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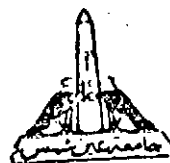
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شبكة المعلومات الجامعية التوثيق الالكتروني والميكرو فيلم



**PERFORMANCE OF BLAST FURNACE SLAG
AND SULPHATE RESISTING CEMENTS
IN SULPHATE SOLUTION**

**A THESIS
SUBMITTED TO THE
CHEMISTRY DEPARTMENT
GIRLS COLLEGE
AIN SHAMS UNIVERSITY**

**BY
EL HOSSINY MANSOUR EL HOSSINY
(B. Sc. 1982)**

**IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS
FOR THE DEGREE
OF
MASTER OF SCIENCE
IN
PHYSICAL CHEMISTRY**


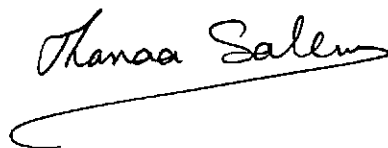
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GIRLS COLLEGE
AIN SHAMS UNIVERSITY

MASTER OF SCIENCE IN CHEMISTRY
EL HOSSINY MANSOUR EL HOSSINY

Thesis Advisors :

1. Dr. THANAA HAMED MOHAMED SALEM
Assistant Professor of Physical Chemistry,
Ain Shams University
Cairo, Egypt.
2. Prof. Dr. HANAA YOUSEEF GHORAB
Professor of Applied Physical Chemistry
Chemical Department
Faculty of Science
Helwan University, Helwan,
Cairo, Egypt.



Approved
Head of Chemistry Department

the 1990s, the number of people in the UK who are employed in the public sector has increased by 1.5 million, from 2.5 million in 1980 to 4 million in 1995. The public sector has also become an important employer of women, with 60% of public sector employees being women in 1995, compared with 55% in 1980.

There are a number of reasons why the public sector has become an important employer of women. One reason is that the public sector has a high proportion of jobs that are traditionally held by women, such as teaching, nursing, and social work. Another reason is that the public sector has a high proportion of jobs that are part-time or flexible, which are more likely to be held by women. A third reason is that the public sector has a high proportion of jobs that are in the service sector, which is also a sector that is traditionally held by women.

The public sector has also become an important employer of women because of the increasing demand for public services. As the population ages, there is a growing need for services such as health care, social care, and education. This has led to an increase in the number of people employed in the public sector, and a corresponding increase in the number of women employed in the public sector.

There are a number of challenges facing the public sector in the future. One challenge is the need to reduce costs and improve efficiency. Another challenge is the need to attract and retain staff. A third challenge is the need to provide high-quality services. These challenges will require the public sector to continue to evolve and adapt to the changing needs of society.

The public sector has a long history of employing women, and it is likely to continue to do so in the future. As the public sector becomes an even more important part of our lives, it will also become an even more important employer of women. We need to ensure that the public sector is able to attract and retain the best talent, and that it is able to provide the highest quality of services to the public.

There are a number of ways in which the public sector can improve its employment of women. One way is to create more part-time and flexible jobs. Another way is to provide training and development opportunities for women. A third way is to ensure that the public sector is a fair and equal employer, with no discrimination on the basis of gender.

The public sector has a vital role to play in our society, and it is important that it continues to employ women in a fair and equal way. By doing so, it can ensure that it is able to provide the highest quality of services to the public, and that it is able to attract and retain the best talent.

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Note

The student in addition to this thesis has attended lectures dealing with the branches here after. He passed successfully the examination as well. These courses are:

1. Advanced Electrochemistry and Electroanalytical Methods of Analysis.
2. Inorganic Reaction Mechanism and Organometallic Compounds.
3. Radiation and Separation Techniques.
4. Computer Science and Spectroscopic Application of Group Theory.
5. Optical Methods for Structural Analysis.

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I thank my advisors:

1. Dr. THANAA HAMED MOHAMED SALEM
Assistant Professor of Physical Chemistry,
Ain Shams University
Cairo, Egypt.
2. Prof. Dr. HANAA YOUSEEF GHORAB
Professor of Applied Physical Chemistry
Chemical Department
Faculty of Science
Helwan University, Helwan,
Cairo, Egypt.

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1- Introduction and Objective

Blast furnace slag is a by-product obtained in the manufacture of pig-iron in the blast furnace. It is formed by the combination of iron ore and limestone flux.

Slag + iron produced by blast furnace + limestone flux \longrightarrow blast furnace slag.

In the operation of blast furnace the Fe_2O_3 is reduced by coke to metallic iron while SiO_2 , Al_2O_3 , CaO and MgO from molten slag float on the top of molten iron. The slag is obtained from the blast furnace as molten stream at a temperature of $1400-1500^\circ\text{C}$. Its conversion into products suitable for various uses depends on the subsequent processing used in cooling the molten slag. When the slag is allowed to cool slowly, a stable crystalline silicic rock product is formed with mechanical properties similar to basalt. This has been used for long time as road construction and is suitable as concrete aggregate. More rapid chilling with a limited amount of water produces a porous honeycombed materials. This lightweight material is called foamed slag and after crushing and grading is used as lightweight aggregate. The slag used in the manufacture of the various slag cements should be granulated and rapidly cooled.

Around thirty years ago, the granulation of the blast furnace slag was started in order to produce a granular bulk material out of the slag melt which can easily be transported, in doing so, a sand with a more or less high content of glassy constituents was formed which was found out to have certain hydraulic properties, the super cooled slag melt being the carrier of the latent hydraulic properties.

Thereupon, the granulation process was improved to obtain granulated blast furnace slag with a high glass content 90% for the production of slag cement. Many granulation processes were tested and applied. The aim of all the processes was to abstract as much heat as possible from a large quantity of molten slag in the shortest time possible. For that purpose the slag was broken into small droplets or grains up to a size of 3-5 mm, which were then brought into contact with a lot of air or water as coolants; Processes running with compressed air had the advantage of a dry product, and a glass content of only 60% to maximum 80% weight, were however obtained. Nowadays the granulation process is done using water cooling process. The slag is chilled very

rapidly either by pouring into a large amount of water or by subjecting the slag stream to jets of water or air and water. The purpose is to cool the slag so quickly that crystallization is prevented and solidifies as a glass. At the same time the quenching breaks up the materials into small particles. The ease with which a glassy phase is obtained depends on the chemical composition of the slag and the temperature at which it issues from the furnace. Siliceous slags are easier to form glasses compared to those of high lime content, the later however possesses a higher hydraulic activity in the presence of alkaline activator. The hydraulic value increases with CaO/SiO_2 ratio up to a limiting points, the CaO content should be around 40%.

In cement industry, slag is blended with portland cement in varying proportions producing what is known as portland blast furnace slag cements. In Egypt ES974 limits the slag content to 35%. BS146 allows slag content up to 65%, whereas BS4246 specified a slag content of 50 to 90 %. In USA where the cement is called portland blast furnace slag cement the granulated slag content is 25 to 65% (ASTMC595-68). In Germany two varieties are specified (DIN 1164) namely, Eisenportland cement containing not more than 40% and Hochofencement, from 41 to 85% granulated slag. In France, Ciment de Fer contains 25 to 35% granulated slag, Ciment Metallurgic Mixte, 45 to 55%, Ciment de Haut fourne 65 to 75% and Ciment de Laitier au clinker at least 80%.

The portland blast furnace cement concrete are known for their low heat of hydration and should generally possess a high resistance to chloride diffusion and sulphate attack. The slag also reduces the reactivity of the cement with alkali reactive aggregates.

The purpose of this study is to characterize the Egyptian blast furnace slag used in the manufacture of local blast furnace slag cements. For this purpose the blast furnace slag obtained from Iron and Steel Company in Egypt was characterized in order to evaluate the suitability of its use in the cement manufacture compared to international standard specifications. Besides the behaviour of different laboratory made slag cements containing water and air cooled slag in water and sulphate solution were studied over a period of one year and compared with the behaviour of pure ordinary portland cement.

2- Literature Survey

In this study the literature is surveyed on the characteristics of the blast furnace slag, methods of slag granulation, and slag-cement system which individual item is described below.

2.1: Characteristics of Blast Furnace Slag :

Blast furnace was operated for producing pig iron low in Si and S by suppressing the activity of SiO_2 in hot zones and by adjusting slag viscosity. Powdered flux containing CaO and / or MgO is injected into tuyeres to control the basicity of slag at 1.22-1.30, and the Al_2O_3 content of the slag was adjusted to $\leq 17\%$ [1].

A method for determining the glass content in inorganic waste was studied to aid in the prediction of the action of the waste on concrete. A quantitative X-ray diffraction method was used to compute the mass percentages of α -quartz, mullite magnetite, and hematite and the glass content by difference. The technique was improved in this study. Glass contents determined with this method ranged from 53.5 to 94.5%[2].

The viscosity and melting point of blast furnace slag containing TiO_2 , CaO, SiO_2 , Al_2O_3 , and MgO were studied. An increase in basicity and TiO_2 and MgO content decreased the viscosity, but an increase in Al_2O_3 increased the viscosity slightly. The properties of the slag were affected mainly by their basicity[3].

The equilibrium phase composition of a blast furnace slag was studied by using the thermodynamic properties of the MgO-CaO- Al_2O_3 -

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