The Method of Obtaining Non-Autoclaved Aerated Concrete by Hardening of Ironportland Cement, Porous with Calcium Polysulfide and Hydrazine

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Abstract. The physicochemical basis of hydration hardening of a slag portland cement mixture in a polysulfide-containing alkaline broth with the addition of hydrazine as a gasifier is studied. The combined action of the CaSn - N2H4 pair provides for the porization of the hardening mass and the increase in the hydraulic activity of the binder mass.

1. Introduction

In recent years, the technology of portland cement concretes has been using calcium polysulfide contained in calcareous broth [1-4]. More often it is used in the technology of quick-hardening high-strength concrete mixtures as a hardener, enhancing the hydraulic activity of portland cement [5-8].

The property of CaSn polysulfide due to the formation of hydrosulfoaluminates thiosulfate-containing phase to accelerate the hydration of slag portland cement mixture, enhanced by the addition of aluminum powder (an additional source of formation of hydrosulfoaluminates) is the basis for the method of obtaining quick-hardening aerated concrete, characterized by high structural quality [9,15-20].

In this work the hydrazine preparation was studied as an activator of hydration of a slag portland cement mixture and a blowing agent in combination with calcium polysulfide.

To understand the chemistry of the processes involving the CaSn - N2H4 pair, which enhances the hydration activity of silicates of high silica slag as a hardener, enhancing the hydraulic activity of portland cement, we compare the sequential series of chemical acts of zero-charged ionization sulfur without the hydrazine and with its participation [10-12].

In the first case, it involves the destruction of the polysulfide molecule and the formation of activated sulfur forms as Sn radical fragments represented by an open chain of polyatomic formation with the acceptor ability of its terminal atoms, and a sulfur hydroxocomplex. In this series, sulfur ionization is completed by the act of electron redistribution between sulfur and oxygen atoms according to a known scheme.

In the case of hydrazine, its reducing effect is determined by the ability of all forms of activated sulfur to assimilate free electrons, ionization can be represented by its reduction
2S + N₂H₄ + 4OH⁻ → 2S₂⁻ + N₂ ↑ + 4H₂O

and the associated hydrolysis of calcium sulfide, an increase in the level of saturation of the solution with hydroxide as an internal activation factor for Portland cement and slag silicates.

The physicochemical nature of alkali activation of silicates, as is known, consists in the depassivation of the grain surface and in the proportional acceleration of protolysis of dioxides final stage — hydration ionization of the silicon-oxygen complex. The activation efficiency is due to the high polarizability of calcium in the hydrolyzed salt solution as a factor that increases the saturation concentration of the latter with hydroxide and ionized silica hydrates. In addition, the regenerative effect of hydrazine excludes the possibility of the formation in the initial stages of hydration hardening of a mixture of calcium thiosulfate, which disproportionately accelerates the formation of a hydroaluminate stone structure in a short time [13-15].

Consequently, the combined action of polysulfide and hydrazine, causing vector multidirectionality in the rate of formation of the leading structures, provides for their greater balance, minimizing the growth of difficultly relaxed internal stresses.

2. Experimental Part

The experiments used medium-sized Portland cement M400, expanded clay gravel fractions of 10-20 mm in the amount of 600 kg / m³ of concrete, the vitrified silica slag fraction passed through a 0.316 sieve, and aluminum powder and hydrazine as gas-forming agents. The chemical composition of the slag in% is given in Table 1.

| Table 1. The chemical composition of the slag. |
|-----------------------------------------------|
|       | SiO₂ | FeO  | CaO  | Al₂O₃ | MgO | SO₃  |
|-------|------|------|------|-------|-----|------|
| %     | 30,6 | 56,6 | 2,4  | 4,0   | 0,5 | 2,9  |

| Table 2. Technical indicators of hydration hardening of lightweight concrete prototypes. |
|-----------------------------------------------|
| Liquid-solid Coater | Blowing agent Coater temperature, °C |
|---------------------|--------------------------------------|
|                     | Water | Calcareous broth | Aluminum powder, % | Hydrazine, % |
| Experiments with samples of lightweight concrete on expanded clay | 0,3 Water | - | - | - | 90 |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the gasifier of aluminum powder | 0,3 - | C₅S, 220 g/l | 0,2 | - | 90 |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the hydrazine blowing agent | 0,3 - | C₅S, 220 g/l | - | 1,4 | 90 |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the gasifier of aluminum powder | 0,4 - | C₅S, 220 g/l | 0,2 | - | 90 |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the hydrazine blowing agent | 0,4 - | C₅S, 220 g/l | - | 1,4 | 90 |

Three series of experiments with different composition of the raw mix for concrete samples were carried out. In one of them, samples of a typical lightweight concrete on expanded clay aggregate were obtained by mixing in heated water, and in the other - two samples of cellular aerated concrete on slag
Portland cement, mixing in heated polysulfide-containing calcareous broth with a different type of blowing agent. The results of the experiments in the form of averaged technical indicators of hydration hardening of concrete samples are given in Tables 1 and 2.

**Table 3.** Technical indicators of hydration hardening of lightweight concrete prototypes (continue).

| Liquid-solid R, MPa | 3 days | 28 days | Density 28-day kg/m³ | The rate of curing, in% of the 28-day after 3 days | Constructive quality |
|---------------------|--------|---------|----------------------|---------------------------------------------------|---------------------|
| Experiments with samples of lightweight concrete on expanded clay | 0,3    | 3,3     | 11,0                 | 1242                                              | 33,0                | 0,089               |
|                     | 0,4    | 2.46    | 8,9                  | 1130                                              | 28,0                | 0,077               |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the gasifier of aluminum powder | 0,3    | 8,24    | 14,4                 | 1336                                              | 60,0                | 0,098               |
|                     | 0,4    | 7,23    | 13,2                 | 1305                                              | 62,0                | 0,106               |
| Experiments with a Portland cement mixture mixed in a calcareous broth with the hydrazine blowing agent | 0,3    | 7,7     | 16,7                 | 1336                                              | 46,0                | 0,125               |
|                     | 0,4    | 5,3     | 14,9                 | 1203                                              | 35,0                | 0,123               |

### 3. Conclusion

This data testifies about high technical indices of hardening of slag Portland cement mixtures with a calcareous grout in comparison with typical lightweight concrete with expanded clay aggregate. In particular, there is a high rate of strength gain in the early stages, especially in the case of aluminum powder, and its final values at 28 days of age in experiments with hydrosine, which indicates a difference in the mechanism of the activating effect exerted on the hydration of slag Portland cement mixture by polysulfide-containing alkaline decoction paired with aluminum powder and hydrazine.

In the first case, the mass formation of the rapidly crystallizing phase of thiosulfate-containing hydroaluminates predominates as an activating factor, which catalyzes the process. But in the presence of hydrazine in the system, silicates are more susceptible to activation, increasing the solid fraction of hydrosilicate neoplasms that strengthen the stone structure. Moreover, in the latter case, the increase in the strength of porous samples with decreasing W/C occurs disproportionately with increasing density, as evidenced by the high rate of structural quality of the porous material, estimated by the ratio of its compressive strength to density.

Therefore, when using aluminum powder in the list of technical advantages of aerated concrete technology, high hardening speed prevails, and in the case of hydrazine, to a greater extent, high strength and structural quality of the porous material.

### 4. References

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