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PHYSICOCHEMICAL, COMPLEX THERMAL, MICROSCOPIC AND RADIATION ANALYSIS OF DRY CONSTRUCTION MIXTURES WITH A NEW COMPOSITION

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Abstract
This article is devoted to the research carried out on the physicochemical, complex thermal, microscopic and radiation investigations of new-containing dry construction mixtures.

Keywords: Physical and chemical analysis, complex thermal analysis, microscopic analysis radiation examination, dry construction mixture (DCM).

Introduction

With the development of industrial production, chemistry and other similar industries in the world, the need for the utilization of waste from these enterprises or the introduction of waste-free technologies is increasing. In this regard, determining the composition of waste from industrial enterprises, studying their harmful aspects, developing optimal methods for waste disposal and creating prospects for their rational use have become one of the urgent issues. In this regard, special attention is paid to the production of new building materials based on local industrial waste.

The tasks set out in the Strategy of the President of the Republic of Uzbekistan No. PQ-4291 dated April 17, 2019 “Implementation of work related to solid household waste in Uzbekistan in 2019-2028”, Decree No. PF-5 dated January 4, 2024 “On measures to improve the waste management system and reduce their negative impact on the environmental situation”, Decree No. PF-5057 dated September 15, 2017 “On approval of lists of exemptions from customs duties when importing special equipment, technological equipment and components not produced in the Republic of Uzbekistan, imported within the framework of the organization of clusters for the collection, transportation, utilization, processing and burial of household waste in the cities of the republic”, and other regulatory legal acts in this area are being implemented. This dissertation research serves to a certain extent to increase [1,2,3].

One of the main reasons that reduces the widespread use of dry building mixtures in mass construction is their high cost and constantly increasing cost. Most domestic dry building mixtures are manufactured using technologies of leading foreign companies, their composition includes a set of various imported additives, the cost of which accounts for up to 97% of all raw material costs. Today, one of the urgent tasks for domestic manufacturers of dry building mixtures (DCM) is to develop high-quality and affordable dry building mixtures. The most promising solution to this problem is to reduce the cost of DCMs by organizing production with maximum use of raw materials closest to the consumer and local industrial waste [4].

In world practice, the scientific foundations of the production of QQQ based on industrial waste and their properties are covered in the scientific works of many foreign scientists - Yu.R. Puchkov, I.S. Pishkina, I.S. Velikanova, O.A. Bichkova, A.A. Klishnikov, D.A. Belikov, M.S. Makarevich, E.R. Akzhigitova, Y.Y. Simonov, A.Y. Nasonova, A.S. Denisov, G.I. Gazaleeva, V.P. Ponomarev, V.N. Logachev, D.S. Tretyakov, T.N. Kuligina, A.I. Vezentsev, Y.V. Safonov, R.A. Burkhanova, M.Yu. Shirev, M.A. Gavrilov, G.N. Sobolova, A.D. Tsigipov and others, who have made a great contribution to solving these issues.

Leading scientists in the field of building materials in our republic - A.T.Djalilov, E.U.Qosimov, N.A.Samigov, A.A.Tulaganov, A.I.Adilkhodjaev, A.T.Djalilov, A.B.Ashrabov, A.A.Tokhirov, I.I.Qasimov, R.A.Rakhimov, V.M.Tsoy, M.U.Karimov, I.N.Abdullayev, E.V.Shipacheva, B.A.Asqarov, U.A.Gaziyev, S.A.Khodjayev, Sh.T.Rakhimov, Kh.Kh.Komilov, Z.M.Sattorov, A.I.Khamidov, A.H.Alinazarov, B.Sh.Rizayev, S.J.Razzakov, S.A.Kholmirzaev and others have contributed to the development of a culture of using local industrial waste in our country and have achieved certain achievements and important scientific those who achieved results.

Methods

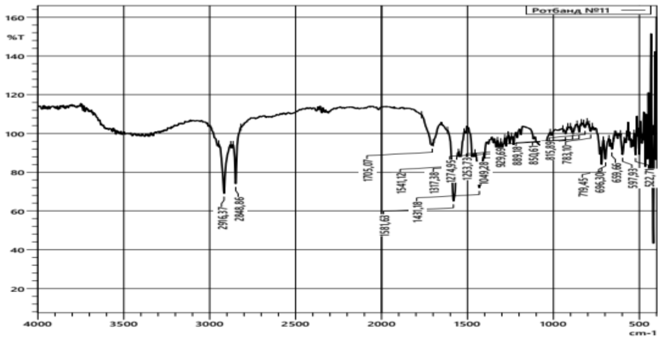
Analysis of the conducted studies shows that research on the production and use of materials based on asbestos cement industry waste has been sufficiently studied. However, despite the fact that there are sufficient opportunities in the construction materials industry in our republic to obtain asbestos cement waste from local raw materials, research has not been carried out consistently.

Physicochemical analysis methods allow us to study the microstructure of DCM compositions and its transformation processes, such as hydration, crystallization, and other properties, under the influence of complex chemical additives.

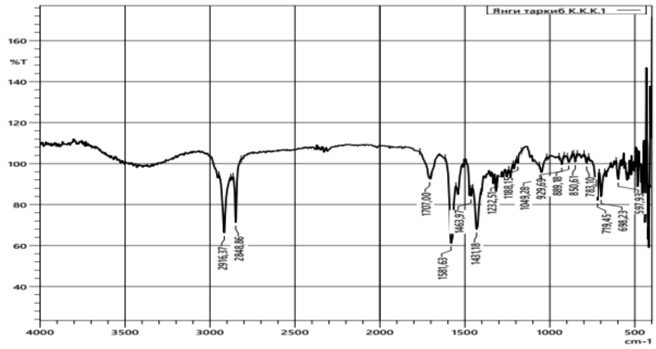
Complex thermal analysis was performed on a PIHSel3D diffractometer. This device is based on determining the temperatures of transformation (transformation into another substance) and interaction of various composite materials in the range of 125, 250, 500, 1000, 1500^{0}C, which occur in conjunction with the thermal effect.

Results

A complex thermal analysis of ACWB samples (Figures 2-3) obtained by mechanical (Figure 1) and thermally activated lime and microsilica, and DCMs based on ACWB modified with MPQ plasticizer, was studied.



a)



b)

Figure 1. Infrared spectral analysis results of conventional dry construction mix a) and ASCH-based dry construction mix b).

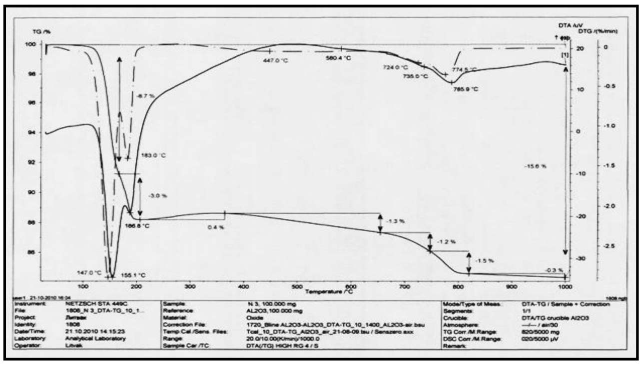


Figure 2. Results of thermal analysis of mechanically activated ACW.

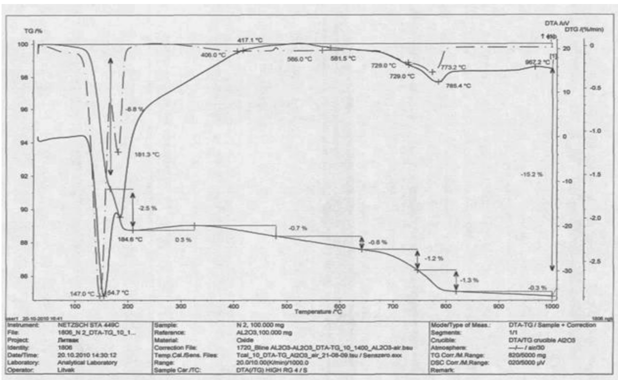


Figure 3. Results of thermal analysis of ACW with lime and microsilica added.

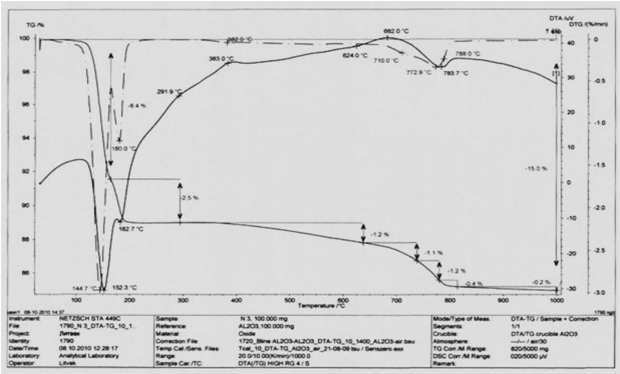


Figure 4. Results of thermal analysis of DCM obtained based on ACWB modified with MPQ plasticizer.

Analysis of the dynamic thermogravimetric analysis (DTGA) curve shows that three endoeffects can be seen in the DTGA curve, which are characteristic of all samples. 1-mass loss at temperatures between 100-200^{0}C, 2-mass loss at temperatures between 200-500^{0}C, 3-mass loss at temperatures between 600-950^{0}C.

1. Endoeffects in the range of 100-200^{0}C are associated with the loss of hygroscopic free water in ACW, accounting for 4.3% of the total mass loss.
2. The endoeffect at temperatures of 250-700 ^{0}C occurs due to chemically bound water released during the partial decomposition of minerals of the CSH, CASH, CAFH type in hydrated cement stone, accounting for 6.7% of the total mass.
3. Endoeffects in the range of 750-850^{0}C related to mass loss are 12.95%. This mainly indicates the decomposition of minerals formed during cement hydration and low-basic hydrosilicates formed as a result of the interaction of lime and microsilica.

1-table **Results of complex thermal analysis of DCM composition samples obtained based on ACWB..**

Components	Endoeffect number						
	1		2		3		Total mass lost, %,
	Temperature, °C	Lost mass, %,	Temperature, °C	Lost mass, %,	Temperature, °C	Lost mass, %,	
ACW	105	4.3	250	6.7	750	12.95	23,95
Thermally activated ACW	200	4,8	284,6	2,5	785,4	11,3	18,6
ACW with lime and microsilica	250	8,5	382,6	6,5	873,5	5,4	20,4
ACWB based DCM modified with MPQ plasticizer	252,3	8,4	482,7	2,5	983,7	1,2	12,1

The release of water from ACW occurs gradually. Most of it, due to its strong binding in the ACW structure, is released at high temperatures.

The main structural element for all modifications of hydrosilicates in ACW is the - C-S-H-, -C-A-S-H-, - C-A-F-H -chains with an inter-ionic distance of 0.31-0.32 nm.

During the dehydration of dihydrates, they retain their orientation, moving mainly perpendicular and parallel to the chain direction [5, 6].

The structure of samples of DCM composites obtained from ACWBs, which were mechanically and thermally activated, and modified with lime and microsilica and MPQ plasticizer, was studied by electron microscopy.

The obtained electron microscopic images are presented in Figures 4-7.

a **b**

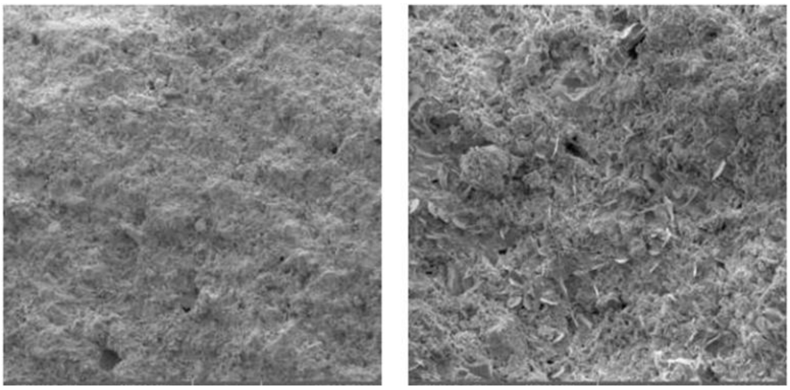


Figure 5. Microstructure of unactivated (a) and mechanically activated ACW.

The microscopic image in Figure 5(a) shows that the composition of ACW consists of asbestos fibers surrounded by a large amount of hydrated cement. As a result of mechanical processing (sandblasting) of this waste, the asbestos fibers are abraded and the hydrated cement is uniformly distributed throughout the base.

a **b**

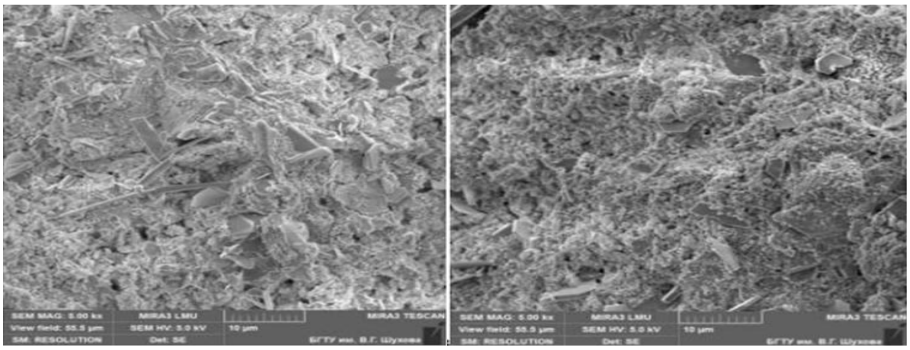


Figure 6. Microstructure of lime (a) and ACWB with microsilica added (b) activated by mechanothermal method at 600^0C.

In figure 6, it can be seen that the composition of ACW, ACWB with lime and microsilica added, which was activated by mechanothermal method at 600^0C, consists of hydrated cement stone CS, CAS and CAF type calcium, aluminate and ferrite minerals, as well as low-basic hydrosilicates and MgO formed by the interaction of lime and microsilica. It is noticeable that the asbestos-cement composition has a uniform distribution of finely dispersed asbestos fibers over the binder volume.

Figure 7 shows the electronic microstructure of DCM modified with 0.2% MPQ and 0.3% Poliplast SP-1 plasticizer additives. The composition of DCM is 67% ACW, 28% lime and 5% microsilica, and 50% filler (lime waste).

a **b**

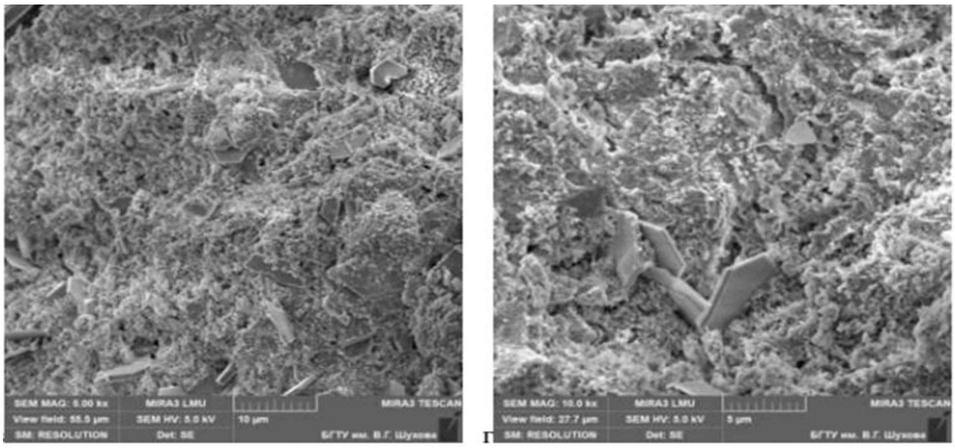


Figure 7. Electronic microstructure of DCM modified with Poliplast SP-1 (a) and MPQ (b) plasticizer additives.

The structure of DCMs, which are made of plasticizing additives, thermomechanical activation methods, and lime and microsilica fillers, is fundamentally different from other compositions obtained on the basis of ACWB. The electron micrographs presented in Figure 7 indicate that the introduction of plasticizers into the composition of DCMs creates dense and structurally strong compositions. This is explained by the fact that the plasticizer increases the flowability of the mixture and reduces its water requirements [7,8].

DCM based on ACW was subjected to radiation testing in the radiology laboratory of the National Reference Laboratory of the Committee of the Republic of Uzbekistan for Sanitary and Epidemiological Wellbeing and Public Health based on SanQM No. 0193-06. The laboratory spectrometer-radiometer “MKGB-01”, “RADEK” (Fig. 8) was calibrated with a calibration certificate No. UZ-05/46-2025 (27.01.2025).

Figure 8. Appearance of the spectrometer-radiometer “MKGB-01”, “RADEK”.

The test took into account the following conditions: temperature 22.8 ^{0}C, relative humidity 42%, γ-background 0.12 μSv/h, atmospheric pressure 735 mm.sym.sup.

Table 2 below shows the results of the analysis.

Table 2 Results of radiation testing of DCM composite samples obtained based on ACWB.

№	The name of the sample	Ra-226 Bq/kg	Th-232 Bq/kg	K-40 Bq/kg	$A_{eff.}$ Bq/kg	Extended uncertainty K=2, ΔQ, Bq/kg	According to the regulatory document Bq/kg
1	ACW asosidagi DCM	11,27	16,25	63,18	38,1	±4,4	<370 Bq/kg
2	ACW-based DCM	30,74	5,52	83,52	45,4	±13,4	<370 Bq/kg
3	ACW-based DCM	25,52	13,18	74,45	49,4	±12,9	<370 Bq/kg
4	ACW-based DCM	12,01	16,40	79,07	40,5	±15,0	<370 Bq/kg
5	ACW-based DCM	21,55	4,87	86,13	35,6	±5,6	<370 Bq/kg

As a result of the test, it was determined that the effective specific activity (effective specific activity Aeff.) in the samples did not exceed the standard (<370 Bq/kg) established in accordance with the requirements of sanitary rules and standards No. 0193-06 and applies to class 1 building materials.

Conclusion

It should be noted that the results of electron microscopy (EM) analysis showed that the composition of ACW consists of asbestos fibers surrounded by a large amount of hydrated cement shell, and as a result of mechanical processing (sanding), it was observed that the asbestos fibers were loosened and uniformly distributed in the hydrated cement base. It was found that the composition of ACW, ACWB with the addition of lime and microsilica, activated by mechanothermal method at 6000C, consisted of hydrated cement stone CS, CAS and CAF types of calcium, aluminate and ferrite minerals, as well as low-basic hydrosilicates and MgO formed by the interaction of lime and microsilica.

As a result of the conducted radiation test, it was determined that the effective specific activity (effective specific activity Aeff.) in the samples did not exceed the established norm (<370 Bq/kg) in accordance with the requirements of sanitary rules and standards No. 0193-06 and applies to class 1 building materials.

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