UDC 666.3.135

M.M. Gyvlyud, L.B. Demidchuk[1], D.V. Smolyak[2]
Lviv Politechnik National University,
[1]Lviv Commercial Academy,
[2]Lviv State University of Safety of Vital Functions

SILICIUM ORGANIC COATINGS FOR THERMAL AND FIRE-PROTECTION OF REINFORCED CONCRETE

Research conducted in the article investigates phase and structural modifications in the process of protective coating forming while heating. There are examined patterns of processes of interaction between silicium organic compounds based on the rich polymethylphenylsiloxane with oxide excipients as well as opportunities of their utilization for high-temperature and fire-protection of constructions made of reinforced concrete.

Key words: protective covering, organosilicate material, phase and structural changes, polymethylphenilsiloxane, fire protection.

Розглянуто фазові й структурні зміни захисного покриття в процесі нагрівання. Досліджено зразки процесів взаємодії міжкремнієвих органічних сполук на основі збагаченого поліметилфенілсилоксану з наповнювачами оксидів, а також можливості їх використання в умовах високої температури та для вогнезахисту конструкцій із залізобетону.

Ключові слова: захисне покриття, органосилікатний матеріал, фазові та структурні зміни, поліметилфенілсилоксан, протипожежний захист.

Introducing

For protecting of surface of the reinforced concrete from fire influence perspective are sheeting which are able in the process of heating to up warp, both on the basis of organic and mineral astringent. But coverage on the basis of organic astringent in the process of heating form a protective layer with low adgezia to the surface of material which is on the defensive, which can collapse thermal gas streams. Therefore more expedient use of fireproof coverage on the basis of mineral astringent, which up warp during heating with formation of heat-insulation protective layer.

Without regard to the known results of scientific researches of Yakovlevoy R.A, Sviderskogo V. A., Belikova A. S., Kharitonova N. P. but other, development of compositions of temperature resistance and fireproof coverage with improving physical and mechanical properties remains, a modern task the decision of which will be instrumental in the increase of efficiency of fire protection of reinforced-concrete constructions.

Perspective direction of development of new compositions of fireproof coverage which can answer the resulted requirements is the use in their compounding of gap-filling polymethylphenilsiloxane, that stipulated actuality of lead through of researches from establishment of conformities to the law of influence of components on efficiency of fire protection of reinforced-concrete constructions.

Analysis of the last researches of publications

High temperature and fire defense of metallic and concrete constructions consists in creation on their surface warmly insulating dense screens with a low diffusivity, which are able to maintain high temperatures and insulate the surface of material from the direct action of aggressive factors of, which diminishes warming up of lining and considerably increases the real limit of temperature resistance and keeps him a function for the actions of high temperatures during the protracted period of time [1].

On this time high temperature and fire protection of constructions is conducted on the basis of technician–economic analysis recognition such factors: proper limit of fire-resistance, as a construction, external of construction, aggressiveness of environment, labor intensiveness of works environments during over coating [2]. Therefore for high temperature and coverage is utilized fire protection of materials on the basis of gap-filling polymethylphenilsiloxane [3]. During heating in coverage there is thermo oxidation destruction of organic connection with the change of their structure.

Connections which in a polymeric chain in place of atoms of carbon contain the atoms of other elements in particular to selishe, can considerably increase thermal properties of protective materials. In quality such connections can be utilized poleorganoselocsane, the finished good of thermo oxidation destruction of which is a polymer [SiO_2]n, which adds material also certain durability [4]. Inorganic polymer which is in composition material, at heating serves as framework at forming of protective layer of sheeting. Polymers which in a basic chain with the atoms of selishe and oxygen contain the periodic including of atoms of metals are synthesized, even insignificant maintenance of which sharply changes properties of selech organic connections due to the increase of mass of mineral constituent.

The purpose of work consists in the study of conformity to the law of processes of co-operation selishe of organic compounds with xfillers at heating that possibility of their use for high temperature – and to fire protection of the reinforced concrete.

Results of experimental researches. Will consider the sequence of processes of co-operation between the components of coverage in the process of his forming at heating by a complex thermo analysis. On the curve of DTA (fig. 1) of composition of polymethylphenilsiloxane – Al_2O_3–ZrO_2 – a fire-clay fight is fixed 5 eczoefection with maximums at 822, 918, 1045, 1395 and 1505 K.

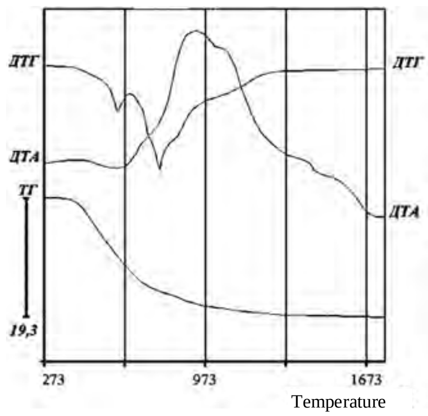

Fig. 1. Complex thermoanalysis of gap-filling Al_2 O_3, ZrO_2 and fire-clay fight of polymethylphenilsiloxane

Beginning of the first exothermic and proper loss of mass of coverage can be attributed to the process of thermooxidation destruction of polymethylphenilsiloxane, that conditioned tearing away of metelion radicals. On the process of destruction of metelion radicals imposed eczoefection destruction of phenic radicals with maximums at 908 K and 1045 K. Destrukciya copulas completed at a temperature 1075 K. Pochatok eczoefection at 1275 K it is possible to attribute to structural transformations to well-educated silica framework and beginning of crystallization of primary mulition phase. Ekzoefekt with a maximum at 1395 K it is possible to attribute to crystallization of mulitu from the aluminium of oxide and well-educated silica, and at 1505 K – to zircon. Loss of mass of standard at heating to the temperature 1673 K makes 19,3 the masses.%.

The results of DTA are confirmed a rengenofazoveme analysis (fig. 2).

The diffractogram of the probed composition to heating specifies on the presence of α-Al_2O_3 (d\n = 0,347; 0,254; 0,237; 0,208; 0,160 нм), ZrO_2 (dμ\n = 0,369; 0,316; 0,283; 0,264; 0,254; 0,184 нм) and мулiта (d\n = 0,537; 0,336; 0,211 нм), which is the constituent of fire-clay fight and cristobalition (d\n = 0,405 нм). To the temperature 1073 K (curve 2, fig. 2) brings heating over to the increase intensity of reflexes of α-Al_2O_3 and ZrO_2 due to the increase of their maintenance in a standard as a result of thermo oxidation destruction of copula.

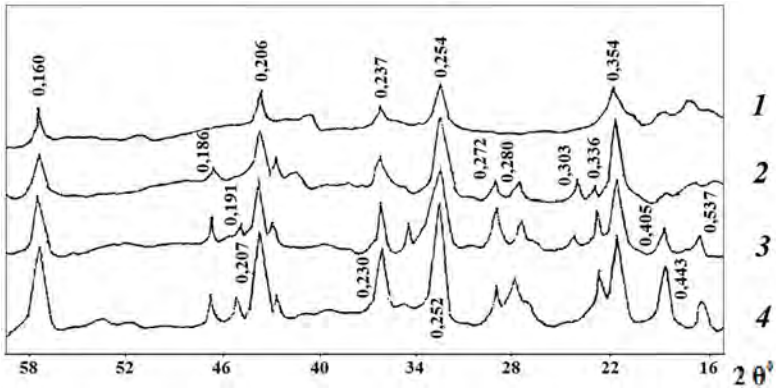

Fig. 2. Diffractograms of gap-filling Al_2 O_3, $ZrO_2$and fire-clay fight of polymethylphenilsiloxane, are at heating to the temperature: 1 is a weekend; 2 – 1073 К; 3 – 1373 К; 4 – 1773 К

To 1373 K conduces the increase of temperature to appearance of diffraction maximums from dµn = 0,537; 0,336; 0,211 нм, which answer mulitu. Heating to the temperature 1573 K is accompanied diminishing of intensity of reflexes of α-Al_2O_3 and education in the system of β–cristobalition (d\n = 0,405 nm). At heating to the temperature 1773 K in the system passes complete co-operation of silica α-Al_2O_3 and ZrO_2 with formation of mulitu and zircon. Reflexes of β–cristobalition disappear fully (curve 4, fig. 2).

It is set the conducted researches, that at heating of gap-filling Al_2O_3 , ZrO_2 and fire-clay fight in the interval of temperatures 573-1045 Kpasses destruction of copula with formation ofhighdispersion amorphous silica. Decline of temperature of completion of destruction of copula on 165 degrees it is possible to explain a catalytic action xfillerson polymethylphenilsiloxane. Heating of coverages for temperatures higher from 1285 K is accompanied formation of mulitu and β–cristobalition, and subsequent heating higher from 1573 K is accompanied crystallization of zircon and intensive diminishing up to disappearance of β–cristobalition.

At introduction in the complement of coverage of previous composition of astringent kaolin on termo grame analogical physical and chemical processes are fixed with additional imposition on them of thermal effects of clay constituent. On the curve of DTA (fig. 3) comparatively with fig. 1 eczoefection is imposed in the interval of temperatures 823-1073 K of degidrateshion of kaolin which results in connection between ions in the crystalline grate of kaolinite. At the subsequent heating of well-educated metacaolene (Al_2O_3 • $2SiO_2$) a sharp exothermic peak appears at 1253 K and in the system more proof phase appears thermodynamics due to proceeding in s-, p- connections of crystalline grate, namely – mulitu. A presence stabilizes the last crystalline structure of coverage which conduces to the increase of thermo stability of material in the process of heating-cooling.

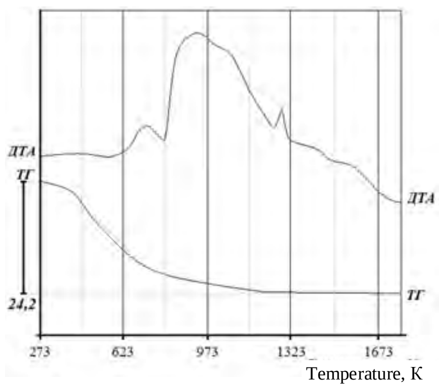

Fig.3. Termograma and curve of loss of mass of gap-filling Al_2 O_3, $ZrO_2$of polymethylphenilsiloxanewith addition 10 the masses. % to the kaolin

Subsequent heating of coverage to the temperature higher from 1573 K conduces to education in his composition of zircon phase. It should be noted that the loss of mass of standard makes 24,2 the masses. %, that on 4,9 the masses. % more high due to degidratesion of kaolin. It is set that at heating of gap-filling Al_2O_3, ZrO_2 and fire-clay fight of polymethylphenilsiloxane to the temperature 1285 K in composition coverage appears mulitu phase from the products of thermo oxidation destruction of copula and Al_2O_3, maintenance of which grows at heating higher from 1393K due to co-operating of xfillers with a Seleshinkesne remain. A zircon phase appears at heat-treated higher from 1573 K.

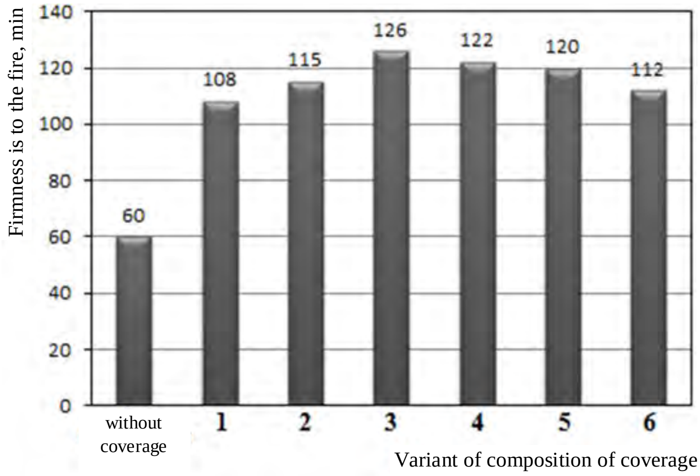

Fig. 4. Limit of fire-resistance of the protected reinforced-concrete standards by the loss of insulating ability

Efficiency of fireproof coverage for reinforced-concrete constructions was determined in a fire stove concordantly DSTU N-P B.V.1.1-29:2010. Expedience of the use of coverages on the basis of gap-filling polymethylphenilsiloxane for fire protection of reinforced-concrete constructions, is well-proven the increase of limit of fire-resistance of material after the loss of insulating ability in 1,8–2,1 times (fig. 4).

Conclusions

Scientific and practical results are taken to the following:

1. The physical and chemical methods of analysis are set the mechanism of forming of sheeting during heating due to co-operating of components between itself with formation of temperature- and fireproof mulitu and zircon phases during heating to the temperature 1473 K. It is set that introduction in the complement of coverage of kaolin on 50–60 degrees reduces the temperature of mulite.

2. It is set that the structure of sheeting consists of case bound needle-shaped crystals of mulit- to zircon, tailings of xfillers of oxide. Porosity of material depends on the temperature of heating, thickness of coverage and speed of raising of temperature. It is set that with the increase of thickness of coverage from 300 to 800 mkm due to his Ksp = 10,9–12,3, the index of porosity grows in 3,2–5,3 times, and speeds of heating a from 20 to 60 hail/min. - in 8,2–9,4 times.

3. Efficiency of fire protection of the developed compositions of sheeting of reinforced-concrete constructions is experimentally well-proven. It is set that the limit of fire-resistance after insulating of protective materials makes 108–126 min, that in 1,8–2,1 times higher than in unscreened.

1. Sharafyev R. H. Ohnezashchytnые pokrыtyya metallycheskykh konstruktsyy / R.H. Sharafyev. F. N. Suleymanov, Y. R. Suleymanov // Yntellektyka. Lohystyka. Systemolohyya: sbornyk nauchnыkh trudov ChNTs RAEN. - 2003. - Vыp. 10. – S. - 103-111. 2. Polyfunktsyonal'nые эlementoorhanycheskye pokrыtyya / pod obshch. red. A. A. Pashchenko. - K.: Vyshcha shkola, 1987. - 198 s. 3. Demydchuk L. B. Ohnestoykye zashchytnые pokrytyya metallycheskykh poverkhnostey / L. B. Demydchuk, M. M. Hyvlyud, Y. A. Lobaev // Nauchnыy Ynternet-zhurnal akademyy AHPS MChS Rossyy: № 4(44) – M., 2012 h. 4. Hyvlyud M. M. Doslidzhennya vplyvu fazovoho skladu na termo- i zharostiykist' napovnenykh sylitsiyelementorhanichnykh zakhysnykh pokryttiv / M. M. Hyvlyud. I. V. Yemchenko Y Naukovi visti NTUU «KPI». - 2007. - № 4 (56). - S. 115-120.