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Investigation on wood pellet quality and relationship between ash content and the most important chemical elements

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ABSTRACT

During the past four years, the European wood pellet market is currently continuing to increase. Total European consumption was about 9.8 Tg and Italian market reaches almost 1 Tg mainly for domestic supply. The present investigation provides an evaluation of pellet quality of Italian market by analysis of 88 wood pellet samples acquired randomly and directly from the sale points. Particular attention has been dedicated to relationship between ash and some elements. Results highlight that only half of samples fulfil the A1 class (best quality) requirements established in the EN 14961-2. Statistical analysis pointed out that ash content is mainly linked to sulphur, potassium and chlorine. The results show that low limit threshold values for ash content ensure low chlorine and sulphur contents.

1. Introduction

During the recent years, wood pellet has become an important worldwide fuel. At global level wood pellet industry production reaches about 13 Tg. Pellet has become popular in many countries, especially in Europe, where its market is nowadays a large business, and is currently undergoing rapid development. About 9.2 Tg were consumed by European countries in 2009 [1]. European Biomass Association expects a consumption of 50 Tg for the European countries by 2020 [2,3]. Nowadays, the rapid growing of pellet market is so substantial that the wood pellet has to be considered one of the largest internationally traded solid biomass commodities [4]. Furthermore, even though most pellets in the past were made from pure wood (sawdust or shavings), the increase of pellet demand entailed the supply of pure wood to be insufficient and other raw materials were used. Currently bark, branches and stem wood have come into use. The variability of characteristics of these materials leads to a greater need of defining qualitative standards, which is an indispensable requirement for orienting the market [5,6].

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Regarding the Italian situation, despite being the third largest European pellet producer, its consumption in 2009 totalled over 1 Tg exceeding significantly the domestic supply [1]. In Italy wood pellets are predominantly used in residential applications such as boilers and stoves [7], therefore product quality is particularly important.

Just to ensure the quality of the pellets, European standards for solid biofuels are continuously under development by CEN technical committee 335. The main European standard for wood pellet is the EN 14961-2 fuel specification which defines several levels of product quality of wood pellets for non-industrial use [8,9]. This standard sets out ranges for several parameters that are relevant to assess wood pellet quality (and other solid biofuels quality) and indicates the technical standards necessary for laboratory measurements. One of the most important parameter refers to ash content (inorganic materials) representing a serious problem in biomass combustion because it causes slagging, bed agglomeration, fouling, and corrosion in the combustion device, which degrades its performance and severely damages the firing equipment [10]. Moreover, ash in wood biomass consists of Cl, S, major elements (Al, Si, K, Na, Ca, Mg, Fe, P and Ti) and minor elements (As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Se, Te, V and Zn) which directly affect aerosol and fly ash formation during wood fuel combustion [11]. Other parameters like durability and bulk density are also important for pellet storage and handling. Pellets are susceptible to mechanical wear, which leads to production of fine particles or dust during transport and storage. This is an inconvenience for the consumer and also a health hazard [12]. Fine particles and dust can also disturb feeding systems of boilers and may lead to inhomogeneous combustion processes. Finally, dust may contribute to fire and explosion risks during handling and storage [13].

The present paper aims to define an overview of the quality of wood pellet that Italian customers could find on the market. Furthermore, the work aims to evaluate possible correlations of ash content with other chemical parameters. This analysis has allowed to assess if the limits defined in EN 14961-2 were chosen independently of each other. Analyses were carried out in the Laboratorio Biomasse (Biomass Lab) of Università Politecnica delle Marche. Several pellet samples were collected directly in the market avoiding any possible influence of producers and resellers on the results. This kind of contribution and the related results are very difficult to find in literature.

2. Materials and methods

In this study, 88 bags of pellets were purchased directly from sale points distributed in Italy in different regions during the period between November 2010 and February 2012. The choice of sale points did not follow any criteria and neither the seller nor the manufacturer was informed about the research. Within this investigation each pellet bag corresponded to one sample analysed in the Biomass Lab. For each sample analyses of some parameters considered by the EN 14961-2 were carried out. The physical and chemical parameters taken into account in this investigation are shown in Table 1 and described as follows.

2.1. Determination of water content

The sample was dried at a temperature of 105 ± 2 °C in air atmosphere using forced ventilation oven (mod. M120-VF, MPM Instruments) until constant mass is achieved and the percentage moisture calculated from the loss in mass of the sample. The average water content was calculated from two measurement series per sample.

2.2. Determination of ash content

The ash content is determined by calculation from the mass of the residue remaining after the sample is heated in air under rigidly controlled conditions of time, sample weight and equipment specifications to a controlled temperature of 550 ± 10 °C using a muffle furnace (mod. ZA, Prederi Vittorio & figli). The average ash content was calculated from two measurement series per sample.

2.3. Determination of mechanical durability

The mechanical durability tester, complying with the EN 15210-1, was used for the determination of the mechanical durability. The test sample is subjected to controlled shocks by collision of pellets against each other and against the walls of a specified rotating test chamber. In this tester approximately 500 g of pellets are exposed to mechanical stress of 500 cycles of rotation of their container. Before the test the pellets must be free of fines and therefore the share of fines must be separated from the pellets by manual sieving using a 3.15 mm sieve. After the test the pellets are weighed and the durability is calculated from the mass of sample remaining after separation of abraded and fine broken particles. The average mechanical durability was calculated from two measurement series per sample.

Table 1 – Chemical and physical parameters analysed and corresponding reference methods according to EN 14961-2 standard.

Parameter	Unit	Normative references
Water content	%[1]	EN 14774-2
Ash content	%[2]	EN 14775
Mechanical durability	%[1]	EN 15210-1
Diameter	mm	EN 14127
Length	mm	EN 14127
Net calorific value	MJ kg^{-1}	EN 14918
Bulk density	kg m^{-3}	EN 15103
Nitrogen	%[2]	EN 15104
Sulphur	mg kg^{-1}	EN 15289
Chlorine	mg kg^{-1}	EN 15289
Potassium	mg kg^{-1}	EN 15290
Sodium	mg kg^{-1}	EN 15290
Manganese	mg kg^{-1}	EN 15290

Note 1: the percentage is a mass fraction of the sample as received.
Note 2: the percentage is a mass fraction of dry matter.