

Bioenergy 2020: A novel woodchip-gasification process for clean syngas feeding of dual-fuel diesel gensets

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Starting from 2011, the innovative SME Tecnoforest Ltd. (formerly a tutorial spin-off of the University of Genoa) has addressed its activity towards the testing of existing, and therefore the development of latest, small-scale woodchip gasification technologies aimed toward assuring electric and thermal self-sufficiency to rural enterprises of the forestry and farming sectors (www.tecnoforest.wordpress.com). On the opposite hand, the high pollutants content of their products (syngas and biochar), common to both downdraft and updraft gasifiers, has become apparent because the main obstacle preventing, in absence of hardly affordable abatement provisions, a widespread penetration in both the agricultural and renewable-energy sectors. because of the novel 'batch' gasification process recently developed at Tecnoforest Ltd., a tar-free syngas is released from gasifier's top nozzle, whilst a solid residue made from a highly clean biochar is produced at rock bottom, in the least suitable, as attested by official certification, for both agronomic and other, quite diversified, applications. The said process takes place, in batch modality, within a reactor provided by tilting capability so to permit discharging the recent biochar at the top of the method, after which a replacement 'gasification cycle' can immediately restart. Details are given in refs. [6,7]. The name of the biochar-producing gasifier is SynChar: it's available for online purchase at website [8]. The same basic process, which in SynChar relies on natural convection, are often converted to forced-air continuous operation by providing the reactor with a bottom airblower also as a side-mounted woodchip feeder, i.e. a hopper-auger motorized unit. During this case, the tar-free syngas are often fed to a water-heater burner or conveyed to an air unit-heater. Most suited applications would be for greenhouse heating, maybe even with the distinct advantage of allowing to induce carbonic fertilization of the ambient-air, to be, of course, limited to sunshine hours. If the woodchips' dimensions are kept within the range of 1 to three cm and their humidity content doesn't exceed 25%, the gasification process seems quite efficient, as attested by a remarkably low solid residue, just made from clean ash. The name of the syngas-generator for thermal applications is SynBurner: its main characteristics with detailed performance data are presented in refs. [6,7]. It too is out there for online purchase at website [8]. The blower-driven, slightly pressurized, gasification process happening in reactor SynBurner has been recently re-engineered into a suction-operated configuration. This latter modality, apart from the pressure (now less than atmospheric)

largely resembles, in design and functionality, the previous counterpart, but, most significantly, it allows during this thanks to directly fuel stationary combustion engines for combined heat and power generation (CHP). The reactor which implements the above provision possesses the name of SynGen: one among its distinct features, special within the present technological scenario of woodchip gasifiers, is that of being suitable to feed with syngas not just spark ignition engines but also compression ignition (diesel) engines. Actually it's just this latter modality which is presently being pursued at Tecnoforest Ltd. within the simpler case, the diesel engines are typically of the dual-fuel typology, wherein the air is premixed with syngas before the valve and a little quantity of liquid fuel (e.g. waste vegetable oil) is injected only for ignition purposes. A most peculiar, although really challenging, alternative modality, presently under investigation, relies on the intent of accelerating the syngas self-ignition tendency, i.e. its cetane number, by inducing an early stage of a gas-liquid FP reaction (Fischer-Tropsch) because of the catalytic effect of oxidized iron wool encountered by the syngas stream just before being premixed with air. Further experimentation remains needed so as to verify, additionally to the just discussed ignition properties (in both above cases, i.e. 'dual-fuel' also as FP modalities), the attainment of 'engine grade' quality for the syngas. This latter issue doesn't ask tar presence, since its concentration has been definitely ascertained as very low, rather to the possible entrainment of char fine particulate within the syngas stream. To tackle this issue a really efficient multi-vortex cyclone separator has been installed before engine intake.

- Tecnoforest woodchips gasification technologies:
- 'SynChar' reactor is at left (biochar producer)
- 'SynBurner' reactor is at center (syngas producer)
- At right, the small-scale 'Mini SynChar' is visible

'SynGen' gasifier (140 kWth) for CHP generation electrical power genset driven by diesel (1500 rpm, 30 kWel) Under many aspects, reactor SynGen appears as quite peculiar 'appropriate innovation': indeed, it succeeds in overcoming the documented limitations of ordinary downdraft (and updraft) gasifiers without resorting to a more complex design, rather, by implementing a robust simplification of the technology. During this way, the poor syngas quality and therefore the tedious, frequent maintenance needs typically encountered when operating standard gasifiers, end up properly fixed with SynGen technology because of a really simple design and a particularly robust structure. Most vital features which counteract the

formation of pyrolytic pollutants within the syngas are the 'floating hearth' provision and therefore the small volume, inside the reactor, occupied by the woodchip column [6,7]. Recently, at Tecnoforest Gasification Lab, all the above aspects associated with reactor SynGen, especially its remarkable reliability in safely sustaining continuous operation for

extended time periods, are deemed capable justify the feeding of its produced gas into a diesel driving an electrical generator. The facility generating unit is now undergoing performance tests which can be reported and discussed within the detailed presentation.