

استهلال

قال تعالى:

بسم الله الرحمن الرحيم

أَشْكُرُ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَىٰ آلِيَّ وَآلِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا  
وَأَدْخِلَنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ )

صدق الله العظيم

سورة النمل الآية (19)

## **DEDICATION**

*To the most wonderful parents in the world my  
parents for their endless love, support and  
encouragement*

*To my brother and sisters*

*To my friends*

*I am trying to say thank you*

## **Acknowledgements**

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## **Abstract**

Cement free lime value generally indicates quality of raw materials, the completeness of the clinkering reaction and the quality of the burning practices hence the quality of the cement. A high free lime clinker is usually due to in-homogeneity and coarseness of cement raw mix or to improper burning and cooling condition in the kiln. Excess free lime results in undesirable effects such as volume expansion, increased setting time or reduced strength; hence it is critical to measure free lime content to ensure the quality of cement.

The aim of this research was to determine the percentage of free lime in different Sudanese cement samples (Berber cement and Atbara cement) by using methods that depend on extraction with ethylene glycol using different methods and also to study the effect of extraction temperature, extraction time and the concentration of hydrochloric acid on the results obtained by extraction with ethylene glycol.

The results obtained by all methods showed that the samples containing free lime percentage agreed with accepted values (not more than to 2% max according to ASTM). Also it is found that the percentage of free lime increased with increasing extraction temperature (50, 70 and 100°C), extraction time (5, 10 and 20 minutes) and hydrochloric acid concentration (0.05, 0.1 and 0.2 M).

## مستخلص البحث

تشير قيمة كمية الجير الحر في التحليل الكيميائي للأسمنت إلى جودة المواد الخام، إكمال عملية المعالجة الحرارية في فرن الحرق، وجودة عمليات الحرق مما يضمن جودة المنتج النهائي. تعود الزيادة في نسبة الجير الحر في عينات الكلنكر إلى عدم تجانس وعدم نعومة مخلوط المواد الخام أو الحرق الغير جيد أو ظروف التبريد السيئة في الفرن. ويؤدي الفائض من الجير الحر في الأسمنت إلى تمدد حجم الجسم الأسمنتي، زيادة في زمن التصلب وضعف في القوة وبذلك يكون قياس كمية الجير الحر مؤشر للجودة.

الهدف من هذا البحث تعيين نسبة الجير الحر في عينات مختلفة من الأسمنت السوداني (أسمنت بربر، أسمنت عطبرة) بطرق تعتمد على الإستخلاص بواسطة مذيب الإثيلين غلايكول وكذلك دراسة أثر حرارة الإستخلاص، زمن الإستخلاص وتركيز حمض الكلور على النتائج المتحصل عليها بالإستخلاص بمذيب الإثيلين غلايكول.

كانت النتائج المتحصل عليها بكل الطرق متفقة مع النسب المحددة في الطرق القياسية الأمريكية لاختبار المواد (في حدود 2%).

ووجد ان نسبة الجير الحر تزيد بزيادة حرارة الإستخلاص (50،70 و 100 درجة مئوية)، زمن الاستخلاص (5، 10 و 15 دقيقة) وتركيز حمض الكلور (0.05، 0.1 و 0.2 مولار).

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### List of Abbreviations

A*	Aluminum oxide or alumina ( $\text{Al}_2\text{O}_3$ )
AR	Alumina Ratio
ASTM	American Standards for testing materials
C*	Calcium oxide or lime ( $\text{CaO}$ )
$\text{C}_2\text{S}^*$	Dicalcium silicate ( $2\text{CaO}\cdot\text{SiO}_2$ )
EDTA	ethylene diamine tetraacetic acid
IR	Insoluble residue
F*	Iron oxide or rust ( $\text{Fe}_2\text{O}_3$ )
LCF	Lime Combination Factor
LSF	Lime Saturation Factor
LOI	Loss on ignition
LHPC	Low-Heat Portland Cement
M*	Magnesium oxide, periclase or magnesia ( $\text{MgO}$ )
M.wt	molecular weight
M	Morality
OPC	Ordinary Portland cement
K*	Potassium oxide ( $\text{K}_2\text{O}$ )
RHPC	Rapid Hardening Portland cement
SR	Silica Ratio
S*	Silicon dioxide or silica( $\text{SiO}_2$ )
N*	Sodium oxide ( $\text{Na}_2\text{O}$ )
$\bar{\text{S}}$	Sulfur trioxide or sulfuric anhydride( $\text{SO}_3$ )

SRPC	Sulfate Resisting Portland cement
$C_4AF^*$	Tetracalcium aluminoferrite( $4CaO \cdot Al_2O_3 \cdot FeO_3$ )
$C_3A^*$	Tricalcium aluminate( $3CaO \cdot Al_2O_3$ )
$C_3S^*$	Tricalcium silicate ( $3CaO \cdot SiO_2$ )
V	Volume
W	weight
W-	weight of sample
XRD	X-ray diffraction
XRF	X-ray fluorescence
Mpa	$1Nmm^{-1} = 10\text{ bar} = 9.87atm = 7500\text{ tor} =$ $145.0\text{ Ib in}^{-2} = 10.198\text{ kg cm}^{-2}$

**\* Cement notation**