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Energy enhancement of solid recovered fuel within systems of conventional thermal power generation

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Abstract

The main objective of this article is to verify the feasibility, in terms of technical and economical issues, of a new refuse-derived fuel SRF (Solid Recovered Fuel) to be used as a new fuel in a thermal power station or in an incineration plants. By means of the innovative micronization technology it is possible to produce SRF suitable for the technical specifications of the plants which, taking into account appropriate modifications, could be reconverted and not decommissioned. The present energy supply scenario shows a partial contraction of the activities of power plant thermal generation despite an increase of the power demand and despite one of the highest energy cost in Europe. It is likely to surmise a gradual stall of such activities and finally the decommissioning due to the fact that plants will turn out to be not economically productive. On the other hand, it is now necessary to promote adequate policies for sustainable waste management. An opportunity in this sense is represented by the smart usage (made possible through innovative manufacturing processes) of the SRF as an energy source. The tests conducted on the innovative chemical-mechanical micronization technology showed an average energetic cost of 30 kWh/ton, and an average production cost of 15 €/ton for the 0.5 mm size. Combustion tests showed a good environmental and combustion performance. In this article, the refuse-derived fuel (which is governed according to the Decrees of the Ministry of Environment, Land and Sea) has been obtained through an innovative technology of chemical-mechanical micronization. We have also proceeded to verify the functional feasibility of the fuel production in order to feed incinerators and power plants in partial or total substitution of the conventional fuels (coal, fuel oil).

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Keywords: Solid Recovered Fuel; CSS; Municipal Solid Waste; Waste to energy; Energy Recovery; Co-combustion; Mechanical biological treatment; Micronization; Fuel characterisation; Alternative fuel;

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1. Introduction

Italy is one of the most industrialized countries depending on foreign imports of energy sources, with marked balance of payments imbalances. Strategic considerations related to accruing global fuel crisis require diversification of the energy mix, reduction of dependence on fossil fuels and greater security and stability of energy supply. It is necessary to promote the availability and use of alternative fuels, paying particular attention to *waste derived fuels* (WDFs) including *solid recovered fuels* (SRFs) having more stable physical-chemical properties than the constituent raw material and markedly cheaper than primary fuels and because of this willingly utilized in energy intensive industrial sectors such as cement industry, pulp and paper industry, thermal power plants [1]. Production and utilisation of the SRF increase level of waste recovery (improving the compliance to EU requirements related to waste management), allows energy recovery and finally transform the waste problem into a resource for productive sector and the community (e.g. waste tax reduction). In the EU research has been conducted for many years on reprocessing different groups of wastes into the alternative fuels, bringing about the implementation of series of technological solutions on the industrial scale. Both international corporations and local companies are engaged in technology development process of alternative fuels from wastes with the appearance of many technological solutions suited to the composition of the local raw material and to the requirements of the local consumer.

The aim of this study is to analyze more in depth the technical and economic feasibility of reconversion of thermal power plants in production downtime by replacing conventional fuel with high-quality SRFs up to 10% w/w of the regular fuels, which proved a solution easy to implement, with low investment costs and appropriate economic and environmental performance. The achievable benefits consist in enhancing plant management, keeping emissions at a substantially invariable level. Pilot projects in Europe have identified a new frontier in the co-combustion of coal with a new low-cost starting material obtained directly from municipal solid wastes (MSW) with scouting and subsequent testing of new technologies.

In 2010 the waste production in Italy is about 32 Mt/y of MSW and the waste management criticality, especially in regions such as Campania, Lazio, Sicily and Calabria, is set to worsen for the need to close part of the landfills where they are currently conferred more of 13 Mt/y. The amount authorized for the waste treatment exceed 6,5 Mt/y and the current production of SRF is about 2 Mt/y. In addition, special waste, similar and non-hazardous (the total amount, especially from industry, is about 160 Mt) not covered by provincial and regional programming is a important amount that must necessarily be treated and managed [2][3]. Is therefore essential to carry out, as well as to the reduction of waste upstream (prevention and eco-design) by starting the re-use, drastically reducing the quantities to landfill, increasing materials and energy recovery in the same way as is done in European countries the most virtuous. Indeed Austria, Germany, The Netherlands and Sweden, the best performing countries in Europe, have experienced high levels of recycling (50-60% material recovery) deeply integrated with high rates of energy recovery (40-50% energy recovery) in thermal power stations, confirming that the solution of the problem to be found with a set of actions, in which the energy recovery must play a decisive role [4].

Nomenclature

t	ton (1000 kg)	GCV	Calorific Value
t/y	ton per year	NCV	Net Calorific Value
t/h	tonnes per hour	d	in a dry state
w/w	Weight fraction or percentage	MBT	Mechanical-Biological Treatment
K/min	Kelvin per minute	EfW	Energy form Waste
ktpa	kilo tonnes per annum	MCT	Mechanochemical Treatment
ALV	Aerodynamic Lift Velocity	RES	Renewable Energy Sources
MSW	Municipal Solid Waste	ETS	Emission Trading System
WDF	Waste Derived Fuel	LCA	Life Cycle Assessment
EoW	End-of-Waste	SRF	Solid Recovered Fuel
WtE	Waste to Energy	GHG	Green House Gas
RDF	Refuse Derived Fuel	ar	as received