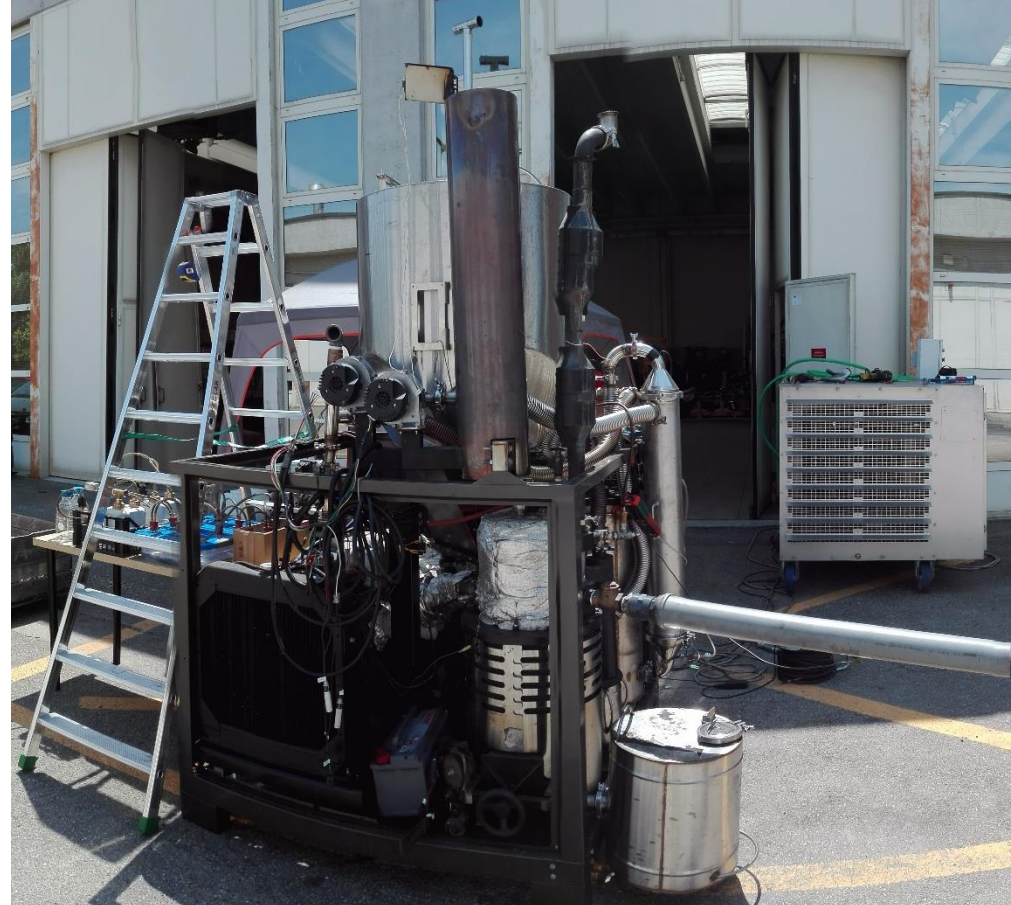
REBAF: WP2 – Gasification experimental

Testing facility: Tar Sampling Protocol CEN/TS 15439

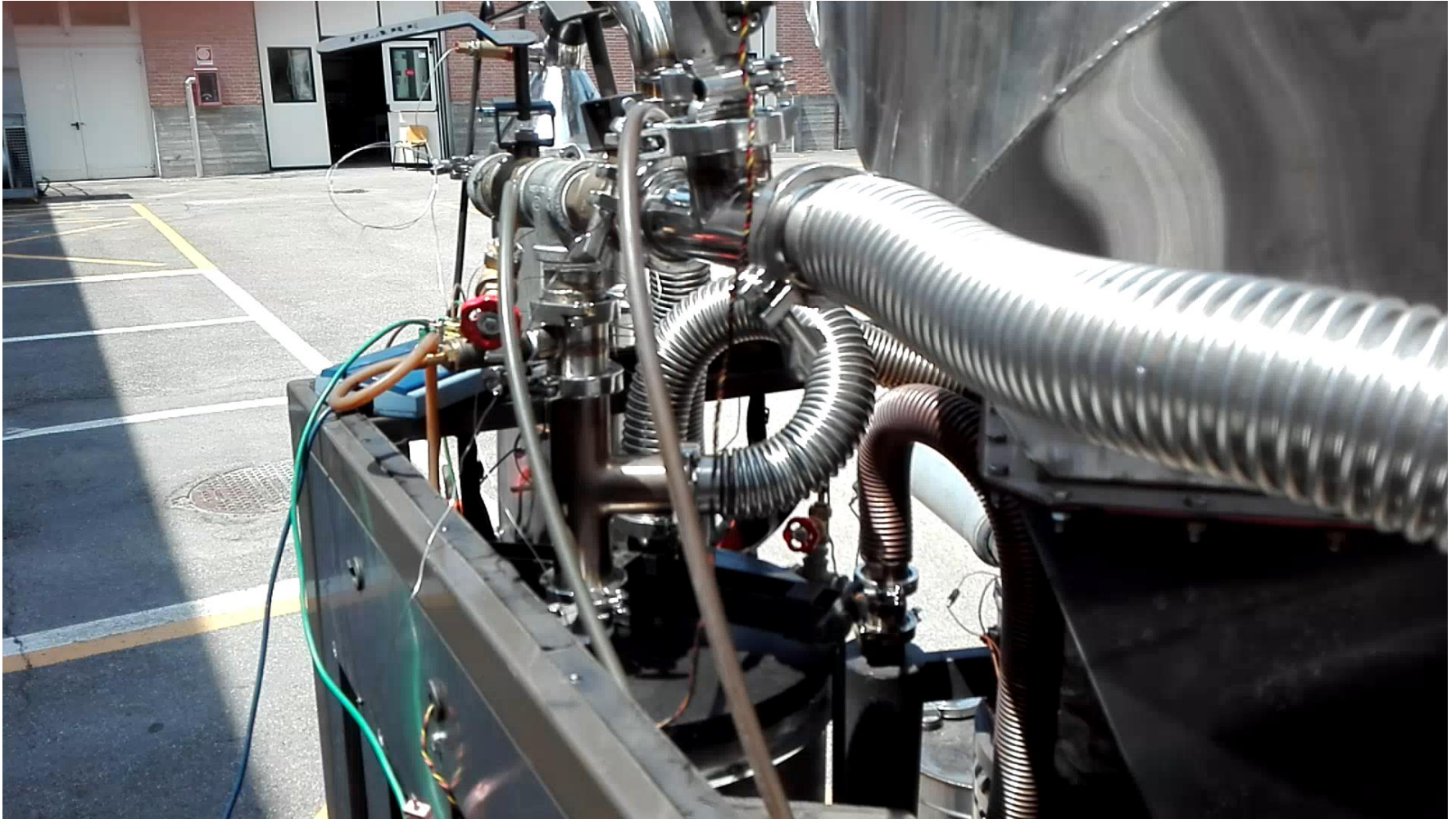


REBAF: WP2 – Gasification experimental

Testing facility



REBAF: WP2 – Gasification experimental



REBAF: WP2 – Gasification experimental

Results: energy balance, efficiencies, syngas composition

Variable	Value
Test date	11/07/2017
Machine	PP20 1061
Biomass moisture [%]	8.6
Test lenght [h]	1.66
Electrical power output [kW]	12
Thermal power output [kW]	16.5
Biomass consumption [kg/h]	15.60 k
Electrical efficiency [%]	15.93
Thermal efficiency [%]	21.90
Biomass specific consumption [kg/kWh]	1.3

Variable	Value
Syngas H ₂ content [% mol]	20.50
Syngas CO content [% mol]	23.67
Syngas N ₂ content [% mol]	37.44
Syngas CO ₂ content [% mol]	10.24
Syngas CH ₄ content [% mol]	1.96
Others (water+light tar) [% mol]	6.18
Syngas HHV [MJ/Nm ³]	6.38
Syngas Vol. flow [Nm ³ /h]	34.77
Gasifier efficiency [%]	79.76
Generator efficiency [%]	83.4
Engine efficiency [%]	23.95

REBAF: WP2 – Gasification experimental

Results: tar and particulate numbers

(literature limits: tar < 0.1 g/Nm³; particulate < 0.05 g/Nm³)

Test date	20/06/2017
Machine	PP20 1008
Syngas volume post-cyclone [l]	520
Syngas volume post-filter [l]	366
Tar post-cyclone [g/Nm ³] (gravimetric)	0.312
Tar post-filter [g/Nm ³] (gravimetric)	0.186
Particulate post-cyclone [g/Nm ³]	0.533
Particulate post-filter [g/Nm ³]	1.53

Test date	23/06/2017
Machine	PP20 1008
Syngas volume post-cyclone [l]	731
Syngas volume post-filter [l]	372
Tar post-cyclone [g/Nm ³] (gravimetric)	0.129
Tar post-filter [g/Nm ³] (gravimetric)	0.719
Particulate post-cyclone [g/Nm ³]	0.131
Particulate post-filter [g/Nm ³]	0

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