IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 18, Issue 7 Ser. 2 (July 2024), PP 62-66
www.iosrjournals.org

Effect of Benghazi (LIBYA) Cement Factory on the distribution of metal oxide contents

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ABSTRACT

This study was carried on some samples collected from regions located at Benghazi cities. Soil samples included different directions (north, south, east and west). The metal oxides were determined (Al_2O_3, TiO_2,SiO_2, Na_2O, CaO, K_2O, SO_3, MnO, P_2O_5 and Fe_2O_3). Also twelve samples of cement samples from different companies were studied. The percentage of each metal oxide were estimated by (XRF). The results of this study recommended that: the contents of SiO_2, TiO_2, Al_2O_3, Fe_2O_3, P_2O_3, MnO, MgO, $CaCO_3$, Na_2O, K_2O and SO_3, were ranged as following: SiO_2: (17.97-41.59%), (14.15-42.75%) for surface and subsurface samples respectively, Tio_2(0.34-0.643%) – (0.170-0.655%), Al_2O_3 (4.29-8.08%), (3.044-7.97%), F_2O_3 (2.36-5.83%), (1.98-5.80%), P_2O_5(0.124-0.203%), (0.28-0.220%), MnO (2.013-4.218%), (1.605-5.64%), $CaCO_3$ (31.40-64.69%), (32.74-60.73%), Na_2O (0.98-1.67%), (0.50-2.93%), K_2O (0.49-1.45%), (0.36-1.53%), SO_3 (1.10-4.32%), (0.57-3.24%). The results showed that the cement of metal oxides were high at southern director of surface samples. The metal oxides at Benghazi factory recorded high levels of SiO_2 on surface samples. Also high cements of $CaCO_3$ were recorded.

Key words: *Metal oxides , XRF analysis , Benghazi Cement Factory, soils.*

Date of Submission: 16-07-2024 Date of Acceptance: 26-07-2024

I. Introduction

Cement is a powdery composition (limestone, laterites, clay and gypsum) used in making and holding blocks or bricks in-place during construction. The major components of cement are derived from toxic heavy metals such as nickel, cobalt, lead, chromium and Silica [1]. Cement production is one of the major sources of environmental pollution associated with industrialization in developing countries. Cement dust emission has been described as the major source of heavy metal contamination of the environment [2]. Molecules of primary importance in cement dust in terms of content and potential health effects basically include 60–67% calcium oxide, 17–25 silicon oxide (SiO2), and 3–5% aluminium (Al) oxide, with some amount of iron oxide, chromium (Cr), potassium, sodium, sulphur, and magnesium oxide. Deleterious effects of exposure to constituents of cement dust on organ system in humans have been described [3].

It was reported that , Cement is an essential material for building and civil engineering construction that affects the environment during production and consumption process. Heavy metals are the major hazard elements presented in the cement. These toxic elements originate mainly from the raw materials, but also from refractory bricks lining the kiln, mineral inputs or the grinding media (normally high chromium white cast iron) in the final finishing mills [4]. The trace element content of clinker is of high scientific interest and can be used to solve practical problems, too, for example, to determine the origin of the manufacturing works. The first paper on a similar topic was published in by Goguel and StJohn [5], showing the Ba, Sr and Mn contents of Portland cements in New Zealand concretes. The rare element levels of cements can be used to identify the manufacturing factory and to estimate the origin of the Portland cement. Portland cement is used in the construction industry as a binder in concrete. The basic raw materials of Portland cement are lime (CaO), silica (SiO_2), alumina(Al_2O_3) and iron oxide (Fe_2O_3). Cement is produced in two steps: in the first step, cement clinker is produced from raw materials. In the second step cement is produced from the cement clinker. In the manufacturing process, the clinker is crushed, then ground to a fineness for the desired composition and then heated up to 1400–1600 °C.

The amount of gypsum added ($CaSO_4$.$4H_2O$) controls the setting time of the cement. The resulting product consists of tricalcium silicate (3CaO .SiO_2), dicalcium silicate2 $CaOSiO_2$), tricalcium aluminate (3CaO.Al_2O_3) and tetracalcium alumino ferrite (4CaOAl_2O_3.Fe_2O_3) [6.[Cement production has several quite serious environmental hazards associated with it, including dust emissions and contaminated run-off water.

Since cement production is energy intensive, it has a number of environmental effects, including greenhouse gas emissions, air pollutants such as SO_2, NOx, CO and heavy metals [6]. The negative environmental impacts are also associated with the used fuels in cement manufacture. The main aim of this study is to estimate the contents of metal oxides at some soil samples collected from surface and sub-surface locations around Benghazi cement Factory by using XRF method.

II. Materials & Method

Twenty different soil samples were collected from different eight locations at Benghazi cement factory . Surface and subsurface samples were collected from the four different sectors during spring 2024. The samples were collected from East , West , South and North sections around the Benghazi cement factory . At each section surface and subsurface soil samples were collected from about one Km and 5 Km from the cement factory. The samples are kept in polyethylene bags and transferred to central unit of chemical analysis , Faculty of science , Omar El –Mukthar University. Sample preparation: The samples were washed with distilling, dried at 105 ^{0}C and grinded in mortar then saving. Samples analysis : X-Ray Fluorescence scanning (XRF) The X-Ray micro scanning of the samples were carried out at the central lab (X- Ray unit) of Alexandria university , Faculty of science.

III. Results and Discussion

This study recorded that , the contents of were ranged as following : The contents of SiO_2 , TiO_2 , Al_2O_3 , Fe_2O_3 , P_2O_5 , MnO , MgO , $CaCO_3$, Na_2O , K_2O , and SO_3 were ranged in surface samples as following :
(17.79 – 41.59 %) , (0.340 – 0.643 %), (4.29 – 8.0 %), (2.36 – 5.83 %) , (0.124 – 0.203 %) , 0.031 – 0.079 %) , (2.013 – 4.218 %) , (31.405 - 64.69 %) , (0.980 – 1.67 %) , (0.49 – 1.45 %) and (1.16 – 4.32 %) .On the other side the contents of the above metal oxides in subsurface sediments were fluctuated in the ranges of :(14.15 – 42. 75 %) , (0.170 – 0.65 %) , (3.044 – 7.87 %) , (1.98 – 5.80 %) , (0.128 – 0.220 %), (0.031 – 0.079 %), (0.017 – 0.075 %) , (1.60 – 5.46 %), (32.74 – 60.73 %) , (0.52 – 2.39 %) , (0.367 – 1.53 %) and (0.578 – 3.24 %), respectively. The presence of metal oxides at high levels in surface samples comparing with the subsurface samples , This is mainly attributed to the effect of cement dusts . These results are lower than those reported in some studies of SiO_2 contents around cement factories . But the other oxides as Al_2O_3 and CaO are harmony with the data which recorded in the same study. Generally , from the obtained results in this study the trend distribution of the metal oxides is as the following order:
SiO_2> CaO > Al_2O_3> Fe_2O_3>> other oxides. Other oxides as (K_2O , CuO, MgO and ZnO) ,

The SiO_2 contents are recorded in the most studied samples , this is mainly attributed for the effect of the dusts of the cement factory . The relative increase or decrease of Si contents from location to another may be due to presence of Si in other chemical structures or may be due the presence the ores of Si . It was reported that there are many chemical structure of silicon as SiO_4 , SiO_2 ,aluminum silicate $AlSiO_8$ and others . The presence of Ca in high contents at most locations of the area under study may be due to presence of $CaCO_3$ (Calcite) or ($MgCO_3$.CaO_3) Dolomite , but the different of contents from satiation to satiation is mostly due the dusts of cement factory .

It was reported that the dust emissions from cement and other related industries therefore have to be given attention for control. This is necessary in view of the pollution load and its impact on the environment [8] .The dust emitted from cement are of two categories. There are cement and clinker dusts which contain cement mineral compounds such as tri calcium silicate (C_3S), di calcium silicate (C2S), tri calcium aluminates (C_3Al) and tetra calcium alumino ferrite (C4AlF) because they are calcite products [9]. The second category is the raw mill and precipitator dust that have not been calcite and they contain calcium carbonates, oxides of iron, silicon, aluminum, magnesium and other minor elements. Those dusts emissions are directly effecting the area under study [10].

Studies has been carried out by a number of researchers to determine the effect of dust on soils. Almost all the results have indicated the absorption of dust into soils[11]. Some experimental results indicated physical effects including the P H soil effect . The soil samples along the easterly and Southey wind directions are most affected by the dust deposition.

Table (1): The contents of SiO_2 at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	**Direction** / Location	
17.797	29.118	35.014	23.378	Surface	200 M
17.988	25.630	34.688	25.875	Subsurface	
19.265	29.144	41.597	34.959	Surface	500 M

24.460	30.711	39.734	42.756	Subsurface	
27.867	25.564	35.467	27.167	Surface	1000 M
28.659	14.156	35.359	21.968	Subsurface	

Table (2): The contents of TIO_2 at different directions around Benghazi cement Factory.

(S)	**(N)**	**(W)**	**(E)**	**Direction** **Location**	
0.341	0.519	0.592	0.356	Surface	200 M
0.336	0.574	0.574	0.423	Subsurface	
0.340	0.508	0.642	0.578	Surface	500 M
0.539	0.461	0.622	0.655	Subsurface	
0.505	0.358	0.576	0.397	Surface	1000M
0.524	0.170	0.572	0.328	Subsurface	

Table (3): The contents of Al_2O_3 at different directions around Benghazi cement Factory.

(S)	**(N)**	**(W)**	**(E)**	**Direction** Location	
17.797	11.496	8.952	5.22	Surface	200 M
17.988	11.757	9.266	10.980	Subsurface	
19.265	11.074	10.086	12.127	Surface	500 M
24.460	12.171	11.375	12.407	Subsurface	
27.867	13.857	11.848	11.427	Surface	1000 M
28.659	14.017	10.760	9.532	Subsurface	

Table (4): The contents of Fe_2O_3 at different directions around Benghazi cement Factory.

(S)	**(N)**	**(W)**	**(E)**	**Direction** **Location**	
4.546	5.124	3.949	5.227	Surface	200 M
5.513	5.428	4.008	4.923	Subsurface	
5.480	5.379	4.505	5.498	Surface	1000 M
5.410	5.477	5.202	5.338	Subsurface	
5.429	5.891	5.235	5.404	Surface	2000 M
5.575	5.900	4.920	4.961	Subsurface	

Table (5): The contents of P_2O_5 at different directions around Benghazi cement Factory.

(S)	**(N)**	**(W)**	**(E)**	**Direction** **Location**	
0.203	0.170	0.146	0.163	Surface	200 M
0.200	0.141	0.145	0.188	Subsurface	
0.200	0.145	0.124	0.147	Surface	1000 M
0.158	0.158	0.133	0.128	Subsurface	
0.175	0.185	0.146	0.176	Surface	2000 M
0.169	0.220	0.141	0.195	Subsurface	

Table (6): The contents of MnO % at different directions around Benghazi cement Factory.

(S)	**(N)**	**(W)**	**(E)**	**Direction** **Location**	
0.079	0.042	0.048	0.032	Surface	200 M
0.075	0.044	0.046	0.037	Subsurface	
0.037	0.033	0.058	0.050	Surface	1000 M
0.047	0.037	0.055	0.057	Subsurface	
0.044	0.031	0.046	0.032	Surface	2000 M
0.044	0.017	0.043	0.027	Subsurface	

Table (7): The contents of MgO at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	Direction	Location
3.145	2.211	2. 74	3.420	Surface	200 M
2.799	3.722	2.186	5.468	Subsurface	
2.853	4.020	2.013	3.337	Surface	1000 M
2.325	4.688	2.244	3.023	Subsurface	
2.732	5.035	2.568	4.218	Surface	2000 M
1.942	4.615	1.605	3.656	Subsurface	

Table (8): The contents of $CaCO_3$ at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	Direction	Location
60.748	51.669	40.264	59.490	Surface	200 M
60.153	40.103	41.543	54.201	Subsurface	
64.694	44.137	31.405	40.971	Surface	1000 M
46.847	45.443	35.017	32.746	Subsurface	
53.101	43.316	40.206	54.155	Surface	2000 M
51.565	45.578	40.987	60.739	Subsurface	

Table (9): The contents of Na_2O at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	Direction	Location
1.284	0.696	1.132	1.574	Surface	200 M
1.452	2.932	0.801	1.720	Subsurface	
1.671	1.619	0.546	1.197	Surface	1000 M
2.036	1.396	0.502	0.869	Subsurface	
1.307	1.332	0.998	0.988	Surface	2000 M
1.218	2.381	0.820	1.261	Subsurface	

Table (10): The contents of K_2O at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	Direction	Location
0.541	1.167	1.458	0.992	Surface	200 M
0.501	0.955	1.456	1.135	Subsurface	
0.492	0.957	1.351	1.67	Surface	1000 M
0.998	0.937	1.402	1.534	Subsurface	
1.114	0.777	1.403	1.063	Surface	2000 M
1.147	0.367	1.422	0.865	Subsurface	

Table (11): The contents of SO_3 at different directions around Benghazi cement Factory.

(S)	(N)	(W)	(E)	Direction	Location
1.584	0.543	0.424	0.285	Surface	200 M
2.297	0.634	0.271	0.238	Subsurface	
4.328	0.476	0.198	0.115	Surface	1000 M
3.242	0.483	0.166	0.067	Subsurface	
1.106	0.517	0.099	0.224	Surface	2000 M
0.578	0.485	0.101	0.270	Subsurface	

IV. Conclusion

The results of this study showed high contents of detected metal oxides in surface samples comparing with the subsurface ones , this mainly due to the effect of Cement Factory dusts , also the results gave indication some location direction was affecting on the distribution of some metal oxides depending up on the winds

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