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Research on the Chemical Characterization of the Oily Mill Scale for Natural Resources Conservation

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Abstract

The paper presents an assessment of the chemical composition of the oily mill scale from wastewater treatment. The determination of chemical composition of the wastes samples was achieved by spectrophotometric methods. The device used was a spectrometer based on X-ray fluorescence and a atomic absorption spectrophotometer. The chemical composition of the oily mill scale varies according to: the chemical composition of the raw materials used in the steelmaking process, the quality of the raw materials, the chemical composition of the auxiliary materials, the auxiliary materials used in the steelmaking process (oxidants (iron ore), ferroalloys (FeNi, FeCr, FeMn, FeMo, FeV)) and the type of steel produced. The results show that the oily mill scale is a significant source of metallic mineral resources. The recovery of the metallic minerals from oily mill, followed by their usage as a raw or auxiliary material to the steelmaking, leads to natural resources conservation.

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Keywords: metallurgical wastes; oily mill scale; chemical characterization; steelmaking; natural resources conservation.

1. Introduction

Steelmaking plants generate various kinds of residues, including oily mill sludge and scales. They are generated at the rolling mill plant during the cooling and rolling processes of hot steel. The European steel industry generates an estimated 500000 tonnes/yr of oily sludge and mill scales. More than 30% of this total is not valorised. The steelmaking by-products such as dust and mill scale are currently produced in large quantities and represent a potential of almost 5 millions tons in the world [1,2].

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Mill scale it can be considered as a valuable metallurgical raw material for iron and steel making industry because it contains valuable metallic minerals [3,4,5,6]. Up to 5% of steel is lost with the scale at hot rolling operation. However, its recycling is confronted with presence of up to 20% of oil and 10% of water [7].

Mills sector is the most important source of water pollution due to particles of iron oxide (scale) and oil in suspension, resulting in the different cooling and cleaning operations taking place in the rolling process [8,9].

Mill scale is a steelmaking by-product from the rolling mill in the steel hot rolling process. The chemical composition of mill scale varies according to the type of steel produced and the process used. The iron content is normally around 70 %, with traces of non-ferrous metals and alkaline compounds. Mill scale is contaminated with remains of lubricants and other oils and greases from the equipment associated with rolling operations. The oil content usually ranges between 0.1 and 2 %, but can reach up to 30%. Depending on the process and the nature of the product, the weight of mill scale can vary between 20-50 kg/t of hot rolled product. The average specific production of this by-product is typically around 40 kg/t. In view of its high metallic iron content and low non-ferrous metal and alkaline compound content, mill scale is suitable for recycling [7,10,11,12,13]. In this context, the recycling and reused of the oily mill scale components, has the effect of the natural resources conservation.

Table 1 shows streams of inputs and outputs for the hot rolling.

Table 1. Inputs and outputs of the hot rolling [14].

Inputs	Outputs
Reheated blooms / billets	Sections
Energy	Scrap, cobble, cutting
Water	Waste water loaded with
Oil and lubricants	oily mill-scale

The chemical characterization of oily mill scale play a key role in their utilization and establish the opportunities for minimize the amount of waste disposed.

The aim of this paper is the assessment of the metallic mineral contents from oily mill scale in order to improve the management of industrial wastes from steelmaking in the electric arc furnaces, by identifying the possible solutions for natural resources conservation.

The objectives of the paper are:

- the chemical characterization of the oily mill scale;
- the assessment of the metallic mineral contents from oily mill scale;
- the assessment of the total iron contents from the oily mill scale;
- the assessment of the alloying element contents from the oily mill scale;
- improving the waste management from steelmaking in the electric arc furnaces.

2. Material and method

The characterized metallurgical wastes samples were taken from a metallurgical plant (Salaj County, Romania). The two samples of oily mill scale, coming from the different cooling and cleaning operations taking place in the rolling process, there were collected and subjected to chemical characterization. The determination of chemical composition of the oily mill scale samples was achieved by spectrophotometric methods. The apparatus used was a spectrometer based on X-ray fluorescence, NITON type and model XL3t 600. With the help of X-ray fluorescence were determined the following chemical elements: calcium, potassium, barium, arsenic, copper, cesium, total iron, manganese, molybdenum, nickel, selenium, antimony, tin, tellurium, zinc, strontium, rubidium and vanadium. The cadmium, cobalt, mercury, lead and total chromium were determined by atomic absorption spectroscopy (AAS). The apparatus used was a atomic absorption spectrophotometer VARIAN SPECTRAA 110.