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Improvement of Reinforced Concrete by the Addition of Spent Iron-rich Molecular Sieves

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Abstract

The molecular sieve used in the gas industry to remove the water in this gas is discarded after four years of use as these molecular sieves are no longer effective. Molecular sieves used in dryers in the gas industry to remove water from the gasto avoid clogging of pipes during storage that is at low temperature are discarded after four years of use. These used molecular sieves are no longer effective because, after various heating and cooling of the dryers, these molecular sieves are charred and crushed. After analysis of these used molecular sieves, it is found that they contain a considerable amount of silica iron (SiO_2). The idea was to add these molecular sieves after finely grinding them to a diameter less than one micron of the added ones to the cement. Fine silica combines with the lime released during the hydration of the cement and forms hydrated calcium silicates that develop within the capillary network by reducing the number and size of pores of the concrete.

Keywords: Molecular sieves • Valorization • Concrete • Analyses • Absorption

Introduction

Water reducing effect

The molecular sieves recovered from the gas industry are in the cement for the preparation of a good concrete is essential to reduce the porosity [1] of this latter;because the excess of water vis-à-vis the quality necessary for the hydration of the cement to obtain perfect handling leaves voids. When it evaporates, these voids called capillaries form genuine networkscontained in the cement paste they are the cause of the ageing of the concrete [2], as well as erosion by dissolution and swellingand bursting of the concrete by the formation of expansive compounds example [3]: the rust of the reinforcements or else the water can freeze the concrete, and it will create the internal pressure [4].

In concrete, molecular sieves reduced toone micron occur according to two mechanisms:

- By a granular effect linked to the shape and the extreme fineness of the molecular sieves.
- By pozzolanic reaction due to high amorphous silica content [5].

Increased compactness by granular effect: Since the particles are smooth, perfectly spherical and have a small diameter [6], then molecular sieves can fill in the gaps between the cement grains. It takes about 100,000 grains of molecular sieve to completely cover cement's grain. This granular effect, when obtained, leads to a significant reduction in the water content of the concrete [7].

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The finely ground molecular sieves combine with the lime released during cement hydration to give additional hydrates of the reactivity pozzolanic is specifically high. The formation of additional hydrates causes a decrease in the size of the concrete pores [8]. This reduction in porosity and the low water demand make it possible to obtain concrete with high performance.

Materials and Methods

Molecular sieves finely ground to 1 µ(micron) means that each grain of cement can surround itself with 100,000 particles of molecular sieve.

XRF fluorescence RX analyses show the composition of these molecular sieveswhich are rich in iron and silica used in thegas industry. The latter can fill the space available between the dispersed cement grains. The electron microscope confirms that the molecular sieves react with the lime produced during the hydration of the C_3S to form HSC particularly well crystallized [9].

We take four concrete samples and add themolecular sieves at different percentages. Then we see the result by the electron microscope.

The adsorption analysis ASAP2010DATA/001-245.SMP give us Langmuir Surface Area and the T-plot report tells us about the microporous volume and microporous Surface of our samples and finally, we do the desorption BJH analysis.

Pore distributions report theory was performed on a micrometer ASAP2010DATA/ 001-245.SMP.

Results and Discussion

RFX analysis has provided the elementarycomposition of the molecular sieves used.

This data informs us, that studies molecular sieves can be classified as ordinary waste and we can reuse them in concrete reinforcement because they are rich in silica and iron it will enrich the quality of the concrete (Table 1).

Langmuir surface area plot

Langmuir surface area: 52.3771 ± 1.0970 m^2/g

Slope: 0.083113 ± 0.001741

Y-Intercept: 0.003300 ± 0.000224

b: 0.039700

VM: 12.031862 cm^3/g STP

Correclation coefficient: 9.982499e-01

Molecular cross-section: 0.1620 nm^2 (Figure1).

t-plot

Micropore volume: -0.001331 cm^3/g

Micropore area: -1.7141 m^2/g

External surface area: 39.2563 m^2/g

Slope: 2.537902 ± 0.006089

Y-Intercept: -8.60318 ± 0.024451

Correlation coefficient: 9.99980e-01

Thickness range: 3.5000 to 5.0000 A

T= [13.9900/ (0.0340- log (P/Po))] 0.5000

Surface area correction factor: 1.00

Density conversion factor: 0.001547

Total surface area (by BET): 37.5422

The role of the air trainer is to create a network of finely distributed macrospores in the concrete capable of absorbing the expansion pressure of the water, a high capillary porosity requiring more expansion pores, it seems obvious to try to reduce it to a minimum to obtain the smallest possible volume of expansion (Figure 2).

BJH desorption

BJH desorption pore distribution report

T= 3.5400 × [-5.0000/ln(P/Po)] 0.3330

Table 1. Result of XRF analysis of used molecular sieve.

Elements [%]	Silicuim pur[%]	Alliage Fesi [%]
SiO_2	94-98	86-90
C	0.2-1.3	0.8-2.3
Fe_2O_3	0.02-1.5	0.3-1.3
Al_2O_3	0.1-0.4	0.2-0.6
CaO	0.08-0.3	0.2-0.6
MgO	0.3-0.9	1-3.5
Na_2O	0.1-0.4	0.8-1.8
K_2O	0.2-0.7	1.5-3.5
S	0.1-0.3	0.2-0.9

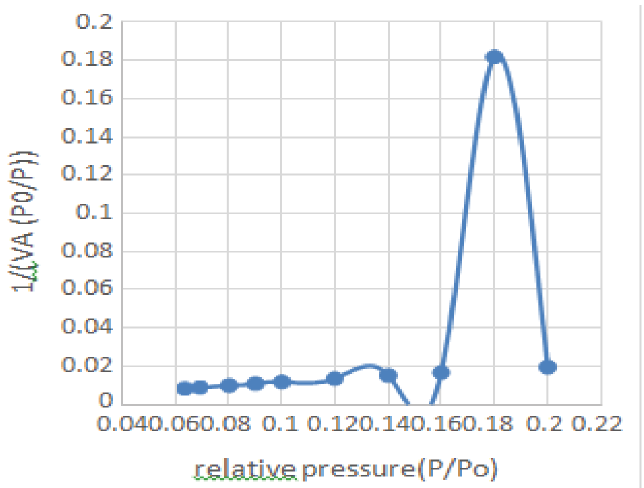

Figure 1. Langmuir surface area plot.

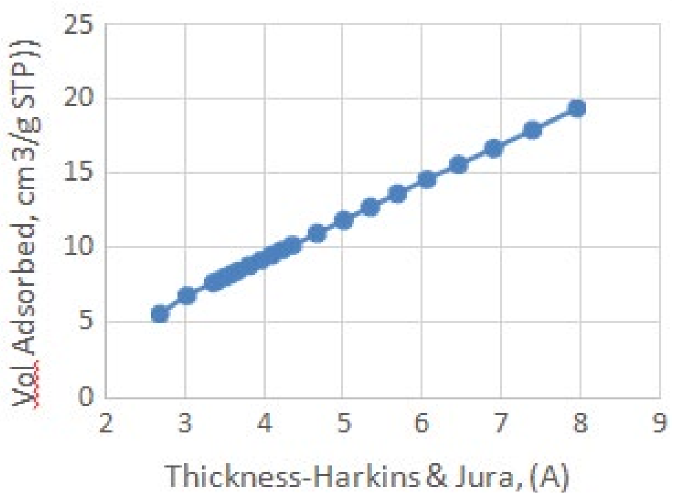

Figure 2. t-plot report.

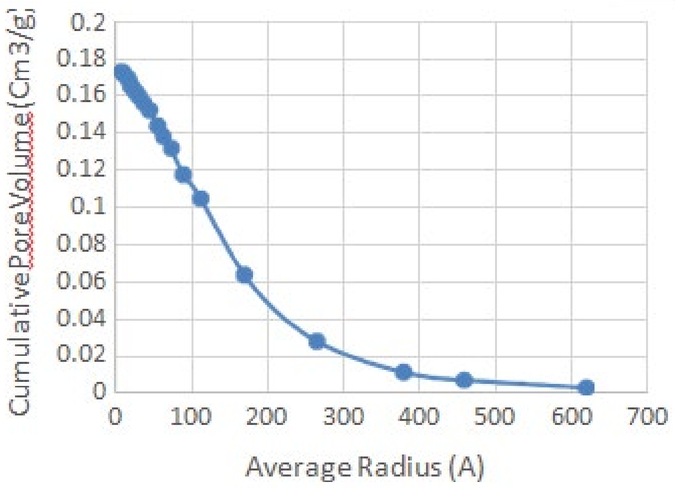

Figure 3. BJH desorption cumulative pore volume.

Radius range: 8.5000 to 15

Adsorbate property factor

Density conversion factor

Fraction of pores open at both ends: 0.000 (Figure 3).

Samples 1, 2, and 3 have a compact microstructure with very dense CSH. The Ca(OH) in sample 3 is rich in cement: the large pores are filled with crystals, and there is a good bond between the cement and the calcareous aggregates. Molecular sieves are only visible in most cement-poor samples 1. There are no more micro-cracks than natural concrete. Sample 4; because its molecular sieve and cement assay has a high porosity and micro-cracks compared to the other samples: the material becomes fragile because the molecular sieve assay is very great.

Conclusion

The technique of molecular sieves added tothe concrete is ideal for any cleaning and renovation work. The physical and chemical properties of this addition develop the largest puzzolana, this materialcan be exceptional if used well. The role ofmolecular sieves significantly reduces the amount of water through better cement distribution. This reduction in the quantity of water in concrete improves it at the level of:

Compression and tensile strength by flexion:

- Water tightness
- Removal and creep
- Capillary porosity

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