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Operation and maintenance of a biomass fired – Organic Rankine Cycle – CHP plant: the experience of Cremona

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Abstract

Thanks to various feed-in-tariff programs, aimed to the development of electric energy production from renewable sources, several biomass firing power plants have been realized in Italy in the last few years, contributing to the reduction of greenhouse gas emissions and fossil fuel energy dependence.

In particular, during 2012 there was a rush for the completion of several renewable energy conversion power plants, leading up to 986 new plants to get the first connection to the grid (+81,3% with respect to 2011); among those, 80 new plants were solid biomass firing plants (+47,1% with respect to 2011) [1].

Linea Energia S.p.A., the Energy Business Unit of the multiutility company LGH, Linea Group Holding, which operates over the areas of Brescia, Cremona, Crema, Lodi and Pavia, gave its contribution in 2012 with the realization and start-up of two waste wood fueled energy conversion plants located in the Northern Italy, more exactly in Cremona and Rodengo Saiano (Brescia).

This paper focuses on the operation and maintenance experience of the waste wood conversion power plant of Cremona, which is capable for a gross electric power production of up to 1.0 MW and a thermal power recovery of up to 5.5 MW. In the first part of this paper a description of the plant is presented, giving an insight of the engineered process.

In the second part, the performance analysis of the energy conversion process is discussed by comparing actual performance of the system with the originally defined reference performance.

In 2016, as a consequence of the operation of the unit in anomalous conditions (air entering in the system) the turbine blades got scaled. The output of the turbine progressively decreased but was then successfully re-established after an extraordinary maintenance carried out by the turbine supplier.

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Nomenclature

$P_{el, gross}$	gross electric power, [kW]
p_{evap}	evaporation pressure, [bar]
p_{cond}	condensation pressure, [bar]
p_T	total pressure, [Pa]
CHP	cogenerative heat and power plant
CNG	compressed natural gas
f	flow coefficient
G	mass flow rate [kg/s]
EBITDA	earnings before interest, tax, depreciation and appreciation
EE	electric energy [kWh]
MCR	maximum continuous rate
ORC	Organic Rankine Cycle
R	specific gas constant [J/kgK]
S	nozzle area [m ²]
T	temperature [K]

1. Introduction

During 2012, Linea Energia S.p.A enriched its plants portfolio with the commissioning of two waste wood fueled energy conversion plants located in the Northern Italy; among the main supplier of the plants components, Turboden S.p.A. (a Mitsubishi Heavy Industries company, global leader in the design, manufacture and service of Organic Rankine Cycle (ORC) turbogenerators) played a key role by the realization, the start-up and the overall maintenance program of both the Organic Rankine.

Since the start-up of the plants, the cooperation between the engineering team of the customer and the Service engineers of the supplier allowed for the fine tuning of the operating conditions and for the detailed monitoring of the overall system performance.

After a description of the plant's features, the paper describes the performance of the biomass power plant of Cremona and an extraordinary maintenance activities carried out in 2016.

2. Waste derived woody biomass: an opportunity for the green energy production

Woody biomass could be classified considering its provenience as [2, 3]:

- virgin wood from dedicated cultivation or as by-product of sawmills and pellet productions plants;
- wood recovered from treatment of waste.

Two sources of biomass from separate collection of municipal waste (mainly refuse from the maintenance of private and public parks and used wood) have been considered as a suitable fuel for the power plant in Cremona:

- used wood, which is mainly composed by ground wood from packaging and furniture (see Fig. 1.a);
- woody by-products from the recovery process of pruning (see Fig. 1.b).

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