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USE OF SAW DUST AS AN ALTERNATE FUEL IN THE PRODUCTION OF CLINKER

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ABSTRACT

World is facing the problems of agro-waste disposal and energy crisis. Saw dust can be used as alternate fuel in place of pet coke in the production of clinker. Various ratios of saw dust were mixed with pet coke and used as fuel. It was observed that clinker produced was not affected adversely, rather sulfur contents were lower in these cases. This improves the quality of clinker and /or cement.

Key words: Saw dust, Cement, Alternate fuel, Clinker

INTRODUCTION

In ancient period, men use to live in forests under trees and in caves, but with the passage of time, he started realizing the need of some new, comfortable and reasonable shelter near some source of water like lake or river and land for cultivation. There was nobody to help him for this and he utilized the natural things available at that time for this purpose. He made huts by branches of trees and grass and of course later on, he used stone and clay also. Then he started making bricks, which were relatively fragile but when by chance, some of them came in contact of heat, they become more strong. In this way, he learned making bricks.

Initially simple clay was used for uniting bricks and later on, by chance some additional materials were mixed in it, which he found more useful in strengthening the union of bricks. Thus, he started constructing the houses. This was the earliest precursor of uniting materials, which was later on named as cement.

Now-a-days, it is our moral duty to safeguard our earth from pollution and crisis of energy by the use of its other raw materials (wastes) to meet our gradually increasing requirements. It is very easy to burn any kind of alternate fuel to produce flame, heat, and temperature but cement kilns are not simply heat producing cylinders, which are used for heat generation only. In cement kilns, one makes clinker in a pyroprocessing manner and this clinker is further usable for cement manufacturing. So, any alternative fuel may be used provided that it does not affect the quality of cement adversely. It is quite possible that one may certainly cut down the use of conventional fuel by substituting the alternative fuel, but with lower quality of cement.

Rice hull ash has been applied as an amendment in many materials due to its high insulating property. It has various industrial applications, i.e. concrete and light weight building materials, refractory

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brick manufacturing, manufacture of insulation and flame retardants, etc.[1,2] Many researchers have done their work on the production of rice husk ash (RHA) and its use in concrete. The effect of pyroprocessing on the pozzolanic reactivity of rice husk ash has been investigated by Mehta[3,4]. Amin[5] has reported the recycling of bagasse ash, which is a waste product of sugar industries. It is used as a cement replacement in concrete. It provides a good solution to environmental concerns, which is associated with waste management. Physical and mechanical properties of hardened concrete, including compressive strength, splitting tensile strength, chloride diffusion, and resistance to chloride ion penetration have also been investigated for use of bagasse ash content as a partial replacement of cement.

Giugliano et al.[6] experimentaly evaluated waste tyres utilization in cement klins while use of tyres derived fuel in clinker burning has also been reported by Pipilikaki et al.[7] Kikuchi[8] recycled municipal solid waste for transforming incineration of solid waste into cement clinker. Giddings et al.[9] observed combustion and aerodynamic behaviour of car tyre chips in a cement works precalciner. The world is facing the scarcity of geo-based fuels like diesel, raw coal and pet coke and there is a pressing demand to find some alternative fuels, which can replace these traditional fuels to some extent as these fuels are depleted at an ever increasing pace and will be exhausted within a few decades. Therefore, it is utmost necessary to use some renewable fuels likes agro-waste. These agro-wastes create the problem of their disposal and using them as fuels will also solve the problem of their disposal. It will also help in reducing green house gases (GHG) emission.

It is therefore, planned to carry out some systematic investigations on the use of some agro-wastes as an alternate fuel along with pet coke in the manufacture of cement without affecting it's quality adversely. Saw dust has been used as the agro-waste in the present investigations.

EXPERIMENTAL

Raw mixtures (Fuel + alternate fuel + kiln feed) were prepared and these were mixed with sufficient amount of water to make a homogenous hard paste. This small peanut like granules were made by hand and these granules were placed in oven upto 250 to 300º C to make them moisture free and completely dry.

The alternative fuel is mixed in desired proportions (according to GCV) to replace the pet coke before clinkerisation, so that the ash content produced by alternative fuel will also become a part of clinker and the advantage of heat produced by burning alternative fuel will also be taken in this process. Each sample of the clinker so produced was analysed to find out the optimum amount (ratio) of alternative fuel without affecting the quality of cement.

After getting these granules dried, these were subjected to calcination in an electrical furnace for 20 to 25 minutes, whose temperature rises from 900º C to 1450º C because it is a known fact that in a cement kiln, it takes about 20 to 25 minutes for the material to pass from one end to another (in the range of temperature 900º - 1450ºC). Then the clinker was taken out from the furnace in a steel tray, where it was rapidly cooled to retain C_3S content of the clinker.

Complete clinkerisation was checked by the colour of the clinker as it is known that if clinkerisation is complete, the colour will change to greenish black (colour remains brownish and dusty, if clinkerisation is incomplete). This is further confirmed by weighing the clinker and weight loss was observed during clinkerisation because of the emission of CO_2. Complete clinkerisation was also assured by checking its free CaO by ethylene glycol method, where the free lime content will be maximum (3 to 4%) (according to BIS) with complete clinkerisation.

This clinker was then powdered in a pulveriser and sieved in 90 μ sieve and the analysis was performed as per standard methods.

RESULTS AND DISCUSSION

On the basis of Gross Calorific Value (GCV) of pet coke (GCV = 8236), the amount of groundnut shell (GCV = 4640) was mixed; for example 1.606 g of groundnut shell was considered equivalent to 10% of pet coke (on the basis of GCV). The results are presented in Table 1.

Table 1: Composition of clinker with 0 % saw dust (Pet coke = 100 %, Saw sust = 0 %)

Kiln Feed = 150 g	**Pet coke = 9.05 g**		**Saw sust = 0.0 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.57	21.62	21.60
Fe_2O_3	4.72	4.65	4.69
Al_2O_3	5.22	5.23	5.23
CaO	64.67	64.72	64.70
MgO	1.02	1.02	1.02
SO_3	1.56	1.57	1.57
K_2O	0.52	-	0.52
Na_2O	0.17	-	0.17
Cl	0.0133	-	0.0133
Free CaO			2.68
LSF			92.51
SM			2.18
AM			1.12
C_3S			57.40
C_2S			18.63
C_3A			5.92
C_4AF			14.26

Free lime was estimated by ethylene glycol method; LSF, SM and AM were calculated on the basis of the results obtained while C_3S, C_2S, C_3A and C_4AF were determined by Bogue equations

Similarly, it was calculated for higher plercentage of saw dust. The results are presented in Tables 2-11.

Table 2: Composition of clinker with 10% saw dust (Pet coke = 90%, Saw dust = 10%)

Kiln Feed = 150 g	**Pet coke = 8.145 g**		**Saw dust = 2.106 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.49	21.54	21.52
Fe_2O_3	4.55	4.62	4.59
Al_2O_3	5.27	5.32	5.30
CaO	64.61	64.76	64.69

Cont…

Kiln Feed = 150 g	**Pet coke = 8.145 g**		**Saw dust = 2.106 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
MgO	1.02	1.04	1.03
SO_3	1.22	1.27	1.25
K_2O	0.54	-	0.54
Na_2O	0.18	-	0.18
Cl	0.0134	-	0.0134
Free CaO			2.88
LSF			92.78
SM			2.18
AM			1.15
C_3S			57.64
C_2S			18.21
C_3A			6.28
C_4AF			13.95

Table 3: Composition of clinker with 20 % saw dust (Pet coke = 80 % Saw dust = 20 %)

Kiln Feed = 150 g	**Pet coke = 7.240 g**		**Saw dust = 4.211 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.54	21.58	21.56
Fe_2O_3	4.55	4.62	4.59
Al_2O_3	5.26	5.31	5.29
CaO	64.52	64.59	64.56
MgO	1.02	1.04	1.03
SO_3	1.05	1.12	1.09
K_2O	0.53	-	0.53
Na_2O	0.18	-	0.18
Cl	0.0134	-	0.0134
Free CaO			2.65
LSF			92.44
SM			2.18
AM			1.15
C_3S			56.83
C_2S			18.95
C_3A			6.25
C_4AF			13.95

Table 4: Composition of clinker with 30 % saw dust (Pet coke = 70 % Saw dust = 30 %)

Kiln Feed = 150 g	**Pet coke = 6.335 g**		**Saw dust = 6.317 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.57	21.68	21.63
Fe_2O_3	4.59	4.66	4.63
Al_2O_3	5.21	5.32	5.27
CaO	64.52	64.58	64.55
MgO	1.02	1.04	1.03
SO_3	1.02	0.98	1.00
K_2O	0.53		0.53
Na_2O	0.18		0.18
Cl	0.0134		0.0134
Free CaO			2.59
LSF			92.19
SM			2.19
AM			1.14
C_3S			56.39
C_2S			19.47
C_3A			6.13
C_4AF			14.07

Table 5: Composition of clinker with 40 % saw dust (Pet coke = 60 % Saw dust = 40 %)

Kiln Feed = 150 g	**Pet coke = 5.430 g**		**Saw dust = 8.422 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.62	21.73	21.68
Fe_2O_3	4.55	4.68	4.62
Al_2O_3	5.14	5.28	5.21
CaO	64.38	64.55	64.47
MgO	1.03	1.03	1.03
SO_3	0.95	0.88	0.92
K_2O	0.54		0.54
Na_2O	0.17		0.17
Cl	0.0134		0.0134
Free CaO			2.95
LSF			91.98

Cont…

Kiln Feed = 150 g	**Pet coke = 5.430 g**		**Saw dust = 8.422 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SM			2.21
AM			1.13
C_3S			56.05
C_2S			19.87
C_3A			6.00
C_4AF			14.04

Table 6: composition of clinker with 50 % saw dust (Pet coke = 50 % Saw dust = 50 %)

Kiln Feed = 150 g	**Pet coke = 4.525 g**		**Saw dust = 10.528 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.72	21.79	21.76
Fe_2O_3	4.59	4.68	4.64
Al_2O_3	5.18	5.26	5.22
CaO	64.42	64.47	64.45
MgO	1.03	1.03	1.03
SO_3	0.76	0.82	0.79
K_2O	0.54		0.54
Na_2O	0.17		0.17
Cl	0.0134		0.0134
Free CaO			2.98
LSF			91.62
SM			2.21
AM			1.13
C_3S			55.27
C_2S			20.69
C_3A			5.99
C_4AF			14.10

Table 7: Composition of clinker with 60 % saw dust (Pet coke = 40 %, Saw dust = 60 %)

Kiln Feed = 150 g	**Pet coke = 3.620 g**		**Saw dust = 12.633 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.61	21.86	21.74
Fe_2O_3	4.53	4.66	4.60
Al_2O_3	5.21	5.32	5.27
CaO	64.43	64.63	64.53

Cont…

Kiln Feed = 150 g	**Pet coke = 3.620 g**		**Saw dust = 12.633 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
MgO	1.03	1.03	1.03
SO_3	0.58	0.69	0.64
K_2O	0.52		0.52
Na_2O	0.18		0.18
Cl	0.0133		0.0133
Free CaO			2.78
LSF			91.78
SM			2.20
AM			1.15
C_3S			55.52
C_2S			20.44
C_3A			6.18
C_4AF			13.98

Table 8: Composition of clinker with 70 % saw dust Pet coke = 30 % Saw dust = 70 %

Kiln Feed = 150 g	**Pet coke = 2.715 g**		**Saw dust = 14.739 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.66	21.89	21.78
Fe_2O_3	4.55	4.69	4.62
Al_2O_3	5.18	5.26	5.22
CaO	64.38	64.45	64.42
MgO	1.03	1.03	1.03
SO_3	0.42	0.53	0.48
K_2O	0.54		0.54
Na_2O	0.17		0.17
Cl	0.0134		0.0134
Free CaO			3.05
LSF			91.52
SM			2.21
AM			1.13
C_3S			55.01
C_2S			20.94
C_3A			6.02
C_4AF			14.06

Table 9: Composition of clinker with 80 % saw dust Pet coke = 20 % Saw dust = 80 %

Kiln Feed = 150 g	**Pet coke = 1.810 g**		**Saw dust = 16.844 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.65	21.85	21.75
Fe_2O_3	4.52	4.65	4.59
Al_2O_3	5.22	5.23	5.23
CaO	64.45	64.48	64.47
MgO	1.03	1.02	1.03
SO_3	0.32	0.45	0.39
K_2O	0.52		0.52
Na_2O	0.17		0.17
Cl	0.0133		0.0133
Free CaO			3.12
LSF			91.70
SM			2.22
AM			1.14
C_3S			55.42
C_2S			20.56
C_3A			6.09
C_4AF			13.95

Table 10: Composition of clinker with 90 % saw dust (Pet coke = 10 % Saw dust = 90 %)

Kiln Feed = 150 g	**Pet coke = 0.905 g**		**Saw dust = 18.950 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.72	21.94	21.83
Fe_2O_3	4.55	4.61	4.58
Al_2O_3	5.17	5.21	5.19
CaO	64.48	64.41	64.45
MgO	1.03	1.02	1.03
SO_3	0.28	0.41	0.35
K_2O	0.52		0.52
Na_2O	0.17		0.17
Cl	0.0133		0.0133
Free CaO			2.84

Cont…

Kiln Feed = 150 g	**Pet coke = 0.905 g**		**Saw dust = 18.950 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
LSF			91.44
SM			2.23
AM			1.13
C_3S			54.98
C_2S			21.12
C_3A			6.01
C_4AF			13.94

Table 11: Composition of clinker with 100 % saw dust (Pet coke = 0 %, Saw dust = 100 %

Kiln Feed = 150 g	**Pet coke = 0.000 g**		**Saw dust = 21.055 g**
Parameter	**XRF (%)**	**EDTA (%)**	**Average (%)**
SiO_2	21.81	21.98	21.90
Fe_2O_3	4.62	4.58	4.60
Al_2O_3	5.19	5.24	5.22
CaO	64.42	64.38	64.40
MgO	1.02	1.05	1.04
SO_3	0.24	0.29	0.27
K_2O	0.54		0.54
Na_2O	0.16		0.16
Cl	0.0134		0.0134
Free CaO			3.02
LSF			91.08
SM			2.23
AM			1.13
C_3S			54.10
C_2S			21.97
C_3A			6.04
C_4AF			14.00

It was observed that almost all parameters remained in permissible range. However, the sulphuric anhydride content was reduced from 1.57% to as low as 0.27%. This reduction in sulphuric anhydride is due to lower percentage of sulphur in agro-waste as compared to higher content in pet coke. This improves the quality of clinker (or cement) where as the other parameters are not affected. This will help in solving the problem of disposal of agro-waste like saw dust and also providing an energy supplement for pet coke and the geo-based traditional fuels.

Agro-wastes are generated every year and it will go on increasing day by day and its use as alternate fuel will reduce the pollution of environment, which will otherwise be polluted further.

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