Highly clean biochar for novel applications in the fields of agronomy, energy, residential housing

Ferruccio Pittaluga
University of Genoa, Italy

Starting from 2011, the innovative SME Tecnoforest Ltd. (formerly an academic spin-off of the University of Genoa) has addressed its activity towards the testing of existing and the development of new, small-scale biomass gasification technologies aimed at assuring electric and thermal self-sufficiency to rural enterprises of the forestry and farming sectors. On the other hand, the high pollutants content of their products (syngas and biochar), common to both downdraft and updraft gasifiers, has become apparent as the main obstacle preventing, in absence of hardly affordable abatement provisions, a widespread penetration in both agricultural and renewable-energy sectors. Thanks to the novel, and very simple, gasification process recently developed at Tecnoforest Ltd., a clean, tar-free syngas is released from gasifier's top nozzle, ready to fuel burners as well as internal combustion engines, whilst a highly clean biochar is produced, at all suitable, as attested by official certification, for several, quite diversified, applications. The paper, after a brief presentation of the latest developments achieved at Tecnoforest in relation to its gasification technologies, discusses the physicochemical characterization (officially certified) of the biochar produced by its wood-chips gasifier 'Bio-SynChar' (ref.[6]), correlating it to syngas quality. The analysis shows, in addition to a very low content of pollutants, an extremely small presence of active oxygen functional groups: this feature, which is brought about by the high temperature, time- prolonged, pyrolysis process taking place within 'SynChar' reactor, guarantees an excellent chemical stability to biochar not only in itself but, most importantly, when mixed with other substances, this latter point being discussed in the 'applications', as below synthesized.On above bases, the presentation will review the latest applications of biochar carried out at Tecnoforest, which encompass a really impressive and diversified range of fields, from atmospheric carbon sequestration to soil fertilization, from greenhouse heating to photosynthetic process enhancement, from biochar-based wall-plasters featuring excellent acoustic/thermal insulation and ambient humidity control to novel biochar- cement mixtures for paving bricks, floor tiles and roof shingles. Each one of the said applications will be discussed in the paper by presenting original outcome and ongoing experimentation directly performed at Tecnoforest. With reference to soil fertilization, results will be discussed of remarkable nutraceutical properties achieved by vegetables grown in activated-biochar soils. A typical greenhouse provision will also be presented aimed at enhancing the level of photo-synthetic activity by mixing its ambient air with the clean exhaust gases issuing from a syngas-fueled burner. From a completely different perspective, several examples will be presented of different biochar-based plasters (with biochar addition up to 60% vol) utilizing as binder either clay or lime. Their extremely interesting properties in wall thermal/acoustic insulation as well as in indoor-air humidity control will be documented. Finally, some prototypical samples will be shown and their peculiar characteristics discussed of floor-paving tiles obtained by pressing biochar cement wet mixtures in properly (maybe artistically) shaped moulds and then allowing adequate curing times.

Figure: T Ecnoforest woodchips gasification technologies: Typical hourly productions from SynChar reactor:

-'SynChar' reactor is at left (biochar producer)-biochar from twigs and brushwood (at left).

-'SynBurner' reactor is at center (syngas producer)-biochar from woodchips (at right).

-at right, the small-scale 'Mini SynChar' is visible.

Recent Publications:

1. D Accornero, E Manzino and F Pittaluga (2012) A novel separation technology for nano- particles at discharge of combustion and incineration equipment. EQA Environmental Quality 8:13-24.
2. D Accornero, A Nilberto and F Pittaluga (2013) Design features and performance data of a new 400 kW biomass gasification plant of downdraft type. J. Energy and Power Engineering, 7(2):229-236.
3. E Manzino, D Olampi and F Pittaluga (2015) Performance Analysis of a Woodchip Downdraft Gasifier: Numerical Prediction and Experimental Validation. J. Energy and Power Engineering 9(4):336-347.

Biography

Ferruccio Pittaluga recently retired, has been full professor of Thermal Machines at the University of Genoa. Now continues his teaching activity as contract professor. His fields of interests have been thermo-fluid dynamics, combustion and gasification, atmospheric emissions. In 1998 he established DIME/SCL, the Combustion Laboratory of the University of Genoa, of which has been in charge up to his retirement in 2015. The participation to numerous national and EC-funded R&D programs, mostly dealing with environmental sustainability of combustion processes, has granted, in the years, rich support for research activities and technological developments. In 2011, with a few of his former doctoral students, he was co-founder (and since then, president) of Tecnoforest, an academic spin-off (now an innovative SME) addressed at rapid growth forestation, wood gasification and biomass-based renewable energy cogeneration. Tecnoforest has been for some year's Italian representative of APL gasifiers (USA).

p ittalug@unige.it

Notes: