EUROPEAN JOURNAL OF LIFE SAFETY AND STABILITY (EJLSS)
ISSN2660-9630
www.ejlss.indexedresearch.org Volume 17, 2022 ||

Utilization of Metallurgical Wastes and Using in Portland Cement Industry

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Abstract: *Metallurgy is essential for socioeconomic development, and the process discharges waste containing a variety of toxic and hazardous compounds. This paper aims to provide Recycle, Reduce and Reuse to manage metallurgical wastes. The rapid development of metallurgical industry, leads to large amount of metallurgical solid waste. The slag, dust and sludge generated by integrated steel plants were called waste. These wastes contain some valuable resources and elements such as iron, zinc, lead, calcium, etc., which can be reused in Portland cement making process or can be used as raw materials therefore the term waste has been replaced with by-product due to intensive re-utilization of these wastes. The authors made an attempt to implement the idea by using the local iron scale of the Tashkent Metallurgical Plant as a ferrite additive during clinker firing. The joint venture Tashkent Metallurgical Plant is a super modern enterprise of New Uzbekistan, with an annual capacity of 500 thousand tons of cold-rolled steel with galvanized and polymer coating.*

Keywords: *Portland cement, cement clinker, structure formation, charge, energy saving, cement clinker minerals, mineralizers, iron dross, zinc, lead, calcium, ferrites, slag.*

Date of Submission: 10-4-2022 ***Date of Acceptance: 12-5-2022***

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1. Introduction

Steel sectors are one of the major waste producer .The steel plants solid wastes can be generated from process unit and pollution control units. Slag, dust, sludge, scrap, refractories, scale, muck and debris, etc. are the generated from steel making or from process unit.

In recent years, the cement industry has become a direct reflection of large-scale plans for urbanization: the implementations of infrastructure projects, as well as industrial and residential construction in the republic, have led to such a tangible increase in the consumption of this material that the industrial sector has only to increase its capacity and production potential. The main goal of the cement industry for the real future is to achieve the production of 20.2 million tons of cement by 2026 [1, 6, and 8].

The waste generated by steel industry not only causes health problems but also causes lot of environmental degradation. Therefore, it becomes very important for the industries who are involved in the manufacture of Portland cement to look for the methods that ensures safe disposal and recycling of waste. The use of mineralizers during firing makes it possible to increase the reactivity of the cement raw mixture, which improves the conditions for the formation of minerals that make up the clinker, primarily dicalcium and tricalcium silicates. Industrial waste from the

Tashkent Metallurgical Plant is proposed in this research. The idea involves the use of a secondary product of steel sheet - mill iron dross [3, 4, 6].

Today, the country has become a huge construction site that requires a radical improvement in production, including the production of economical, energy-efficient types of cement. Decree No. PQ 4335 of May 25, 2019 “On additional measures for the accelerated development of the building materials industry” provides for a doubling of cement production volumes [2].

The production of steel sheets by rolling is carried out in a 4-stage technological process. At the first stage, a sheet is rolled under pressure from a finished steel casting in a molten state, during which a burnt layer (iron dross) is formed on the surface of the molten steel sheet under the action of atmospheric oxygen, which is exposed to steel, and this layer is chemically resistant, but brittle, therefore, it is cleaned from the metal surface by chemical and mechanical treatment [5].

It is known that limestone and aluminosilicate clay are used as raw materials for cement clinker. Iron oxide III (Fe_2O_3), silicon oxide II (SiO_2) and alumina (Al_2O_3), which are important oxides in the formation of clinker minerals, play an important role in the formation of clinker minerals. When firing cement clinker, the composition of the charge is always planned, and corrective additives are actively used to regulate the composition of raw materials [7, 8, 9].

2. Materials and methods

The production of Portland cement includes two main technological limits - the production of clinker and the grinding of clinker together with gypsum and other additives. In the cost of Portland cement, up to 70 ... 80% is the cost of clinker. Its production mainly uses fuel, the cost of which is more than 20% of the total cost of cement. At the same time, approximately 40% of the total electricity consumed is spent on cement grinding.

The features of cement production are high capital intensity, due to the saturation of complex equipment, materials and energy intensity, the need for solutions aimed at increasing production efficiency [10].

The disadvantage of cement production is that, along with the useful properties of this material, many negative properties appear, namely the need for a guaranteed temperature in the clinker firing process. To reduce the sintering temperature, a corrective iron component is usually added to the composition of the raw mixture; however, in the conditions of the republic, such a component is scarce.

The objective of the proposed technology is to expand the raw material base, recycling production waste and reducing the temperature of clinker formation reactions and the energy intensity of Portland cement clinker production.

The problem to be solved is achieved by the fact that the raw mixture for clinker roasting contains limestone, aluminosilicate components and, as a ferruginous component, contains the scale of the steel sheet rolling production of the Tashkent Metallurgical Plant (TMZ) or the cinder of the Almalyk Mining and Metallurgical Plant (AMMP) in the following ratio of components, table. 1.

According to the grain composition, TMZ iron scale is a finely dispersed substance (more than 92% passes through a sieve with an opening of 0.08 mm) and does not require additional grinding before use. The studies were carried out within the framework of the analytical control of the "Testing Laboratory and Technical Supervision Department" of JV "KIZILKUMCEMENT". Based on the results of the analysis in table 1, the following results were obtained.

The proposed ferruginous scale has a sufficiently high carbonizing effect, as a catalyst reduces the sintering temperature by 150-170 ° C, therefore, it is an effective national and environmentally friendly remedy. The limits of input into the composition of the raw mixture of ferruginous scale are due to the content of iron oxides in it, which is characterized by a high carbonizing ability. With the usual heat consumption for burning Portland cement clinker in the range of 3000 kcal/kg, the maximum allowable level of iron dross input into the raw mixture, taking into account losses during ignition, is 4.5%. The addition of iron scale as a corrective component to the composition of the raw mix significantly intensifies the firing process of Portland cement clinker. The completion of the firing process, characterized by the value of CaO free 2%, occurs at a temperature of 1450 ^{o}C, which corresponds to the firing temperature of conventional Portland cement clinker and confirms the achievement of the task of reducing the energy intensity of Portland cement clinker production. The increased reactivity of the raw mixture and the decrease in the clinker firing temperature due to this provide an effect in reducing heat consumption, estimated according to the data of the carried out heat engineering calculations by the value of 800-1200 kcal/kg of clinker.

As can be seen from the results, the proposed technology is simple, cheap, reliable, and iron scale or cinders are very effective corrective components that reduce material costs through waste disposal.

The firing of clinker according to this method is technically and economically most feasible in cases where the raw materials are characterized by low moisture content, as well as relative uniformity in chemical composition and physical structure, which makes it possible to save a significant amount of energy.

Table 1. Comparative analysis of finished clinker

Compo-nents	Charge composition					Free lime conten t CaO	Compressiv e strength, MPa, after	
	Waste of neutralizati on of rolling production	Iron dross of the Tashkent Metallurgic al Plant	Iron dross of the Tashkent Metallurgic al Plant	Alum-nous raw materials - shale	Carbonate raw material - limestone		3 days	28 days
analogue	1	-	-	20	rest	2,8	23	40
analogue	7	-	-	18		1,65	24	39
1	-	1,1	-	15		0,76	28	46
2	-	1,65	-	15,5		0,66	32	50
3	-	2,2	-	16,0		0,32	36	52
4	-	-	1,3	15		0,80	28	45
5	-	-	1,95	15,5		0,70	30	47
6	-	-	2,6	16		0,45	33	44

Grinding of raw materials and finished clinker in mills can be carried out at a raw material moisture content of not more than 1%. In nature, there are practically no raw materials with such humidity, therefore, at all stages of the technological chain; the drying process proceeds, while the drying of the components is carried out by hot gases exhausted from the main kiln. It is desirable to combine the drying process with the grinding of raw materials. Grinding is carried out to a residue on the sieve of 6-10% on a sieve № 008.

With an increase in the number of glandular components, it is overused;

With a decrease in the amount of ferruginous components, the quality decreases, more temperature is required for the clinker formation process;

Iron scale and cinders are local secondary waste, the disposal of which provides a significant economic benefit;

Due to high-quality roasting, the grinding capacity of clinker improves, which increases its strength characteristics at 28 days of age by 44-52 MPa.

4. Results and Discussion

The proposed compositions of raw mixes relate to compositions for the production of Portland cement clinker. Effect reduced temperature of clinker formation reactions, power consumption of Portland cement clinker production and disposal of industrial waste. The raw mix for clinker roasting contains limestone, aluminosilicate components and, as a corrective and activating component, contains TMZ ferruginous scale or AMMP cinders in the aluminosilicate component 15-16; iron scale TMZ 1.1-2.2; limestone component - the rest and aluminosilicate component 15-16; cinder AMMP 1.3-2.6; limestone component - the rest.

Technological line for the production of energy-efficient cement is given: limestone and clay shale are put in the drying and pre-grinding bunker for shredding. After grinding make again drying and fine grinding. Here should be doing composition adjustment (may be not need or introduced Cinder with iron cross). Then process continue to roasting of raw materials (obtaining clinker) using fuel, while all these four parts of technology are highlights hot gases. After a time making cooling, testing and clinker slagging process, To support quality of cement introduce gypsum with a splitting up for joint grinding, ready cement warehouse are keeping in a bunkers for clinker.

The efficiency of the utility model was 100%, compared with the deficient waste of neutralization of rolling production, while the firing temperature is reduced by 150-170 ° C, therefore, it is an effective national and environmentally friendly remedy and the clinker activity increases after 28 days of hardening to 44-52 MPa .

5. Conclusion

One of the most common ways to reduce the firing temperature of cement clinker and intensify the firing process is to activate the formation of clinker minerals in exchange for mineralizers. Many people suggest using ferrite and emir oxides as such mineralizers. The use of mineralizers in the clinker firing process makes it possible to increase the reactivity of the cement-raw mixture, which improves the ability to form minerals that make up the clinker, primarily dicalcium and tricalcium silicates.

To this end, the use of iron storm (dross) as common mineralizers in our country changes the mineralogical composition of the clinker, which leads to an increase in the content of tricalcium silicate. Such additives increase the activity of Portland cement clinker and reduce the temperature of clinker formation by 100-150°C. At present, research has important scientific and practical implications for a significant reduction in the clinker firing temperature.

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