



Cairo University

BEHAVIOR OF GEOPOLYMERS SUBJECTED TO FERTILIZERS SOLUTIONS

By

Hanaa Mazhar Abd Alhady Mohamed Soliman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

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Title of Thesis:

Behavior of geopolymers subjected to fertilizers solutions

Key Words: metakolin – geopolymer – aggressive environment- brick- fertilizer

Summary:

In the present thesis, metakoline was used to prepare geopolymer as a main raw material activated with alkaline solution composed of sodium silicate and sodium hydroxide .

Geopolymer bricks had been exposure to aggressive environment represented as ammonium nitrate , urea and ammonium sulfate , the two parameters compressive strength and weight in loss have been studied .

All experimental works repeated again by change metakoline by fly ash to tudy the difference in behavior.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute .

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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Acknowledgment

Firstly , I am grateful for the God for kindness, good health and wellbeing that were necessary to do that research .

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Table of Contents

	<i>Page</i>
Disclaimer	i
Acknowledgment	ii
Table of content	iii
List Of Tables	vii
List Of Figures	ix
Abstract	xi
I.Chapter 1 : Introduction	1
1.1 Introduction	1
1.2 Aim of the Work.....	2
1.3 Thesis layout.....	2
II. Chapter 2: Literature Review	5
2.1 Geopolymer Materials for the Building industry.....	5
2.1.1 Introduction.....	5
2.1.2 Definition of geopolymers	5
2.1.3 Geopolymerization reactions	5
2.1.4 Geopolymer Cement and concrete	6
a) Conventional geopolymers	6
b) fly ash geopolymers	6
c) Slag based geopolymers.....	8
d) Red mud based geopolymers.....	9
e) Silica fume based geopolymer.....	10
f) Geopolymer based on other binding materials	12
2.2 Ammonium Based Fertilizers.....	13
2.2.1 introduction	13
2.2.2 Ammonium nitrate.....	13
2.2.3 Urea.....	13
2.2.4 Ammonium sulfate.....	14

2.3 Chemical durability of building materials	14
2.3.1 Introduction.....	14
2.3.2 Durability of Portland cement concrete	14
a) Leaching corrosion.....	15
b) Carbonate corrosion.....	15
c) Sulfate (sea water) corrosion.....	15
d) Acid corrosion.....	16
d.1 Corrosion by hydrochloric acid	17
d.2 Corrosion by sulfuric acid.....	17
d.3 Corrosion by nitric acid.....	18
d.4 Corrosion by ammonium nitrate.....	19
d.5 Corrosion by ammonium sulfate.....	19
d.6 Corrosion by urea.....	20
2.3.3 Durability of geopolymer building components.....	21
a) Corrosion by acids.....	21
a.1 Corrosion by hydrochloric acid.....	21
a.2 Corrosion by sulfuric acid.....	22
a.3 Corrosion by nitric acid.....	23
a.4 Corrosion by ammonium compounds.....	24
2.4 Kinetics of liquid – solid reactions	25
2.4.1 Introduction	25
2.4.2 Unreacted core model	25
a) Diffusion through liquid film controlling	26
b) Chemical reaction controlling.....	26
c) Diffusion through ash controlling.....	26
d) First order model.....	26
III . Chapter 3 - EXPERIMENTAL WORK	27
3.1 Introduction	27
3.2 Raw Materials	27
3.2.1 Metakaolin.....	27
3.2.2 Sodium hydroxide.....	27
3.2.3 Sodium silicate.....	27
3.2.4 Common sand.....	27
3.2.5 Fly ash.....	28
3.2.6 Ammonium nitrate.....	28

3.2.7 Urea.....	28
3.2.8 Ammonium sulfate.....	28
3.3 Characterization of raw materials	28
3.3.1 Particle size distribution.....	28
3.3.2 Determination Powder Density of Raw Material.....	29
3.4 Preparation of geopolymer bricks	29
3.5 Estimation of the degree of geopolymerization	31
3.6 Determination of bulk density of geopolymer bricks.....	31
3.7 Preparation of fertilizer solutions.....	31
3.8 Immersion of geopolymer cubes in fertilizer solutions.....	32
3.9 Determination of compressive strength	32
V .CHAPTER 4 : Results And Discussion.....	35
4.1 Introduction.....	35
4.2 Characterization of raw materials.....	35
4.2.1 Particle Size Distribution	35
4.2.2 Powder density of materials used.....	36
4.2.3 Bulk density of prepared bricks.....	36
4.3 Effect of percent NaOH used on the properties of geopolymer bricks.....	36
4.4 Results on impregnating bricks in ammonium nitrate.....	38
4.4.1 Effect of impregnation in ammonium nitrate on loss in weight.....	39
4.4.2Effect of impregnation in ammonium nitrate on compressive strength.....	40
4.4.3 Kinetics of ammonium nitrate attack.....	40
4.5 Results on impregnating bricks in urea	43
4.5.1 Effect of impregnation in urea on loss in weight.....	43
4.5.2 Effect of impregnation in urea on compressive strength.....	44
4.5.3 Kinetics of urea attack.....	46
4.6 Results on impregnating bricks in ammonium sulfate	47
4.6.1 Effect of impregnation in ammonium sulfate on loss in weight.....	47
4.6.2 Effect of impregnation in ammonium sulfate on compressive strength....	48
4.6.3 Kinetics of ammonium sulfate attack.....	50
4.7 Fly ash based geopolymers.....	51
4.7.1 Effect of attack by ammonium nitrate.....	51
4.7.2 Effect of attack by urea.....	54
4.7.3 Effect of attack by ammonium sulfate.....	56

VI. CHAPTER 5 : CONCLUSION	61
VII. REFERENCES	65
VIII. Appendix I	71

List of Tables

	<i>Page</i>
I. Chapter 2 : Literature Review	
Table (2.1): Flay ash composition	6
Table (2.2): Red mud composition.....	9
II. Chapter three : Raw Material And Experiments	
Table (3.1): Mass of solid fertilizers used(gm) per liter water.....	32
Table (3.2): PH of fertilizers used for each molarity.....	32
III. Chapter Four : Results and Discussion	
Table 4.1: Correlation coefficients for loss in weight in ammonium nitrate solution.....	39
Table 4.2: Correlation coefficients for strength in ammonium nitrate solution.....	40
Table 4.3: Total time of failure of the bricks.....	41
Table 4.4: Correlation coefficients for loss in weight in urea solution.....	43
Table 4.5: Correlation coefficients for strength in urea solution.....	44
Table 4.6: Correlation coefficients for loss in weight in ammonium sulfate solution.....	47
Table 4.7: Correlation coefficients for strength in ammonium sulfate solution.....	49
Table 4.8: Comparison of weight loss for ammonium nitrate attack.....	52
Table 4.9: Correlation coefficients for loss in weight in ammonium nitrate solution for ash based bricks.....	52
Table 4.10: Correlation coefficients for Compressive strength of ash based bricks in ammonium nitrate solution	53
Table 4.11: Comparison of 28 days exposure strength (MPa) for ammonium nitrate attack.....	53
Table 4.12: Correlation coefficients for loss in weight in urea solution for ash based bricks.....	54
Table 4.13: Correlation coefficients for Compressive strength of ash based bricks in urea solution.....	55
Table 4.14: Comparison of Percent weight loss for urea attack.....	55

Table 4.15: Comparison of 28 days exposure strength (MPa) for urea attack	56
Table 4.16: Correlation coefficients for loss in weight in ammonium sulfate solution for ash based bricks	57
Table 4.17: Correlation coefficients for Compressive strength of ash based bricks in ammonium sulfate solution	58
Table 4.18: Comparison of Percent weight loss for ammonium sulfate attack.....	59
Table 4.19: Comparison of 28 days exposure strength (MPa) for ammonium sulfate attack.....	60

List of Figures

Page

I. Chapter 2 : Literature Review

Figure (2.1): The Bayer process.....	9
Figure (2.2): Silica fume from the silicon industry.....	11
Figure (2.3): Flow diagram for urea production.....	14
Figure (2.4): White patches on external walls.....	15
Figure (2.5): Deterioration of concrete in sea water.....	16
Figure (2.6): Deterioration of concrete in ammonium nitrate of KIMA company	19
Figure (2.7): Deterioration of concrete in ammonium sulfate of NASR company.....	20
Figure (2.8): Deterioration of concrete in urea plant of DELTA company	21
Figure (2.9): Progression of reaction in unreacted core model.....	25

II. Chapter 3 : Raw Material And Experiments

Figure (3.1): Set of standard sieves was used for screen analysis test.....	28
Figure (3.2): Flow diagram of samples preparation.....	30
Figure (3.3): Compressive strength testing machine	33

III. Chapter 4 : Results and Discussion

Figure (4.1): Particle Size Distribution of metakaolin and fly ash.....	35
Figure (4.2): Particle Size Distribution of sand.....	36
Figure (4.3): Effect of NaOH molarity on 28 days strength.....	37
Figure (4.4): Effect of NaOH molarity on degree of geopolymerization after 28 days.....	37
Figure (4.5): Relation between the 28 days strength and degree of geopolymerization.....	38
Figure (4.6): Effect of time and ammonium nitrate molarity on loss in weight.....	39
Figure (4.7): Effect of time and ammonium nitrate molarity on compressive strength.....	40
Figure (4.8): Relation between Compressive strength and Weight loss for ammonium nitrate attack.....	41

Figure (4.9): Surface reaction controlled kinetics for the attack of ammonium nitrate	42
Figure (4.10): Effect of solution molarity on the reaction rate constant of ammonium nitrate attack.....	42
Figure (4.11): Effect of time and urea molarity on loss in weight.....	44
Figure (4.12): Effect of time and urea molarity on Compressive strength.....	45
Figure (4.13): Relation between Compressive strength and Weight loss for urea attack ...	45
Figure 4.14: First order kinetics of urea attack	46
Figure (4.15): Effect of time and ammonium sulfate molarity on loss in weight.....	48
Figure (4.16): Effect of time and ammonium sulfate molarity on Compressive strength ...	49
Figure (4.17): Relation between Compressive strength and Weight loss for ammonium sulfate attack	50
Figure (4.18): First order kinetics of ammonium sulfate attack.....	51
Figure (4.19): Effect of time and ammonium nitrate molarity on loss in weight for ash based bricks.....	52
Figure (4.20): Effect of time and ammonium nitrate molarity on Compressive strength of ash based bricks.....	53
Figure (4.21): Effect of time and urea molarity on loss in weight for ash based bricks.....	54
Figure (4.22): Effect of time and urea molarity on Compressive strength of ash based bricks.....	55
Figure (4.23): Relation between Compressive strength and Weight loss for urea attack on ash based bricks.....	56
Figure (4.24): Effect of time and ammonium sulfate molarity on loss in weight for ash based bricks.....	57
Figure (4.25): Effect of time and ammonium sulfate molarity on Compressive strength of ash based bricks.....	58
Figure (4.26): Relation between Compressive strength and Weight loss for ammonium sulfate attack on ash based bricks.....	59

ABSTRACT

Building components present in fertilizers production line are continuously subjected to the corrosive action of present solutions and their vapors. Cement based structures have shown severe deterioration over time to the extent that has triggered the search for substitute materials.

In the present thesis, geopolymer bricks, alternatively based on kaolin and fly ash were prepared using a mixture of sodium hydroxide and sodium silicate as alkaline activators. These bricks were submerged in solutions of ammonium nitrate, urea and ammonium sulfate at 0.5M, 1M and 1.5M molarities for time periods up to 28 days. The solutions were refreshed on daily basis to assess their corrosion resistance under extremely harsh conditions. Brick samples, consisting of three specimens each, were taken out of the solutions at time intervals of 1, 7, 14, 21 and 28 days, dried and checked for loss in weight and compressive strength.

In all cases, the loss in weight increased with increasing time of exposure and solution molarity although the effect of the former parameter was mostly much higher than the latter. However, the samples containing fly ash, although exhibiting loss in weight comparable or higher than kaolin based geopolymer samples, generally displayed higher compressive strength. In most cases investigated, the strength after 28 days immersion was still higher than the minimum standard strength required by ASTM C62-17 for building bricks (8.7 MPa). This proved the possibility of using these materials as substitute for cementitious components in fertilizers production lines.

The kinetics of chemical attack were also studied for the three aggressive solutions investigated. In case of attack by ammonium nitrate, the reaction was controlled by boundary reaction at interface, while it turned out to follow first order kinetics in case of attack by urea and ammonium sulfate. In all cases, the reaction rate constants were calculated and related to the solution molarity.