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STUDY OF THE THERMAL STABILITY OF CONCRETE PRODUCED ON THE BASIS OF CEMENT WITH THE USE OF THE CEMENT CLINKER GRINDING INTENSIFIER

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Abstract: In this article, the thermal stability and structure of concrete obtained on the basis of cement using cement clinker grinding aids MI-1 and MI-2, studied by differential thermogravimetric and IR spectroscopic methods of analysis, were studied. Based on the thermal analysis of concrete samples, it was found that crystalline hydrates decompose in the temperature range of 600-800 ° C and the IR spectrum fluctuations in the region of 3630 cm-1 show OH groups associated with crystalline hydrates in the structure, as a result, concrete loses its strength.

In order to increase the strength of concrete while reducing the consumption of Portland cement, the developed cement clinker grinding intensifiers MI-1 and MI-2 were used. The structure of concrete was studied by IR spectroscopy. The results showed that the addition of cement clinker grinding aids improves the physical and mechanical properties of concrete.

Keywords: intensifier, concrete, mechanical strength, additives**.**

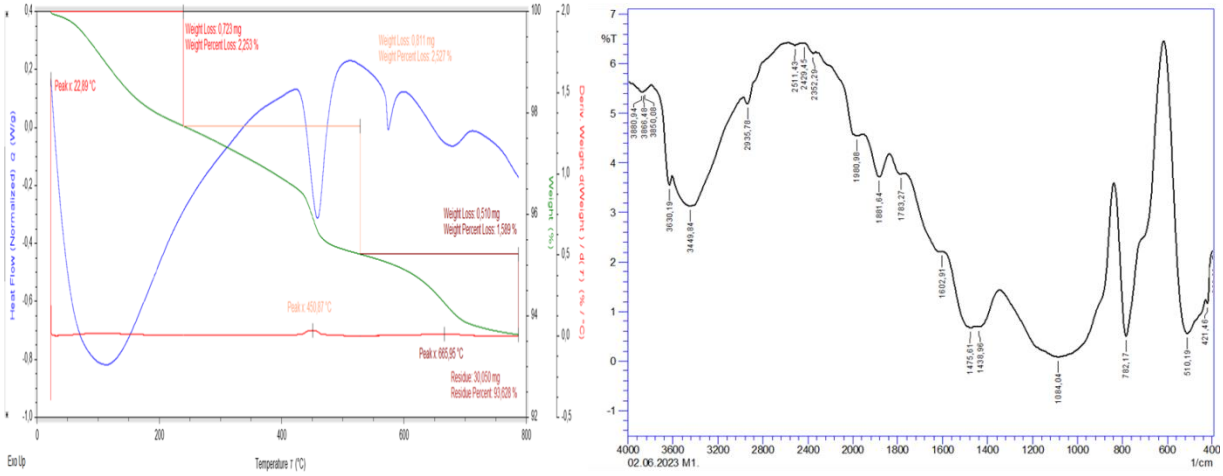
Introduction. Currently, to improve the properties of cement compositions, complex modifiers containing effective superplasticizers, water-repellent additives and active mineral additives are used [1]. Numerous works are devoted to the use of the IR spectroscopic method in studying the effect of plasticizers [2], a complex nanoscale modifier [3], a complex additive in the range of small doses of nanoparticles [4], carbonization processes of cement from calcium aluminate [5], air-entraining additives [6], accelerators [7], setting retarders [8], water reducers [9] and other combinations of these additives [10] regarding concrete strength. Works will also be introduced to study the thermal stability of concrete by the method of synchronous [11], thermal [12] and differential thermal [13] analysis. It must be taken into account that concrete, as a heterophase system, which has capillary and hydrated water in its composition, is capable of breaking down under strong heating [14]. In this regard, we studied the effect of cement clinker grinding intensifiers MI-1 and MI-2 on the thermal stability of concrete by DTA/TG and IR spectroscopy.

Experimental part. Thermal analysis was carried out on a thermodynamic device - Thermo Scientific TA Instruments STD 650 (USA), a K-type thermocouple (Low RG Silver) and an aluminum crucible. All measurements were carried out in an inert nitrogen atmosphere at a nitrogen flow rate of 50 ml/min. Temperature range of analysis 20-1000°C, heating rate 5K/min. The amount of sample in one measurement is 6-10 mg. The measuring system was vibrated using a standard set of substances

KNO3, In, Bi, Sn, Zn, CsCl. It was determined that the mass of the sample, the mass of decomposition of the complexes, and the thermal stability change with increasing temperature. IR spectroscopy was recorded on an IRTracer-100 spectrometer (Shimadzu, Japan) in the range of 400-4000 cm^{-1} using a sample in the form of a KBr pellet with a diameter of 7 mm and a resolution of 4 cm^{-1}. To prepare samples, 150 g of gypsum and 1.25 g of MI-1 intensifier were added to 2850 g of Portland cement clinker and ground in a roller drum for 10 minutes. The MI-2 intensifier was also mixed with equal amounts of Portland cement and gypsum and ground for 10 minutes. The samples were sieved to a particle size of 0.9 mm. Weighed 450 g of each sample, added to it 1350 g of sand divided into halves and mixed with 225 ml of water. The mixture was stirred using special equipment equipped with a mechanical stirrer for 4 minutes. Mixing speed n=140/62 rpm.

Results and its discussion. The MI-1 grinding intensifier is effective in grinding and improves the physical and mechanical characteristics of the crushed cement material while reducing energy costs and provides concrete strength for the next 90 days [15]. It has been experimentally established that the use of hexamethylenetetramine as part of the MI-1 grinding intensifier contributes to an increase in the rate of concrete strength gain both in the initial hardening period - up to a day, and in the next 90 days or more. This effect is explained by the fact that in the composition of the grinding aid MI-1, hexamethylenetetramine manifests itself as a micro-reinforcing substance, which positively affects the strength of concrete.

DTA/TG and IR spectral images are shown in Figure 1.



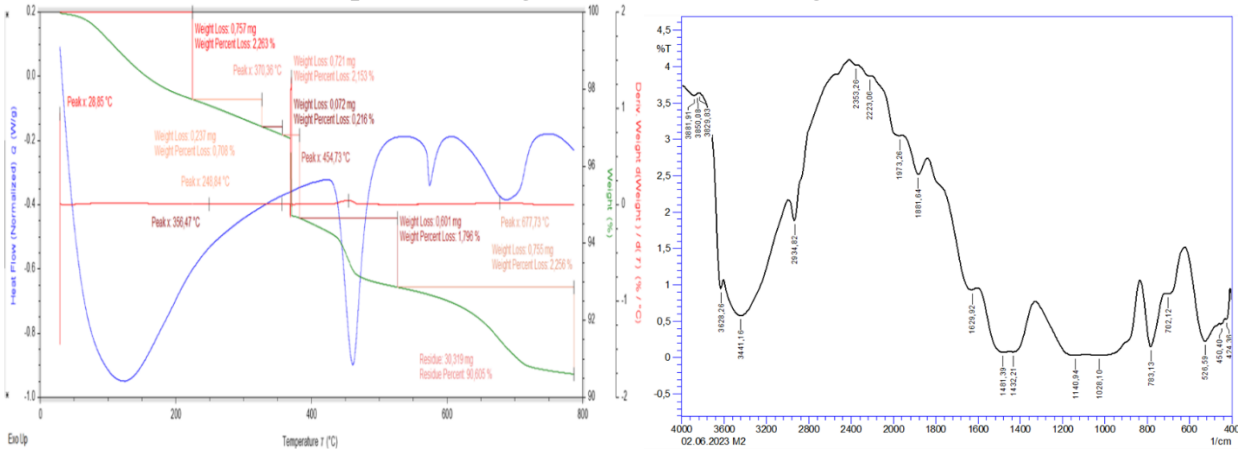
a) **b)**

Fig.1. DTA/TG images (a) and IR spectroscopic (b) studies of concrete using cement clinker grinding aid MI-1.

As can be seen from Figure 1 (a), a significant release of unbound water occurred at temperatures up to 100°C. From 100 °C to 200 °C, water molecules separate in the form of hydrates of inorganic salts, mainly carbonates, with a weight loss of 2.25%. At a temperature of 400 °C, cement stone (concrete) was mainly formed due to the dehydration of hydroaluminates, as well as the decomposition and recrystallization of calcium hydrosulfoaluminates. Between 450°C and 600°C decomposition of tricalcium silicate and decomposition of carbonates at higher temperatures can be observed. The weight loss was 2.57%. It can be seen that the concrete sample, on which the MI-1 intensifier is based, lost the bulk from a

temperature of 500°C and retained 93.6% of the mass up to a temperature of 800°C. On the IR spectrum, characteristic vibrations of the test sample are present at the following wave numbers, cm^{-1}: 3630; 3449; 1438; 1084; 782. Deformation vibrations in the region of 3630 cm-1 belong to -OH groups characterizing calcium hydrosilicates of various structures, as well as portlandite [16]. Stretching vibrations in the region of 2935-3630 cm-1 correspond to -CH- and methoxy groups -CH2O-, which are actually absent in the studied compositions of cement stone [17]. As part of the grinding intensifier MI-2, diphenylamine acts as an initiator of the hydraulic dissolution of clinker (cement) minerals, retains water near their surfaces, as well as the surfaces of fillers through the hydrogen bonds formed between the hydrogen atoms of the amino groups of amines and the oxygen atoms of water. It has been experimentally proved that diphenylamine as an additive in the grinding aid MI-2 accelerates the process of curing concrete. After 12 hours after concrete production, its strength increased by 45% [18]. The mentioned amines perform micro-reinforcing concrete functions, which in turn contributes to an increase in the strength of concrete.

DTA/TG and IR spectral images are shown in Figure 2.



a) b)

Fig.2. DTA/TG images (a) and IR spectroscopic (b) studies of concrete using cement clinker grinding aid MI-2.

The experiments performed showed that the endoeffect, which is formed in the temperature range of 370°C-450°C, occurred due to the destruction of hydroaluminates and silicates, hydroxides and carbonates. The weight loss of the sample in these temperature ranges was 0.6 mg (1.79% of the total weight). Also, the main weight loss was observed in the temperature range of 677°C (0.755 mg) due to the decomposition of inorganic salts and, to a lesser extent, the dehydration of hydroxides and hydroaluminates. The weight loss at 800°C is due to the decomposition of carbonates. IR spectral studies have shown that the bending vibrations include bands representing carbonization (CO32-1432-1481 cm^{-1}), calcium carbonate (1881-2353 cm^{-1}), hydroxylation and water molecules (1607, 3441-3628 cm^{-1}), sulfates (1028 cm^{-1}). It has been experimentally established that the grinding aid MI-2 increases the strength of concrete by an average of 45-52%.

Conclusion. The use of grinding intensifiers MI-1 and MI-2 makes it possible to provide a synergistic effect, as a result of which the required specific surface area of cement is achieved from 3499 to 3579, respectively. For grinding aids, the dosage range is from 0.01% to 0.02%.

In a conclusion, grinding intensifiers MI-1 and MI-2 are effective in grinding and allow improving the physical and mechanical characteristics of the crushed cement material, along with a reduction in energy consumption, and provides concrete strength for the next 90 days.

Reference:

1. Богданов Р.Р., Ибрагимов Р.А., Потапова Л.И. Исследование взаимодействия компонентов комплексного модификатора методом ИК-спектроскопии. Известия Казанского государственного архитектурно-строительного университета, 2017, № 4, Т.42, С. 280-288.
2. Ибрагимов Р. А. Исследование влияния пластификаторов на структурообразование активированного цементного камня методом ИК-спектроскопии. Эксперт: теория и практика, 2022, №. 2, Т.17, С.-39-45.
3. Korolev E.V., Inozemtcev A.S. Preparation and research of the high-strength lightweight concrete based on hollow microspheres // Advanced Materials Research. 2013. Vol. 746. P. 285-288.
4. Полонина, Е. Н. Комплексная нанодисперсная система для модифицирования тяжелого бетона / Е. Н. Полонина, С. Н. Леонович // Междунар. науч. конф. «Архитектурно-строительный комплекс: проблемы, перспективы, инновации». – Новополоцк : ПГУ. – 2019. – С. 292–296.
5. Fernndez-Carrasco, Lucia & Torrens-Martn, D. & Morales, L.M. & Martnez-Ramrez, Sagrario. (2012). Infrared Spectroscopy in the Analysis of Building and Construction Materials. 10.5772/36186.
6. Barabanshchikov Yu.G., Komarinskiy M.V. Effect of Air-Entraining Agent LHD on the Technological Properties of Concrete Mix Containing Superplasticizer S-3 // Innovative Technologies in Development of Construction Industry. 2015. Vols. 725-726. Pp. 419–424. doi:10.4028/www.scientific.net/AMR.725- 726.419
7. Морозов Н. М., Степанов С.В., Хозин В.Г. Ускоритель твердения бетона на основе гальванического шлама. Magazine of Civil Engineering, no. 8 (34), 2012, pp. 67-71.
8. Сердюкова А. А., Рахимбаев И. Ш. О механизме действия ускорителей схватывания и твердения цементной матрицы бетона. Вестник Белгородского государственного технологического университета им. В. Г. Шухова, no. 2, 2013, pp. 26-28.
9. Муртазаев С-А.Ю., Саламанова М.Ш., Сайдумов М.С. Разработка составов водонепроницаемых бетонов с использованием комплексной полифункциональной добавки. Системные технологии, no. 1 (26), 2018, pp. 93-97.
10. Casale, A.J., Doukakis, J., Najm, H. *et al.* Quantitative Assessment of Infrared Analysis of Concrete Admixtures. *Int J Concr Struct Mater* **7**, 2013, pp. 203–214.
11. Флегонтов Д.В., Акулова М. В., Петров А. В., Потемкина О. В. Методика комплексного исследования бетонов, подвергшихся термическому воздействию

на пожаре. Современные проблемы гражданской защиты, 2019, № 1, Т.30, С. 36-43.
12. Плотникова Г.В., Дашко Л.В., Ключников В.Ю., Синюк В.Д. Применение методов термического анализа при исследовании цементного камня. Вестник Восточно-Сибирского института МВД России, no. 2 (65), 2013, pp. 47-54.
13. Бондаренко Н.И., Здоренко Н.М., Ляшко А.А., Волошко Н.И., Антропова И.А., Бурлаков Н.М. Исследование кинетики дегидратации гидроалюминатов алюминатного цемента // Международный журнал экспериментального образования. – 2015. – № 12-2. – С. 252-252.
14. Федосов С.В., Акулова М.В., Алоян СМ., Щепочкина Ю.А. Оценка времени прогрева изделий при высокотемпературной обработке// Доклады IX Польско-рос. семинара «Теоретические основы строительства». М., 2000. С.185.
15. Интенсификатор помола. Патент на изобретение РУз. IAP 07061. 30.09.2022. Бюлл. № 9. / Куватов Д.Г., Турабджанов С.М.
16. Солоненко А.П., Блесман А.И., Полонянкин Д.А. Синтез и физико-химическое исследование гидросиликатов кальция различного стехиометрического состава. Динамика систем, механизмов и машин, vol. 6, no. 2, 2018, pp. 215-221.
17. Yusuf MO. Bond Characterization in Cementitious Material Binders Using Fourier-Transform Infrared Spectroscopy. *Applied Sciences*. 2023; 13(5):3353.
Интенсификатор помола. Полезная модель РУз. № FAP 02089. 30.10.2022. Бюлл.№10. / Куватов Д.Г., Турабджанов С.М.