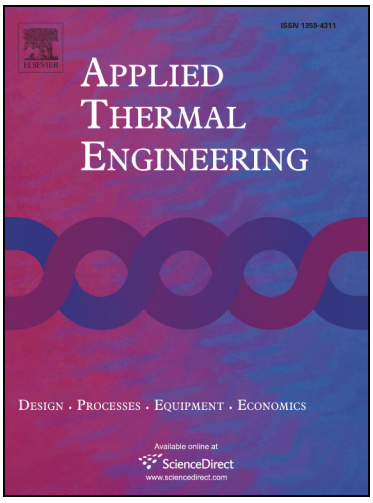

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SPENT COFFEE GROUNDS AS HEAT SOURCE FOR COFFEE ROASTING PLANTS: EXPERIMENTAL VALIDATION AND CASE STUDY

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ABSTRACT

The aim of this work is to validate a new sustainable economic circle where coffee roasting companies recycle spent coffee grounds as a source of thermal energy to produce roasted coffee. The green coffee beans need a significant quantity of heat in the roasting process and this energy could be obtained from the spent coffee grounds ~~(SCG)~~ discarded by espresso bars. According to the concept of circular economy, a coffee company collects the coffee disposed by the bars where it was brewed, and uses it in a heat generator for the roasting process. This paper presents the feasibility of SCG-wood sawdust pelletization and combustion in a 29 kW_{th} air furnace. Results of the tests report a thermal efficiency of 41.2% instead of 37.7% obtained with only wood pellet. In addition, the case study of a small Italian roasting company is discussed. The company produces about 5 tons of roasted coffee per day and it uses 400 Nm^3/day of natural gas as heat source. The company totally satisfies its energy demand through wood-coffee pellet combustion instead of natural gas. According to the business plan, the pay-back period of the investment is four years after which company CO_2 emissions significantly decrease.

Keywords: combustion, coffee, circular economy, thermal valorisation, case study.

1. INTRODUCTION

Industrial energy demand represents an enormous percentage in the world energy panorama: production plants consume about 50% of the world's energy supply [1]. In 2015, Italian production plants consumed more than 25 billion of toe, emitting millions of tons of CO_2 into the atmosphere and the food factories use about 1661 ktoe of energy [2-4]. Both the high cost and the use of fossil fuels constitute a big issue that can be solved thanks to the exploitation of renewable resources like biomass for energy production in a circular economy context [5].

In particular, coffee companies need a large amount of heat to convert green coffee beans to brown roasted coffee beans ready for the brewing process. Coffee is the second biggest traded commodity after petroleum and Italy has a very diffused and appreciated culture in coffee brewing: in the Italian territory, there are hundreds of coffee roasting companies and the province of Modena has a high density of coffee production plants [6]. In the largest majority of the cases, these companies use fossil fuels, like natural gas, to produce the required heat for the roasting. Although natural gas is a good fuel, during the combustion, a substantial quantity of VOCs is generated [7, 8]. The roasted coffee is then directly delivered and sold to the clients, mostly bars, where it becomes espresso and SCG (spent coffee ground). According to the ICO (International Coffee Organization), in 2015 in Italy, the consumption of coffee exceeded the large number of 340000 tons of roasted beans [9]. Therefore, almost the same amount represents the limit for the Italian market in terms of SCG that could potentially be converted into energy.