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**RECYCLING OF SOME INDUSTRIAL  
BY-PRODUCTS IN THE PREPARATION OF  
BLENDED CEMENT**

BY

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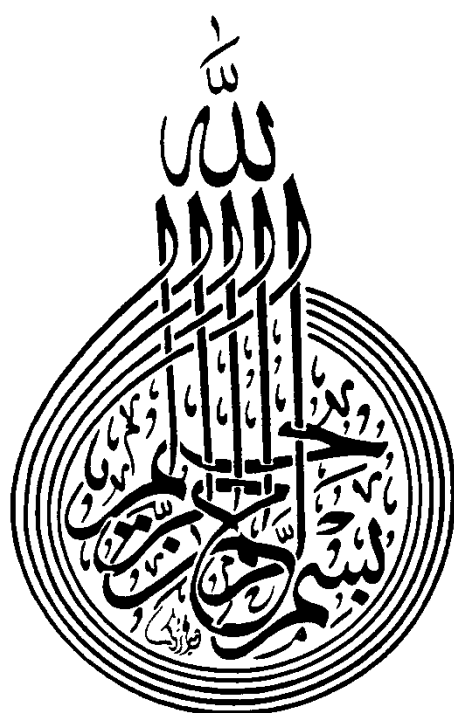
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## **ABSTRACT**

**RECYCLING OF SOME INDUSTRIAL BY-PRODUCTS IN THE PREPARATION OF BLENDED CEMENT (M.Sc. THESIS)**, Submitted by Chemist: **Tarek Moustafa El-Sokkary**, B.Sc.(1984), Mansoura University, Geology/Chemistry Department, Chemist in Soil Mechanics and Foundation Department .at **Housing and Building Research Center, Dokki - Cairo**.

The materials used in this work were cement kiln dust from the dry process, condensed silica fume (Kom-Ombo), Ordinary Portland, slag as well as Karnak cements provided from Helwan Cement Company. The effect of leaching and firing of dry cement dust on the sublimation and removal of the alkali oxides  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$  as well as  $\text{Cl}^-$  and  $\text{SO}_3$  was studied . Blended cements were prepared from each type of cement with various proportions from fired as well as wet cement dust and silica fume. The Kinetics of hydration of the cement pastes such as the liberated free lime and combined water contents were determined as a function of curing time up to 90 days. Also, the water of consistency, initial and final setting times, as well as bulk density and compressive strength of hardened cement pastes were measured. It can be concluded that the washed and fired dry cement dust at  $1350^\circ\text{C}$  can be used in the presence of silica fume for the activation of slag cement . Also, the raw wet cement dust can be used up to 5% in the preparation of blended cements from ordinary Portland , slag and Karnak cement . The liberated  $\text{Ca(OH)}_2$  was consumed by the condensed silica fume whereas the addition of washed and fired as well as raw wet cement dust tends to increase the liberated  $\text{Ca(OH)}_2$  which increases with the amount of added cement dust . The fired cement dust increases the mechanical properties of slag cement and decreases that of ordinary as well as Karnak cements .

**\*Key Words :**

**O.P.C : Ordinary Portland Cement**

**SL.C : Slag Cement**

**K.C : Karnak Cement**





## CONTENTS

	Page
ACKNOWLEDGEMENT	I
ABSTRACT	II
CONTENTS	III
<b>CHAPTER I</b>	
<u>INTRODUCTION</u>	1
1.1. Introductory Remarks	1
1.2. Cement Kiln Dust and its Recycling	3
1.3. Hydration of Portland and Blended Cements	8
1.4. Blended Cements	12
1.5. Effect of Alkalies on the Hydration of Cement	16
1.6. Corrosion of Reinforcement	18
1.7. The Objective of The Present Work	19
<b>CHAPTER II</b>	
<u>MATERIALS AND METHODES OF INVESTIGATION</u>	21
2.1. Starting materials	21
2.2. Leaching and firing of cement kiln dust	22
2.3. Preparation of Different Blended Cements	22
2.4. Preparation of Cement Pastes	24
2.5. Methods of Investigation	25
2.5.1. Water of consistency and setting time	25
2.5.2. Bulk density measurements	26
2.5.3. Compressive strength determination	27
2.5.4. Stopping of hydration	27
2.5.5. Chemically-combined water determination	28
2.5.6. Free lime determination	28
2.5.7. Electrochemical measurements	29
2.5.7.1. Preparation of the reinforcing steel samples	30
2.5.7.2. Preparation of the steel in paste electrodes	31
2.5.7.3. Curing in humidity chamber	32
2.5.7.4. Curing in sea water	32
<b>CHAPTER III</b>	
<u>RESULTS AND DISCUSSION</u>	33
3.1. Effect of Leaching and Thermal Treatment on Chemical and Mineralogical Composition of Cement Kiln Dust	33
3.2. Chemical Composition of Washed, Fired Cement Kiln Dust	36
3.3. Mineralogical Composition of Washed, Fired Cement Kiln Dust	37
3.4. Effect of Washed, Then Fired Cement Klin Dust on the Properties of Different Cements	39
3.4.1. Ordinary Portland Cement	39
3.4.1.1. Water of consistency and setting time	39
3.4.1.2. Free lime content	43
3.4.1.3. Chemically-combined water content	47

- IV -

3.4.1.4. Bulk density	53
3.4.1.5. Compressive strength	57
3.4.2. Slag Cement	60
3.4.2.1. Water of consistency and setting time	60
3.4.2.2. Free lime content	64
3.4.2.3. Chemically-combined water content	66
3.4.2.4. Bulk density	68
3.4.2.5. Compressive strength	70
3.4.3. Karnak Cement "Sand Cement"	72
3.4.3.1. Water of consistency and setting time	72
3.4.3.2. Free lime content	74
3.4.3.3. Chemically-combined water content	76
3.4.3.4. Bulk density	78
3.4.3.5. Compressive strength	80
3.5. Effect of Raw Wet Cement Kiln Dust on the Properties of Different Cements	82
3.5.1. Ordinary Portland Cement	82
3.5.1.1. Water of consistency and setting time	84
3.5.1.2. Free lime content	87
3.5.1.3. Chemically-combined water content	91
3.5.1.4. Bulk density	95
3.5.1.5. Compressive strength	99
3.5.2. Slag Cement	103
3.5.2.1. Water of consistency and setting time	105
3.5.2.2. Free lime content	108
3.5.2.3. Chemically-combined water content	112
3.5.2.4. Bulk density	116
3.5.2.5. Compressive strength	120
3.5.3. Karank Cement "Sand Cement"	124
3.5.3.1. Water of consistency and setting time	126
3.5.3.2. Free lime content	130
3.5.3.3. Chemically-combined water content	134
3.5.3.4. Bulk density	136
3.5.3.5. Compressive strength	140
3.6. Corrosion Behaviour of Reinforcing Steel Embedded in Different Mixes of Hardened Cement Pastes Cured in Aggressive Environments	144
3.6.1. Anodic polarization behaviour of reinforcing steel embedded in different mixes of hardened cement pastes cured in humidity chamber	148
3.6.2. Anodic polarization behaviour of reinforcing steel embedded in different mixes of hardened cement pastes cured in sea water	151
<b>CHAPTER IV</b>	
<u>SUMMARY AND CONCLUSION</u>	156
REFERENCES	161
ARABIC SUMMARY	

# **CHAPTER I**

# **INTRODUCTION**



# **CHAPTER I**

## **INTRODUCTION**

### **1.1. Introductory Remarks**

The word "cement" denotes any kind of binding agent. This definition includes a wide variety of substances having little in common with one another but adhesiveness. However, materials most commonly associated with this word are hydraulic cements of which Portland cement is the most familiar. The use of cement is very old. The ancient Egyptians used calcined impure gypsum. The Greeks and Romans used calcinated limestone and later learned to add to lime and water, sand and crushed stone or bricks.

Portland cement is manufactured by intimately mixing a calcareous (lime-containing) and argillaceous (clay-containing) materials which can be done either in water (wet process) or in dry (dry process). After mixing and grinding of the raw mixture it is burned at a clinkering temperature, up to 1450 °C. The product of the rotary kiln is called cement clinker, which is cooled, mixed with a few percent of gypsum and ground to a very fine powder.

The main constituents exist in the cement clinker are : -

Tricalcium silicate	$3 \text{ CaO} \cdot \text{SiO}_2$ ( $\text{C}_3\text{S}$ )	"Alite"
$\beta$ -Dicalcium silicate	$\beta\text{-}2\text{CaO} \cdot \text{SiO}_2$ ( $\text{C}_2\text{S}$ )	"Belite"
Tricalcium aluminate	$3 \text{ CaO} \cdot \text{Al}_2\text{O}_3$ ( $\text{C}_3\text{A}$ )	
Tetracalcium aluminoferrite	$4 \text{ CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$ ( $\text{C}_4\text{AF}$ )	

These four compounds occur together to the extent of about (90%) of the cement by weight with some free CaO, MgO, Na<sub>2</sub>O, K<sub>2</sub>O, SO<sub>3</sub> and few other trace elements [(Lee,1970), (Taylor,1964)].

Several types of Portland cement are manufactured having different characteristics. The most important standard types of Portland cement are (Neville, 1981) :-

\* **Normal or Ordinary Portland Cement** : This is a general purpose cement, suitable for all uses when the special properties of other types are not required. The cooled clinker typically contains four compounds in the approximate proportions (Neville, 1981).

Tricalcium silicate, ( $C_3S$ )	= 55%
$\beta$ -Dicalcium silicate, $\beta$ -( $C_2S$ )	= 20%
Tricalcium aluminate, ( $C_3A$ )	= 10%
Tetracalcium aluminate ferrite ( $C_4AF$ )	= 10%

\* **High-Early Strength Portland Cement** : This cement is used when early strength is required. It is ground to a higher fineness than ordinary Portland cement which is usually ground to a specific surface area of 2500 to 3000  $\text{cm}^2/\text{g}$  compared with at least 3300 to 4000  $\text{cm}^2/\text{g}$  for this type.

\* **Low Heat Portland Cement** : This is a special cement for use where the amount and rate of heat generation must be kept very low. It is used in the construction of massive structures such as dams. This type of cement has a strict composition where the maximum  $C_3A$  is limited to 7 % whereas the  $\beta$ - $C_2S$  should not be less than 40 % (Neville, 1981).

\* **Sulphate - Resisting Portland Cement** : This cement is used only in structures exposed to severe sulphate action. It is manufactured in the same way as Portland cement, except that the iron content is increased to reduce the percentage of tricalcium aluminate to below the 3.0% and the  $\text{SO}_3$  content to 2.5%