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Original Article

Recycling of Cement Kiln Bypass Dust in the production of Portland Cement and environmental impact, El Arish Cement Company, Sinai - Egypt

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Abstract

The present work focuses on the possibility of recycling the cement kiln bypass dust (CKBp) in cement industry through its replacement to the raw meal (clay, limestone) and/or clinker. Replacement of CKBp dust by washing processes techniques were applied on reuse cement kiln bypass dust for El Arish Cement Company (ACC) in the central Sinai for solving the problem of high Cl contents to be conformable with the quality control factors. This study proved that replacement process of raw meal by washed CKBp dust did not affect the quality of the raw mix therefore replacement limit 3% for raw meal is considered. The process of replacement on the other hand will save raw meal and reduced the cost. Using of washed CKBp dust to replace raw meal will consume every day about 156 to 160 tons (about 78% CKBp dust). Using of 5% washed CKBp to replace the clay lead to consume about 114 t/d from CKBp dust. Thus, the remove of about 52% from the total quantity CKBp dust was achieved. The produced clinker per day was about 6000 t. If we replaced 3% clinker by washed CKBp dust about 180 t clinker is saved every day. This consumed about 81% per day from CKBp dust this results for one production line.

1. Introduction

Cement plays an important role in the building industry of any country in this fast developing world. Therefore, the need and use of cement is increasing gradually. New cement plants are being set up at a very rapid speed. The reserves of raw material for the cement, already explored, are limited. (Ali *et al.,* 2008). It is therefore very much necessary to find out new reserves of the raw material for different types of cement.

Limestone is a valuable raw material, which is widely used in the chemical, metallurgical and construction industries throughout the world. With huge deposition of limestone in Egypt, it is greatly used as the major raw material in cement manufacturing.

Lime is one of the raw materials used for cement manufacturing (Bhatty *et al.,* 2002). The location of a cement works is usually determined by the availability of adequate supplies of raw materials and the reasonable distance between the works and the provenance of raw material supply. Gabal Libni is an elongated SW-NE anticline dome affected by transverse normal faults trending NW-SE to E-W. Gabal Libni is mainly composed of high grade limestone, of terminal Cretaceous age, overlying a dolomitic substratum of late Cretaceous age (Farouk & Faris, 2008 and Armed Forces Cement Project, 2009) .

Wadi El-Mashashe is a flat and large valley accommodates a succession of strata composed mainly of recent surface sediments (siliceous and argillaceous materials mixed with carbonate fragments and gypsum) of variable thickness, covering a succession of massif clay beds with rare lenses of marly limestone or calcareous siltstone beds (Armed Forces Cement Project, 2009) and Military cement project, 2007).

The principal oxide of cement is CaO which is obtained from naturally occurring calcium carbonate (calcite) generally, makes up approximately 75%–80% of the raw material mixture used in cement clinker. This primary calcareous raw material may contain significant amounts of other oxides as impurities (Bouazza, 2016).

The secondary raw material is the clay 20%-25%. Widespread deposits of suitable raw materials for the manufacture of Portland cement are common in North-Central Sinai. Different types of limestone in different areas in Gebel Libni are extensively quarried. The quality, uniformity, quantity and likely problems of extraction, which are the amount of overburden to be removed. The study area covers Gebel Libni and adjoining areas of the Wadi El Masheshe (Figure 1, Temraz, 2010).

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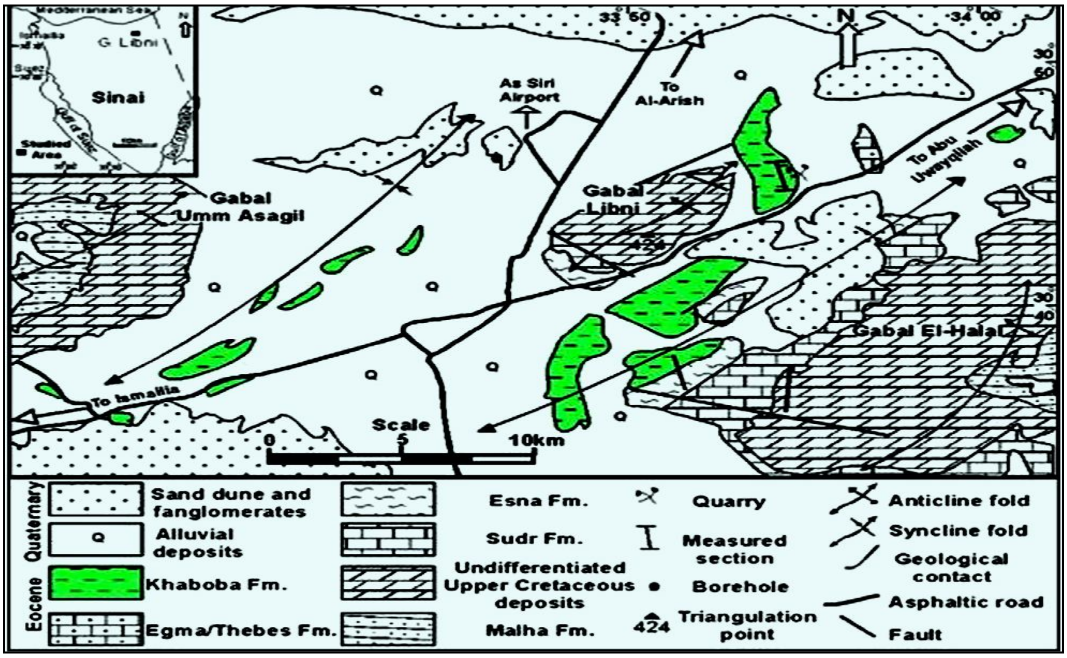

Fig. 1. The study area for cement manufactory in Gebel Libni and Wadi El Masheshe in north central Sinai, Egypt (after Temraz, 2010).

Cement kiln Bypass (CKBp) is one of such industrial waste or byproduct which is gradually major environmental concern related to its emission and disposal (katz and Kovler, 2004). CKBp dust is fine grained, solid, highly alkaline particulate material chiefly composed of oxidized, anhydrous, micron-sized particles collected from bad filters during the production of cement clinker (Kunal *et al.,*2012). Due to lack of landfilling space and ever increasing disposal cost, utilization of CKBp in highway uses, water treatment, soil stabilization, cement mortar/concrete, etc. has become an attractive alternative to its disposal (Rukzon and Chindaprasirl 2009).

Due to the high Cl, alkalis and the slightly high sulphate content in the clay deposited and aridity of the Egyptian country where rainwater is not sufficient, an appreciable amount of cement kiln bypass dust (CKBp) is produced during the manufacture of ordinary Portland cement clinker (Ghorab *et al.,* 2004).

The amount of the cement bypass added to landfill from El Arish Cement Company (ACC) is estimated between 200 and 250 T/d for one cement production line. This related to produced cement from the dry process. The bypass dust is a powder with fineness equivalent to that of ordinary Portland cement, has grayish white color. Its chemical composition depends on the volatility of its constituents and varies with the composition of the raw materials, their fineness and the type of fuel used in the production process.

This research focuses on the best suitable method used for recycling the CKBp dust in cement industry through replacement processes in cement production line . Results of this work have been composed with the work given by Khodary and El Kelesh (2015). Environmentally, the present work have advantage to avoid the accumulation of the solid waste and to turn it out as a beneficial material.

2. Experimental Processes

2.1 Sample preparation

Forty CKBp samples are collected from El Arish Cement Company (ACC) manufactory. These samples represent the four lines of production. They are subjected to chemical and mineralogical analyses. XRF (ACC Lab ARL 9900 X-ray) was used to determine the major oxides according to (Johnson, *et al.,* 1999). XRD (type PW3710 with CKα radiation, Metallurgy Institute of Minerals, Cairo) was used for identification the bulk mineral components. The identification was confirmed by computer-aided search of the PDF database obtained from the joint committee on Powder Diffraction Standard-International Center for diffraction data (Wong *et al.,* 2001).

2.2 Assurance chemical analysisw

Wet analytical method has been applied for chemical assurance of SiO_2, Al_2O_3, Fe_2O_3, CaO, and finally Cl was determined by XRF (ASTM C114, 2004). Flame photometry was used for determination of the contents Na_2O, K_2O % (Eubank and Bogue*,* 1949).

2.3 Experiments on reuse cement kiln bypass (CKBp)

2.3.1 Direct replacement by CKBp dust

The first experiment was done by replacement of untreated kiln bypass dust (CKBp) to raw meal, clinker (primary product) and cement (final product). Check process was performed by chemical analysis of cement kiln bypass (CKBp) to ensure the quality control index of the product given by El-Arish Cement Company (ACC).

2.3.2 Treatment of CKBp by washing process

From the experimental preparation, CKBp dust can't be used without treatment due to the high Cl and SO_3 contents. Treatment was carried out by washing of the CKBp dust with fresh and drain waters for reducing concentration of the undesirable elements. CKBp samples were soaked in different quantities of water. Then after 2 days washing water was removed from CKBp samples using Buchner pump and dried at (105 °C). Alkalis SO_3 and Cl in the washed CKBp dust are checked. Also the contents of SiO_2, Al_2O_3, Fe_2O_3, CaO and MgO are determined.

2.3.3 Recycling of washed CKBp in cement industry

This was done by the following replacements: i- replacing part of main raw meal by washed CKBp with limits (1 : 3%). ii- replacing part of each component in the raw meal by washed CKBp (limestone 1 : 3% and clay 2 : 5%). iii- replacing part of the primary product (clinker) by washed CKBp with limits (1 : 3%). iv- comparison results of replacement process with ACC quality control index.

Table 1. ACC quality control index for (raw meal – cement – clinker) TCDRI (2009).

Samples. No.	Raw meal		Clinker		Cement	
Undesired Elements	SO_3	Cl^-	SO_3	Cl^-	SO_3	Cl^-
Maximum limit%	≤ 0.60	≤ 0.30	≤ 1.2	≤ 0.10	≤ 3.0	≤ 0.10

3. Results and Discussion

3.1 Characteristics of the cement kiln bypass dust (CKBp)

The mineral components were determined by XRD analysis for a representative sample of CKBp dust. The X-ray diffraction pattern is shown in Figure (2). The mineralogical composition of the analyzed CKBp dust is consists of free lime (C), hydrates partly to Portlandite (CH) and Hartrunite(Ha) , depending on the exposure time to the atmosphere. Potassium chloride, known as sylvite (K), exceed halite (H), and/or anhydrite (AH), larnite (La).

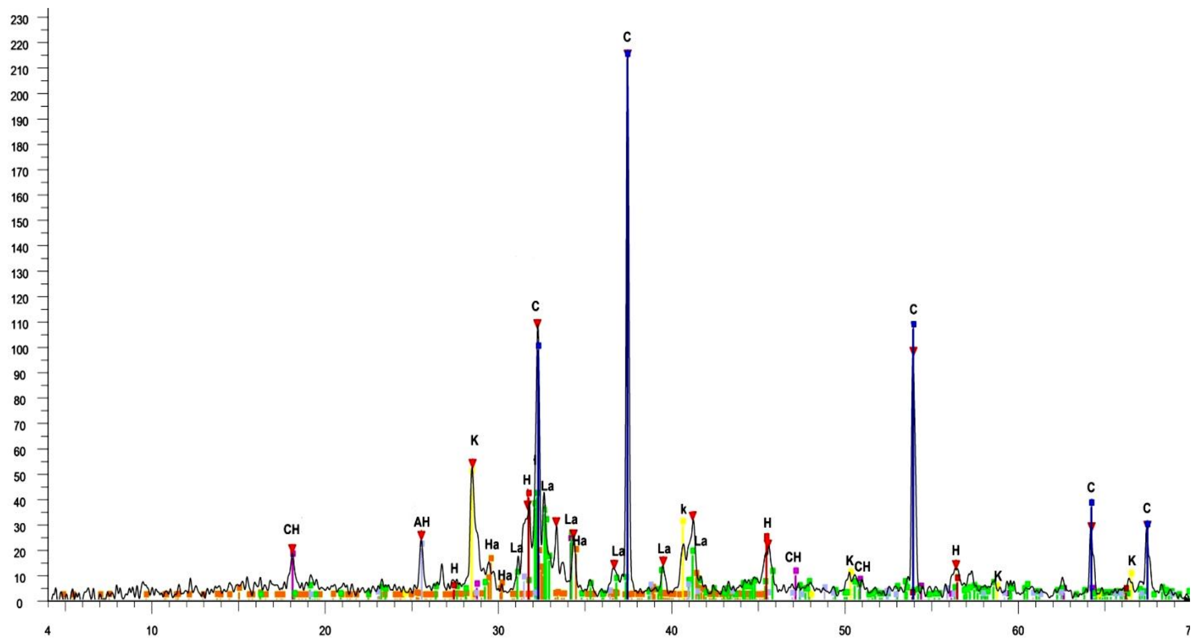

Fig. 2. Typical XRD pattern of minerals determined in a bulk cement kiln Bypass dust.

Data of chemical analysis for 40 CKBp dust samples obtained from XRF is summarized in Table (2) indicate that the lime average contents fluctuated between 41 and 56.82% with total average value 51.16%. In general, SiO_2, Al_2O_3, Fe_2O_3, and MgO_2 occur in quite similar contents in the four production lines. Their average values are 13.02%, 4.02%, 2.39%, and 3.39%, respectively.

Table 2. Ranges and averages of chemical composition for 40 CKBp samples which were collected from the four production lines of the ACC factory. (Data obtained from XRF analysis in %).

Oxides	Line 1			Line 2			Line 3			Line 4			Total Aver.
samples		No	=10		No	=10		No	=10		No	=10	
	Min	Max	Aver	Min	Max	Aver	Min	Max	Aver	Min	Max	Aver	
SiO_2	9.53	13.80	12.15	11.5	15.08	12.86	12.9	15.08	11.55	12.15	13.8	9.5	13.03
Al_2O_3	3.24	4.38	4.0	3.91	4.89	4.28	4.28	4.89	3.91	4	4.38	3.2	4.02
Fe_2O_3	2.09	2.47	2.31	2.25	2.64	2.40	2.4	2.64	2.25	2.3	2.47	2.1	2.39
CaO	41.10	54.38	49.08	49.8	56.82	52.98	53	56.82	49.81	49.08	54.38	41	51.16
Mgo	0.51	0.61	0.57	0.49	0.63	0.57	0.57	0.63	0.49	0.57	0.61	0.5	3.39
SO_3	3.53	6.21	4.40	3.41	4.70	4.16	4.16	4.7	3.41	4.4	6.21	3.5	4.95
Na_2O	0.57	2.87	1.07	0.46	0.87	0.67	0.67	0.87	0.46	1.07	2.87	0.6	2.32
K_2O	7.28	11.4	9.05	5.72	8.77	7.61	7.61	8.77	5.72	9.04	11	7.3	6.62
Cl	6.47	13.67	9.02	5.16	8.39	6.91	6.91	8.39	5.16	9.02	13.67	6.5	7.76

It was observed that Na_2O generally occurs in amounts lower than that of K_2O. Chloride and sulfate concentrations varied greatly corresponding to the kind of production line. Sulfate and chloride values varied from 3.5 to 6.2% and from 5.16% to 13.67%, respectively.

3.2 Recycling of cement kiln bypass (CKBp)

3.2.1 Direct replacement by CKBp dust

Results of chemical analyses are given in Tables (3, 4&5) and shown in Figures (3, 4& 5). Table (3) illustrates the effect of replacing 1% of the raw meal by cement kiln bypass dust (CKBp) on the chemical composition of the resulting mixes. It was noticed that replacement 1% of raw meal by CKBp dust leads to mix characterized by chemical analysis fitting the permissible values for all oxides except chloride (Cl) and sulfur trioxide (SO_3) whose values are higher than the allowed limits (0.28 to 0.40% for Cl and 0.44 to 0.60% for SO_3, respectively). Thus this procedure does not match with the quality control index of the raw meal (Cl ≤ 0.3 and SO_3 ≤ 0.6 %). It is concluded that replacement of raw meal by fresh CKBp is not a suitable process. This result is unconfirmed with the study of Ghorab *et al*. (2004). They concluded that cement kiln dust containing up to 8% chloride may replace 1% of the raw meal without varying its final composition and up to 5% of the clay used in the meal. Less than 1% of the sulfate- rich cement dust containing 11.5% SO_3 should however, replace the raw meal or the clay used. Also they found that replacement of limestone by cement dust in not recommended due to lowering of the lime content in the raw meal.

Table 3. Replacement raw meal by 1 % CKBp dust

Samples	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl	L.S.F	SM	AM
CKBp	13.16	4.67	2.52	58.3	1.1	3.78	3.00	4.00	8.75	-	-	-
Raw meal	13.39	3.91	2.44	41.93	0.54	0.44	0.36	0.22	0.28	95.9	2.11	1.6
99%RM with 1%CKBp	13.11	3.92	2.41	41.97	0.53	0.5	0.39	0.29	0.40	97.7	2.07	1.62

L.S.F. Lime saturation factor SM Silica modules AM Alumina modules

Samples	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl
CKBp	13.16	4.67	2.52	58.30	1.1	3.78	3.00	4.00	8.75
clinker	21.18	6.28	4.05	65.7	0.77	1.08	0.47	0.155	0.029
99% CK with 1% CKBp	21.09	6.20	3.996	65.3	0.75	1.10	0.471	0.207	0.103

Table 5. Replacement cement by 1% CKBp dust

Samples	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl
CKBp	13.16	4.67	2.52	58.30	1.1	3.78	3.00	4.00	8.75
Cement	19.7	5.64	3.56	64.87	0.61	2.95	0.39	0.18	0.02
99% Cement replaced with 1%CKBp	19.45	5.58	3.54	64.39	0.6	2.96	0.423	0.24	0.12

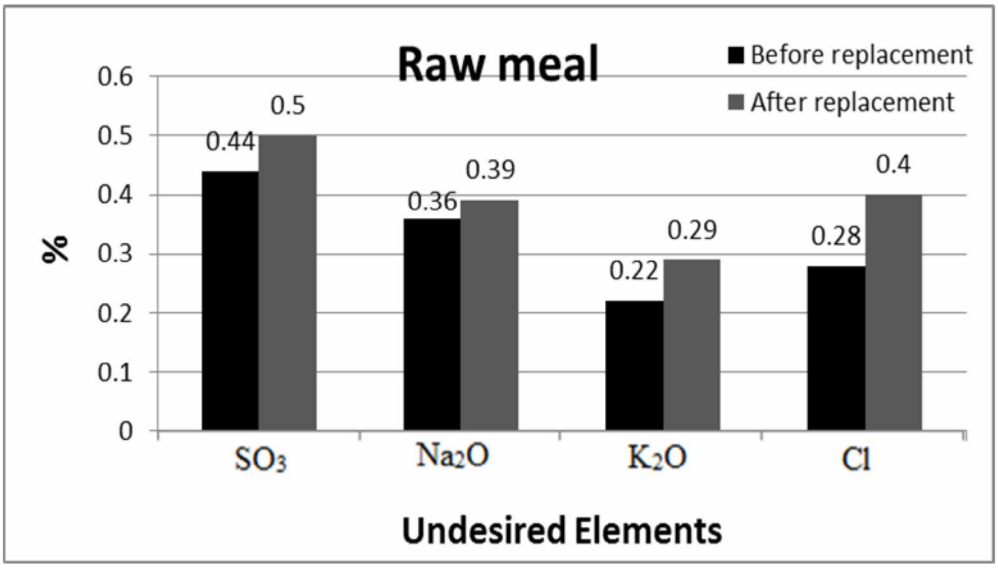

Fig. 3. Bar graph distribution for concentrations of the undesired elements before and after replacement of raw meal with1% CKBp dust.

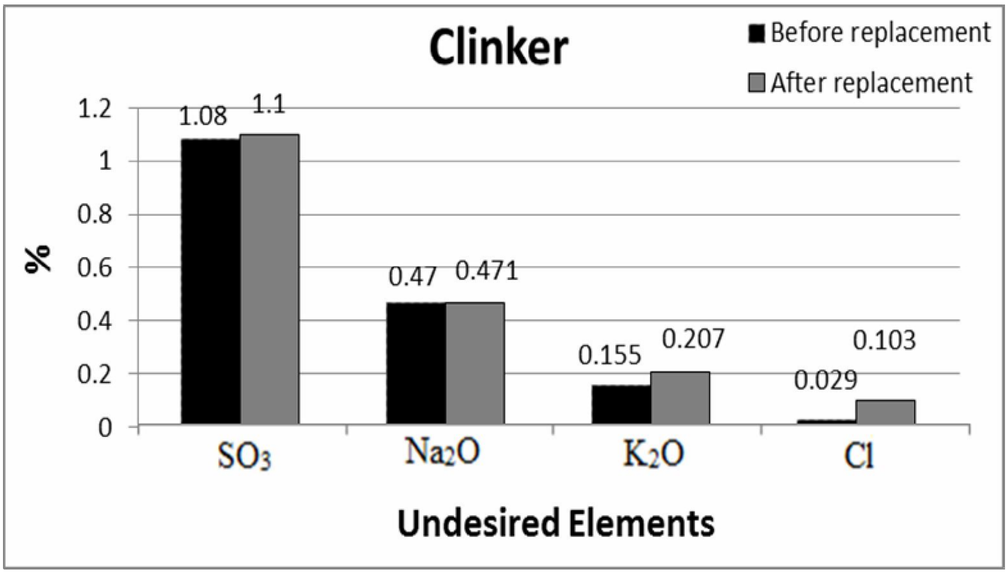

Fig. 4. Bar graph distribution for concentrations of the undesired elements before and after replacement of clinker with 1% CKBp dust.

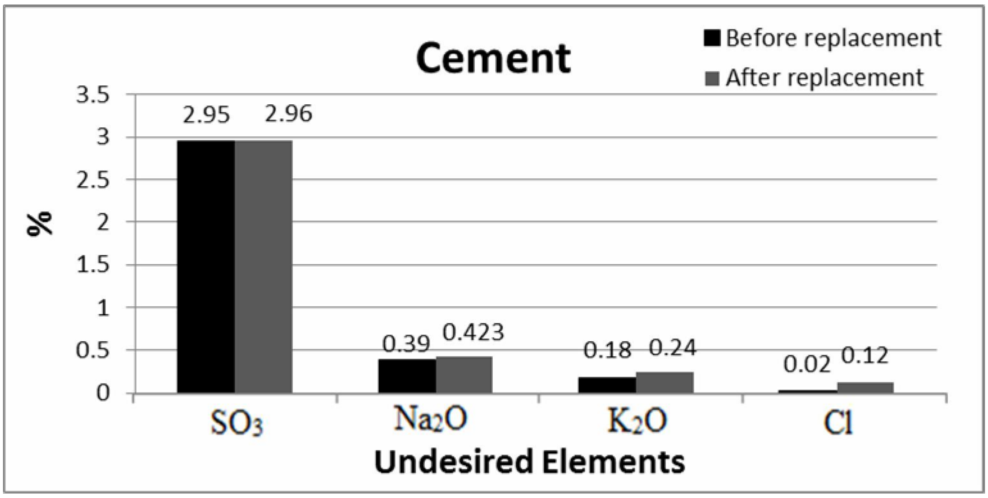

Fig. 5. Bar graph distribution for concentrations of the undesired elements before and after replacement of cement with 1% CKBp dust.

The second and the third replacement processes for clinker and cement product by fresh CKBp cause increasing of SO_3 and Cl values. The obtained results of these experiments are not conformable with quality control index for cement raw materials to produce both clinker (primary product) and cement (final product).

3.2.2 Replacement with washed CKBp dust

In fact, the more effective process to reuse CKBp again in cement manufacture is soaking CKBp in fresh or drain water before replacement in order to decrease concentration of the undesirable elements (Cl and SO_3). Step of washing process was done to determine whether suitable and effective fresh or drain water.

In general, washing process was made up by mix 100 gm CKBp with 200ml and 250 ml fresh and/or drain water. Process of washing was done by soaking the CKBp dust for two days. Experiment results are summarized in Tables (6&7) and shown in Figures (6&7).

Table 6. Effect of washing CKBp dust with fresh water.

Limits of washing process	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl	*Washing Eff.%
CKBp	13.2	4.67	2.52	58.3	1.1	3.7	3.00	4.00	8.76	-
100gm:200ml	14.3	3.76	2.58	57.5	1.2	4.6	0.99	1.7	1.7	80.5 %
100gm:250ml	14.1	3.94	2.56	57.6	1.1	4.5	0.82	1.5	1.4	84.0 %

*Washing efficiency is based on the change of chloride content.

Table 7. Effect of washing CKBp dust with drain water.

Limits of washing process	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl	*Washing Eff %
CKBp 100gm	13.16	4.67	2.52	58.3	1.1	3.78	3.0	4.0	8.76	-
100gm:200 ml	13.12	4.03	2.59	57.58	3.51	5.67	0.97	1.69	2.03	77%
100gm:250 ml	13.39	4.12	2.64	59.04	3.47	5.34	0.77	1.24	1.47	83.2%

*Washing efficiency is based on the change of chloride content.

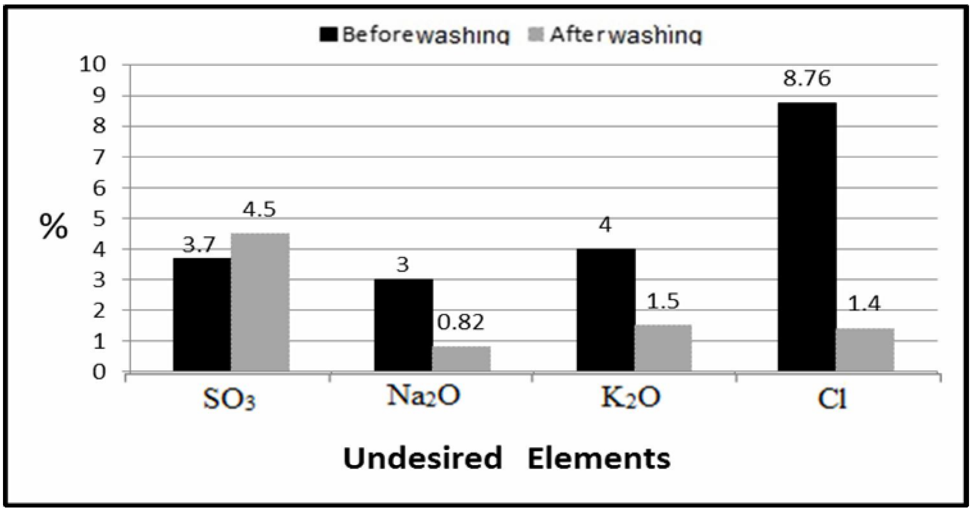

Fig. 6. Bar graph distribution for content of undesired elements in CKBp after washing with water.

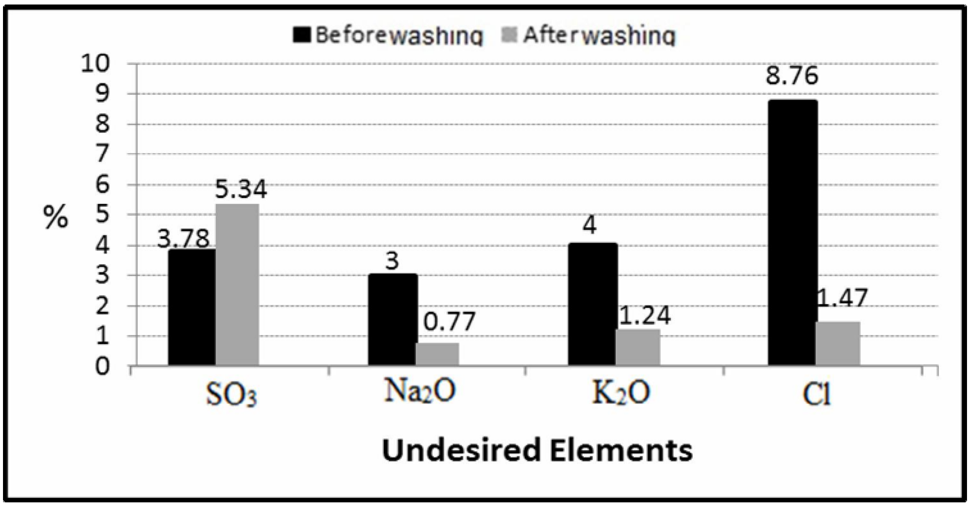

Fig. 7. Bar graph distribution for content of undesired elements in CKBp after washing with drain water.

It was noticed that when the amount of fresh water increased washing efficiency increased too (Table 6). The best result was found in step (4) where Cl value decreased to 1.4 %, while SO_3 value increased to 4.5%.

The second experiment was made by washing 100 gm of CKBp in different quantities of drained water for 2 days. It was observed that when the amount of water increases washing efficiency increases too (Table 6&7). The best result is focused to step where Cl value was decreased to 1.47 %, and SO_3 value increased to 5.34%. Increasing of SO_3 is related to the high concentration of salts in the drain water. It is concluded that the optimum water type for washing cement bypass is related to the drain water for several reasons:

i. Using of fresh water in washing is very expensive especially for those cement plants constructed in desert regions where ~ $1m^3$ pure water cost about 25 to 35 pound.

ii. El-Arish Cement Company (ACC) produced about 600 M^3 drain water daily for two production lines. Thus using this water for washing treatment of CKBp leads to consume all drain water which will causing pollution to the environment.

iii. Washing of CKBp by drain water remove nearly 83.1% of undesirable elements therefore, it seems to be the best suitable treatment for CKBp.

However, in case of insufficient drain water for washing, the author suggests heating of drain water to certain degrees as additional process applied on washing the cement byproduct to improve washing of the CKBp dust for reducing the undesired elements. It is interesting to mention here that source of heat can be obtained from the cement factory main chimney. The suitable degrees of temperature for washing process fall at the 50 °C, 60 °C and 70 °C.

Table 8. Effect of washing CKBp dust by drain water at different degrees of temperature.

Treatment in different Temp.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Cl
CKBp	13.16	4.67	2.52	58.3	1.1	3.78	3.00	4.00	8.75
50 °C 100gm:200ml	14.25	4.33	2.78	59.84	5.21	3.55	0.72	0.94	1.37
60 °C 100gm:200ml	14.32	4.21	2.76	58.90	5.1	3.52	0.91	1.25	1.88
70 °C 100gm:200ml	13.36	3.93	2.64	57.37	4.6	3.62	1.37	1.96	2.95

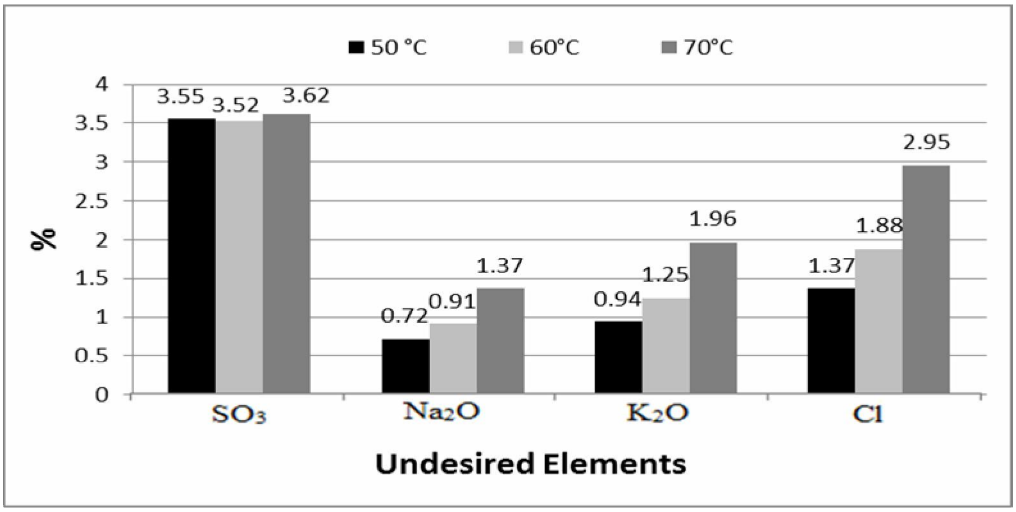

Fig. 8. Bar graph representation showing results of washed CKBp dust by drain water at different degrees of temperature (100gm : 200ml).

CKBp is washed by drained water at 50 °C then dried, process of replacement is carried out on raw meal, clinker and cement. Results are summarized in the following:

3.2.2.1 Replacement of the raw meal by washed CKBp dust

Replacement limits 0.5 – 3% had been done for the raw meal by washed CKBp. Result of analysis is summarized in Table (9). This experiment proved that replacement process of raw meal by washed CKBp dust has no effect on the quality of the raw mix therefore replacement limit 3% for raw meal is considered. It is interesting to mention here that replacement process will saving raw meal and reduce cost. The most important aim for waste (CKBp) dust recycling is improve the environment. On the other hand, a cement production line of the ACC consumed about 10500 tons per day raw meal. Using of washed CKBp dust to replace raw meal will consume every day about 156 to 160 tons (about 78% CKBp dust).

Table 9. Results of replacement cement raw meal with washed CKBp dust.

Analyzed parameters	Raw meal	*Washed CKBp	Replacement limits				
			99.5% R.M : 0.5% w.CKBp	99 % R.M : 1% w.CKBp	98.5% R.M: 1.5% w.CKBp	98% R.M :2 % w.CKBp	97%: RM : 3% w.CKBp
SO_3	0.47	3.55	0.48	0.51	0.54	0.57	0.61
Na_2O	0.36	0.72	0.37	0.37	0.38	0.37	0.37
K_2O	0.22	0.94	0.23	0.23	0.27	0.26	0.25
Cl	0.23	1.37	0.24	0.25	0.25	0.27	0.29
L.S.F	96.09	-	96.43	96.45	96.81	96.95	97.06
SM	2.08	-	2.06	2.08	2.06	2.07	2.08
AM	1.63	-	1.60	1.63	1.61	1.62	1.64

*Washing took place with hot drain water (at 50 °C)

3.2.2.2 Replacement of limestone in the raw meal by washed CKBp dust

This was performed by preparing raw meal in the lab with percentages (70% limestone, 28% clay, 1% sand and 1% iron ore). Results of replacement limestone in the prepared raw meal by washed CKBp are summarized in Table (10). This experiment indicates that using washed CKBp for the replacement of limestone in cement raw meal causes a decrease in LSF (lime saturation factor) to value equal 89.37 thus more limestone will be needed to correct this module. Replacement of limestone in the raw meal by washed CKBp dust is not recommended.

Table 10. Results of replacement limestone in raw meal with washed CKBp dust.

Analyzed parameters	Prepared R.M	*Washed CKBp	Replacement limits		
			99% L.M:1% W.CKBp	98% L.M: 2% W.CKBp	97 % L.M:3% W. CKBp
SO_3	0.58	3.55	0.62	0.64	0.67
Na_2O	0.41	0.72	0.45	0.44	0.46
K_2O	0.24	0.94	0.25	0.25	0.25
Cl	0.22	1.37	0.23	0.24	0.25
L.S.F	94.97	-	91.06	90.01	89.37
SM	2.01	-	2.03	1.99	1.98
AM	1.66	-	1.76	1.72	1.69

* Washing took place with hot drain water (at 50 °C)

3.2.2.3 Replacement of clay in raw meal by washed CKBp dust

Observations on the addition of washed CKBp dust to the clay in the raw meal indicate that replacement process did not affect the quality of the prepared raw meal (Table 11). In addition, increase of the lime saturation factor (LSF) therefore, percentage of raw limestone must be decreased to meet the standard 97.6 LSF therefore saving the raw materials. In fact, the replacement of clay in raw meal by washed CKBp appears most beneficial for recycling CKBp dust in cement industry. Thus the percentages of the raw material must be recalculated to meet with raw meal modules. If we used 10500 t/d of raw meal with clay percent 21.1%, this corresponds to about 2280 tons clay per day. Using of 5% washed CKBp to replace the clay lead to consume about 114 t/d from CKBp dust. This help to remove about 52% from the total quantity CKBp dust.

Table 10. Results of replacement of clay in cement raw meal by washed CKBp dust.

Analyzed parameters	Raw meal	*Washed .CKBp	Replacement limits				
			99 % Clay: 1% W. CKBp	98% Clay: 2% W.CKBp	97% Clay: 3% W.CKBp	96% Clay: 4% W.CKBp	95 % Clay: 5% W.CKBp
SO_3	0.43	3.55	0.45	0.45	0.45	0.46	0.46
Na_2O	0.34	0.72	0.34	0.33	0.33	0.33	0.32
K_2O	0.21	0.94	0.22	0.22	0.23	0.22	0.21
Cl	0.14	1.37	0.154	0.157	0.159	0.163	0.166
L.S.F	97.60	-	99.2	100.9	103.8	103.4	104.4
SM	2.11	-	2.10	2.09	2.09	2.09	2.10
AM	1.50	-	1.51	1.52	1.53	1.54	1.54

* Washing took place with hot drain water (at 50 °C)

3.2.2.4 Replacement of clinker by washed CKBp dust

The experiment firstly begins by analyzing qualified clinker and take it as a reference sample (Table 11). The process carried out with replacement clinker by1% to 3% washed CKBp dust with limits (1% to 3%). It was observed that using limits 1 -3% for washed CKBp to replace clinker appears more effective where no change for clinker quality (Cl and SO_3 not exceed than 0.12% and 1.2%, respectively). Clinker produced per day was about 6000 t. If we replaced 3% clinker by washed CKBp about 180 t clinker is saved every day. This consumed about 81% per day from CKBp dust.

Table 11. Results of replacement clinker with washed CKBp dust.

Analyzed parameters	Clinker	*Washed CKBp	Replacement limits		
			99% Clinker +1% W. CKBp	98% Clinker +2% W. CKBp	97% Clinker +3% W. CKBp
SO_3	1.2	3.55	1.36	1.40	1.41
Na_2O	0.46	0.72	0.48	0.48	0.49
K_2O	0.192	0.94	0.21	0.22	0.24
Cl	0.03	1.37	0.063	0.078	0.120
C_3S	57.93	-	55.32	55.30	55.25
C_2S	16.13	-	17.35	17.06	16.97
C_3A	9.6	-	9.48	9.44	9.34
C_4AF	11.67	-	11.58	11.52	11.52

* Washing took place with hot drain water (at 50 °C)

4. Conclusions

The majority of CKBp is recycled back into the cement kiln as raw feed. In addition, new technology has allowed the use of landfilled CKBp to be use as raw feed stock. Recycling this by-product back into the kiln not only reduces the amount of CKBp to be managed outside the kiln, it also reduces the need for limestone and other raw materials, which saves natural resources and helps conserve energy. The value of CKBp is not limited to its use as a raw material for return to a Portland cement kiln.

1. Direct replacement of raw meal, clinker and final cement product by fresh CKBp is not recommended due to the high contents of undesired elements Cl^- and SO_3 in cement manufacturing.
2. Washing of CKBp dust by drain water removes nearly 83.1% of the undesired chlorides. Valuable fresh water is not recommended.
3. The most effective washing process for CKBp dust is using hot drain water at 50°C.
4. Using of washed CKBp to replace raw meal mix will consume every day about 156 to 160 tons (78% CKBp dust).
5. Using of 5% washed CKBp to replace the clay leads to consume about114 t/d from CKBp. This help us to remove about 52% from the total quantity CKBp.
6. Using limits 1-3% for washed CKBp to replace clinker is more effective due to the constant of clinker quality. Replacing 3% of clinker saves180t clinker every day and consuming about 81% of CKBp dust per day.
7. Utilizing cement bypass dust have large effect on the environmental and socioeconomic benefits which can be summarized in the following:

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الملخص العربى

إعادة تدوير غبار فرن صناعة الأسمنت البورتولاندى وتأثير ذلك على البيئة ، مصنع أسمنت العريش بسيناء- مصر

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الدراسة الحالية تركز على إمكانية تدوير غبار فرن الأسمنت و إستخدامه فى صناعة الأسمنت عن طريق إحلاله محل الخليط الخام المطحون (الحجر الجيرى - الطين) أو الكلنكر. طبقت عمليات الغسيل على غبار فرن الأسمنت وذلك لإعادة إستخدامة فى مصنع العريش للأسمنت بوسط سيناء لحل مشكلة إرتفاع محتوى كل من الكلوروالكبريتات وذلك لملائمتها لعوامل الجودة. الدراسة أثبتت أن عملية إحلال خليط الخامات بغبار مخلفات الأسمنت المغسول لم يؤثر على جودة الخليط ولهذا فإن حدود الإحلال ٣% لخليط الخام يعتبر مناسب جدا. وعلى الجانب الآخر فإن عملية الإحلال سوف توفر خليط الخامات وتقلل التكلفة. ولقد وجد أن إستعمال غبار فرن الأسمنت لإحلاله محل خليط الخام يستهلك من ١٥٠ إلى ١٦٠ طن يوميا أى حوالى ٧٨% من غبار فرن الأسمنت لخط إنتاج واحد. بينما إستخدام ٥% من الغبار المغسول ليحل محل الطين يؤدى إلى إستهلاك ١١٤ طن يوميا من هذا الرماد. وهذا يساعد على التخلص من حوالى ٥٢% من الكمية الكلية للغبار. إن إنتاج الكلنكر فى اليوم الواحد يصل إلى ٦٠٠٠ طن فإذا ما تم إحلال ٣% من الكلنكر بالغبار المغسول يوفريوميا حوالى ١٨٠ طن من الكلنكر. وهذا بدوره يؤدى إلى إستهلاك حوالى ٨١% من غبار فرن الأسمنت يوميا.

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Recycling of Cement Kiln Bypass Dust in the production of Portland Cement and environmental impact, El Arish Cement Company, Sinai – Egypt

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