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The Plasticizerson the Basis of the Modified Fatty Acids

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Abstract

The various chemical additives regulating properties of the concrete mix and concrete among which has special place occupy fluidifier and widely applied to depreciation of concrete and improvement of its quality. The fluidifiers are not issued by the industry of Kazakhstan, therefore the production technology development fluidifiers on the basis of the fat-and-oil industry waste is actual, and will allow to provide highly effective fluidifiers manufacture of concrete and mortar and to utilizethe fat-and-oil industry waste. Fundamentally technology of obtaining of additive is put thermoalkaline processing of tar of distillation of fat acids by the saponification ofwater solution of alkali with removal insoluble components in water. The results of researches of influence of obtained fluidifiers on the basic characteristics of concrete mix and concrete on the conditions of the raised temperature and low relative humidity of environment have shown that the implementation of the obtained additives in concrete mixes leads to substantial improvement of technological and physical-mechanical properties of concrete.

Keywords: fluidifiers, gossypol pitch, thermoalkaline processing

1. Introduction

Run-up of economy of Kazakhstan, and also aspiration of major population parts to improvement of the housing conditions has caused housing construction urgency in republic. Housing construction is recognized by one of priority directions of Strategy of development of Kazakhstan till 2050 and is one of the most important problems of national character. Besides, the government programs directed to building of transport highways, objects of farm building actively implement into industrial life of republic. The basic building material are concrete and mortars on the basis of cement and others binding material. The concrete, the artificial composites possessing by high durability, frost resistance, water resistance, high bio - and chemical durability are required in modern building (Bazhenov *et al*., 2006) and their updating is necessary for obtaining of such concrete.

As the basic modifiers of concrete and mortars are the various nature additives. Use of additives of certain quality and in optimum quantity allowsoperatingby the processes of structuration of concrete and mortars. Use of additives allows to obtain notablebenefits and to raise durability of concrete and ferro-concrete constructions. The types of the additives modifying properties of mixes and the hardened stone are various; among which special place occupy fluidifiers (Khigerovich and Bayer, 1979). It is known that application fluidifiers improve operational properties of concrete, especially in road and hydraulic engineering building, simultaneously reducing the cement expense.

Necessity of extension of fluidifiers application became even more actual than additives with increase in monolithic building. In some cases only self-condensed concrete in view of its high fluidity allows to carry out thin-walled unique designs with very high content of armature in sections, reliably filling even cages with the concave surface.

Requirements to properties of fluidifiers are the following: it should be substance, effective already in small doses; their efficiency should not change too at change of temperature of the concrete mix and should not depend on concentration change, and also the water binding relation too. They should mix up easily with the concrete mix and should not change other properties of concrete; they shouldn’t be difficult-to-obtain and inexpensive.

Deficiency of a raw-material base for obtaining of super plasticizers demands intensive search of new effective plasticizers on the basis of industrial wastes, and development of methods of strengthening of their action by ionic-chemical, structurally-topological and procedural influence. Taking into account updating of such plasticizers by alkaline and salt waste of the various enterprises for increasing of rheological activity and an intensification curingof binding is solved the substances the nature protection aspect of the problems by means of recycling of by-products.

Requirements of quality and availability are additives of raw materials for which can serve the industry waste and secondary raw materials. Now the chemical industry are turned out fluidifiers on the basis of condensation products of naphthalensulfonic acids and formaldehyde, melamine-formaldehyde pitches, on the basis of sulfonic naphthalenformaldehyde compounds, polyoxyethylene glycol, poly carboxylate, sulfate contain waste of acrylate manufactures, lignosulphonate, production wastes of manufacturing of fodder yeast, waste products of pentaerithrits, waste products of cellulose, alkaline drains of manufacture aminocaproic lactam and etc (Kalashnikov *et al*., 1985).

Southern region of Kazakhstan are manufacturers of cotton, products on its basis and has an abundance of annually renewing vegetative raw materials. In processes of manufacture of cotton oil and fat acids depending on the technological scheme and the way of culture of the basic products is formed the set of waste products. A waste concerns such products fat and oil manufactures (gossypol pitch and soap stock) which are gatheredin the special pools and they are the source of environmental pollution today.

The highly effective fluidifiers are not turned out by the Republic Kazakhstan industry; therefore fluidifiers are got from other countries that they rise in price and reduce quality at long storage. In this connection there is exigence in development of obtaining technology of highly effective fluidifiers for concrete and mortars on the basis of local materials and, in particular, fat and oil waste products.

Now this waste is a little used, basically collect in special storehouses that creates economic and environmental problems. Economic problems of the enterprises are connected with entitlement payment, necessity of warehousing and storage of gossypol pitches. Environmental problems are caused by its toxic properties. The different ways of utilization of these wastes offer: addition for cement concretes (Baibulekov *et al*., 1997), addition at the grade of cement (Gelchinova, 1994), superplasticizer of concrete (Gilko, 2007), component of elastomeric composition (Nadirov *et al*., 2002), components of cleansers (Khamitova, 2009) and superficial-active substances (Bimetova, 2006), but they or use the negligible quantity of resin, or technologically difficult, therefore development of technology of receipt of plasticizing and multifunction additions for concretes and building solutions on the basis of wastes of fat and oil industry is the issue of the day, that will help to get quality and cheap home addition for concretes and improve the ecological situation of region.

2. Materials and Methods

2.1 Methods for Recycling of Production Waste Cotton Oil

The gossypol pitch (GP) is slop in the result of distillation of fat acids of cotton soap stock. Gossypol pitch - homogeneous frictional flow mass from darkly - brown to black color. Its properties depend on quality of feed stock, observance of processing method, decomposition of fat, depth of distillation of the obtained fat acids and other factors. In gossypol pitch content crude fat acids and their derivatives, condensation and polymerization products of gossypol and its transformation, formed which contain at oil extraction, mainly in the course of distillation of fat acids from soap stock. Soap stock - paste like oily substance - a large-tonnage waste of the refined vegetable oils. During the research various soap stocks (cotton, sunflower, castor) is established that cotton soap stock unlike others - fermentative - steady.

Monitoring of the waste of fat and oil industries of southern region RK has shown that, small enterprises by the manufacture of vegetable oil has no possibility of decomposition of fat and the subsequent distillation of fat acids (DFA) and all soap stock flows to joint-stock company "Shymkentmai". In joint-stock company "Shymkentmai" from 01.01 till. 2012. is collected 759,22 tons, and 473,571 tons of tar for 8 months in 2013. And it is annually made about 750 thousand ton cotton oil in republic Uzbekistan. Gossypol pitch is formed in number about 2 % from weight of oil (15 thousand ton in a year). The additionaldistillatory by the obtaining of DFA are established at many factories till today. Thedistillatory work more than half formed fat and oil waste (Dauletov, 2002), cleaning products (Aydar *et al*., 2003), additives (Bajbulekov *et al*.1997), decomposition, decomposition of distillation waste (Royzman, 1970).

Division of fat acids into fractions conducts several methods. The processing of soap stock saponify with alkali and obtained so-called "glue" which process the concentrated sulfuric acid in some Fat-oil plants by new technology . The brown fat acids, containing gossypol are in such way allocated. After washing by water before neutral reaction obtain crude fat acids (CFA) with acid number 180-200.

In the periodic way of distillation heated to 60-70°C, fat acids are transferred from capacity to vacuum-drier where heat up to 120°C and dried up. Then submit them todistillatory cube where the temperature is supported 220-230°C and the heated steam is entered under the pressure of 1,2-1,3 physical atmosphere. Acids evaporate, separate from water and collect in the collection. At such way of processing of soap stock the high degree of distillation is reached. the obtained tar contains less fat acids, but has a viscous consistence (Novolik, 1954).

It is widely applied the carbamide method based on formation of some complexes in practice. Theunsaturated fat acids are less,than the insoluble complexes with urea are easier formed (Sayfutdinov, 1999).

At distillation of the fat acids allocated from the waste of purifying of cotton oil - cotton « soap stock », in gossypol there is their interaction among themselves, with fat nonsaturated acids and other accompanying substances. As a result of these processes simultaneously with stripping of fat acids is formed so-called gossypol pitch. Distillation of fat acids is conducted at temperatures 220-230°C. As a result of these processes simultaneously with stripping parts of fat acids is formed at cubed GP, containing from 40 to 50 % of products of condensation, polymerization and interaction products with gossypol.

2.2 Characteristics of Gossypol Pitch

Gossypol pitch is homogeneous, viscous weight, from dark brown to black color, it is practically insoluble in water and well dissolved in products of distillation of oil (gasoline, kerosene, diesel fuel) chloroform, acetone etc. It is 35-40 % of products of transformation of fat acids in the kind of lactones consist of 10-12 % nitrogen-containing compounds, and also polymerized pitches, are present polyphenols, hydrocarbons, nitrogen - and phosphorus containing compounds - reactive with high complex forming properties (Markman and Rzhehin, 1965).

In the mix of the sated and nonsaturated acids of gossypol pitches are recognized the myristic acid (0,5-1 %), stearin acid (30-40 %), the others - polymerization and polycondensation products.

On molecular weight of gossypol pitch corresponds to low-molecular polymers.

It is underlined (Sergeev and Tavbin. 1961) that one of the most important lacks of gossypol pitches is more water content - about 30-35 % from weight whereas under standard requirements moisture content in pitch should not be more than 4 %. It will be explained that under the plant conditions at transportation of GP by the pipelines, for viscosity reduction its heating by direct steam is conducted. As a result of pitch is enriched with water and further considerable time and expenses is required for the moisture removal which formed at thermal processing.

Various properties of different parties of GS are controlled by depth of distillation of fat acids of cotton soap stock and temperature conditions of processes.

Tests of pitches of various fat and oil plants of the south of Kazakhstan and Republic Uzbekistan have been obtained and their properties are studied.

Table 1. The characteristic of gossypol pitches of various fat and oil plants

GP (FOP)	Solubility in acetone, % not less	Ashcontent % nomore	Number of acid мg KOH/g	Calculated molecular weight. by CN	Product of oxidation and transformationof gossypol, %	Fat acids in the kind of lactones, polymer, pitches, %
Goint-stock company "Shymkentmai	71,2-73,6	1,01-1,3	72,4-75,1	715,5-753,6	28-29	56,1-58,3
Yangiyl fat and oil plant	78,6-79,2	1,2-1,3	84,3-86,4	600,8-640,3	30-32	58,6-59,0
The Andizhan fat and oil plant	70,0-71,3	0,89-1,05	67,0-68,0	784,780,0	28-31	57,0-58,0

The research of chemical properties of structure of GP after distillation of fat acids of cotton soap stock has shown that it is homogeneous plastic weight of black colour with characteristic odor of cotton oil. It contains to 96,3 % of solids, 3,7 % of moisture and other flying substances and 1-1,2 % of ashes. The content of the general lipids to 82 %, unsaponifiable matter to 25 %, fat acids to 5 %, nitrogen-containing substances of 1 %, rosin to 1 %. In structure of GS also are phospholipid,triglycerides, stearin, tocopherol, etc. Research of fractional structure of GP shows that it consists of three particles: unsaponifiable, fat-acid and phenolic parts (Fatkhulayev *et al*.,1998).

Table 2. Structure of separate particles GP

Particle	Ways for weight of GP, %	Colour and types	Structure of particles
Unsaponifiable part	21-24	Dark-brown	Hydrocarbons C_{27},C_{28}, ... C_{33},spirittesteron
Fatty-acid part	52-57	Black-oil likesubstance	Fat acidsC_{16}-C_{18}, lactones and polymerized acids
Phenolicpart	22-24	From brown till deep-brown	Phenols

These particles, everyone by separately at updating can give GP some special properties.

In IR-spectra GP of various fat and oil plantsis observed the change of degree of absorption in regions 1580, 1350, 1000-1490 sm-1, determined by presence C=O, - COOH groups. It is connected with various degree of polymerization of process of gossypol - fat acids or other similar processes proceeding at distillation of fat acids, allocated from cotton soap stock.

3. Results

3.1 Properties of Gossypol Pitch and Its Derivatives

The influence the content of unsaponifiable matter on viscosity and specific conductivity are investigated in the work.

The results of the analysis on viscosity with the help of Ostwald viscosimeter and specific conductivity by the TLC method has shown (Table. 3) that the content of unsaponifiable matter strongly reduces these indicators, i.e. viscosity and specific conductivity at the maintenance of not water-soluble substances of 18,63 percent have made 1,26x10-6м2c-1 and 0,21Ом-1м-1. Absence or the small maintenance of these substances has led to increase conductivity to 4,1 … 5,5 times and to increase in viscosity of the mortar to 1,21 … 1,30 times.

Table 3. Structure of initial raw materials and updating products

Numbers of parties	The maintenance of saponifiable matter , %		Characteristics of a target product	
	Inaninitialproduct	In a targetproduct	Viscosity,$v \cdot 10^{-6}$ $м^2 \cdot c^{-1}$	conductivity, $\delta \cdot 10^2$ $Ом^{-1}м^{-1}$
1	18,63	18,63	1,26	0,21
2	18,63	0,4	1,09	0,87
3	18,00	0,9	1,07	0,91
4	20,70	0,3	1,05	0,90
5	19,01	0,1	1,04	0,93
6	16,20	0,5	1,09	0,85
7	21,50	0,43	1,07	0,87
8	21,00	0,5	1,06	0,89
10	19,30	1,0	1,11	0,71
11	18,00	1,01	1,11	0,75
12	19,70	0,7	1,08	0,95

The nature of chemical compounds and the functional groups which are the part of gossypol pitch, studied by means of electronic and infra-red spectra.

In IR-spectra thermoprocessed gossypol pitch and its samples with additives of cotton soap stock have been studied.

In IR-spectra initial of gossypol pitches in the form of intensive strips are observed valency (νCH), deformation (δCH), fluctuations bonds inC-Hmethyl and methylene groups. Lack doublet band indicates the presence of a linear hydrocarbon radical.

Comparison of IR-spectra ofdehydrated gossypol pitches with a spectrum after thermal processing has shown that at initial of gossypol pitches aldehyde resin groups and OH- groups participate in the formation of hydrogenbonds andthey are in associated or strongly connected type with other components. After thermal processing aldehyde group is released and consequently value ν - CO is displaced in high-frequency area of a spectrum of 1705-1730 sm-1.

IR-spectra of samples of gossypol pitches at presence of soap stock are identical with the spectrum initial gossypol pitches. The basic difference is occurrence of strips of absorption ionized carboxylic groups over 1580 (νas - COO) sm-1 and 1450-1470 (νS-COO) sm-1. Occurrence of these strips specifies in interaction of carboniferous acids with components of soap stock.

It has been established that the water-soluble form of gossypol pitches are stable in range pH = 7-12. In an acidic environment, they lose solubility, increased pH results in an increase of the number of ionized groups per molecular weight of the solution, which contributes to better solubility of gossypol pitches in water. In a strongly alkaline medium at pH - 9 and above aqueous system is stable for a long period of time.

It is known that, to obtain water-soluble form of gossypol pitches heat treated to 220-240 ° C mass is cooled to 120-130 ° C and mixed with any alkaline reagent, in particular the triethanolamine to pH 7.5-8.0. After cooling of the mass is taken hinge for the dissolution, the preparation of aqueous solutions and corrosion research. The initial aqueous suspension of gossypol pitches was purified by dialysis.

3.2 Technology of Production of Plasticizer

For the synthesis of new chemical additives used tar distillation of fatty acids (gossypol pitches), which is the predominant fatty acids particles C11-C17-60…65%, C1phosphites 13 ... 26% unsaponifiables ... .21,5 18% (mixture of complex triglycerides, colorants, tocopherols, sterols, gossypol and its derivatives). The second component is an aqueous solution of caustic soda (NaOH). For the extraction of unsaponifiables used white spirit. For additives distillation of fatty acids of plant oils previously saponified 5-20% by aqueous alkali solution in the ratio of 1.3 ... 5 at temperature 70-85C saturated compound (nonaqueous soluble particles) separated by extraction with white spirit, taken in a ratio of gossypol pitches: white spirit 1: 5.

Thermoalkaline processing were carried out in the chemical reactor equipped with steam jacket, stirrer and cooling coil. Initial components are loaded when the stirrer continuously in the following sequence: warm water, aqueous solution of sodium hydroxide, gossypol pitches, cold water. Water and gossypol pitches metered by volume dispenser and then gravity fed to the reactor. Sodium hydroxide was weighed and charged into the reactor through an opening in the roof.

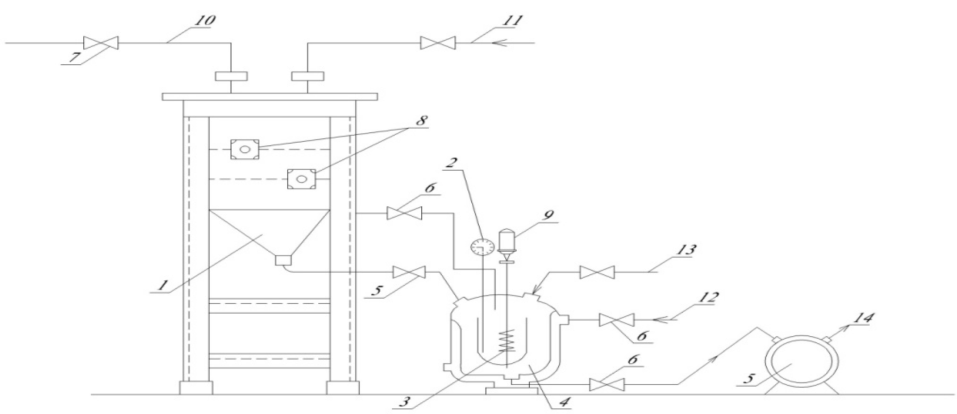

Figure 1. Flow diagram of the synthesis of the plasticizer on the bases of gossypol pitches

1-dispenser; 2-manometricthermometer ; 3-coil; 4-container; 5-vortex pump; 6-mechanical valves; 7 solenoid valves; 8 sensors relay by the level of tar and water; 9 motors with gear; 10 pipe for pumping tar; 11-supplying respectively of hot and cold water; 12 steam; 13-supplying of alkali solution; 14 supply of the finished products into the container.

An equivalent amount of sodium hydroxide, loaded for synthesizing additives is determined depending on the acid number of fat (KOH), and exceeds 6 ... 10%, which is in a free state in the compounds of additives. It is known that sodium hydroxide acts as an inhibitor of corrosion of steel reinforcement , and hardening accelerator of cement.

In the proposed scheme, despite the fact that the regeneration of organic solvents in small amounts is carried out, they remain in solution. Positive role of such agents is in the stabilizing effect, representing damage of additives during the storage.

Supply of warm water facilitates and accelerates the heating of the components in the reaction mixture to 40 ... 45C in the first stage preparation and continuous stirring ensures the homogeneous mixture prevents the formation of tar products of high viscosity. In the synthesis process the temperature of the additive should be brought to 72 ... 80C to provide dissolution nubble like portion. At this temperature, the reaction is intense and lasts 2 hours. For extract of the saponifiable particle was white spirit through a vacuum evaporator with a further drain of these particles.

Table 4. Characteristics of initial substances and target product

Numbers of parties	The maintenance of saponifiable matter , %		Characteristics of a target product	
	Inaninitialproduct	In a targetproduct	Viscosity,$\nu \cdot 10^{-6}$ $м^2 \cdot с^{-1}$	conductivity, $\delta \cdot 10^2$ $Ом^{-1} м^{-1}$
1	18,63	18,63	1,26	0,21
2	18,63	0,4	1,09	0,87
3	18,00	0,9	1,07	0,91
4	20,7	0,3	1,05	0,90
5	19,01	0,1	1,04	0,93
6	16,20	0,5	1,09	0,85
7	21,50	0,43	1,07	0,87
8	21,00	0,5	1,06	0,89
10	19,3	1,0	1,11	0,71
11	18,00	1,01	1,11	0,75
12	19,70	0,7	1,08	0,96

The resulting product consists of 61 ... 70% of sodium salts of unsaturated fatty acids preferably with predominant particles of C11-C17 in the molecules between the carbon atoms which are double or triple bonds, in which the carboxyl groups are in the form of salts dissociate - COOH, -Na +, differing total plasticizing properties. The additive also contains 21 ... 25% of lipids and phospholipids. Chemical and physical properties of lipids determined by the presence in their molecules as polar groups, and polar hydrocarbon chains. The polar groups are hydroxyl groups (-OH), carboxyl (COOH) and phosphoric acid (-RO4) and hydrocarbon radicals (chains) are different affinity for oils, fat, bitumens. According to this structure of lipids naturally identify plasticizing effect for the cement composition.

The resulting product is a dark brown liquid density of 1.01 ... 1.025 g / cm 3, without any negative specific odors and absence of reducing agents (poly, aminosaccharides). Its content of organic and organic-matter up to 28 000 mg / m 3, and pH is 11.5 ... 12.0. It follows that the proposed use of the additive is not limited and the alkaline nature of the solution adopted by the range is not dangerous for the cement paste and fittings.

Material composition of the resulting additive investigated according to normative documents (9) is shown in Table 5.

Table 5. Material structure of an additive

№	Names	Factors
1	Physicalconfiguration	The liquid is dark brown
2	Odor	Weak. The specific characteristic of the tar
3	Massfractionofsolids, %	23-25
4	Solidity, g/sm^3	1,020-1,148
5	pH 20%-solution	11,0-14,0
6	Watercontent, % no more	72,0
7	Ashcontent, %	4,67-8,0

4. Discussion

Physical-chemical studies of gossypol pitches showed that GP has active functional groups such as C = O, -COOH,-OH, and nitrogen compounds which are necessary for obtaining of surface-active substance (SAS) and various surfactants and additives thereof, and easily modified.

The basis of the work in the field of organic fatty acids in concrete technology laid the theoretical position that the combination of organic compounds with inorganic, the latter will enter into the chemical bond with the active sites of the organic polymers in the case of inorganic compounds have reactive functional groups (OH, -ONa etc.).

In the concrete must be chemical reaction between organic compounds and released during cement hydration, calcium hydroxide with further joint crystallization.

On the other hand, formed organiccalciumsilicone chemically fixed on the material surface,hydrophobizing wall pores and capillaries due to the formation of the hydrophobic film facing palisade from organic radicals in the liquid side. This should affect the increasing resistance of concrete, since the adhesion of ice and salt crystals to the hydrophobic surface of the pores decreases.

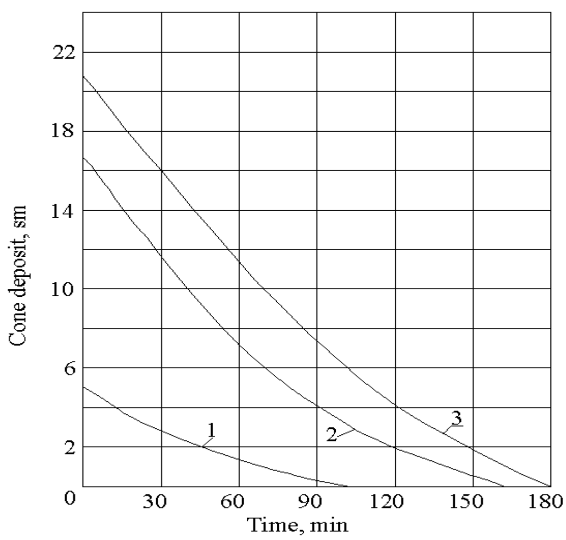

Figure 2. Kinetics of loss of mobility during dry hot climate (M / C = 0.50, flow-cement 370 kg / m^3)

1-without additives; 2-with the addition of 0.40%; 3-with the addition of 0.60%

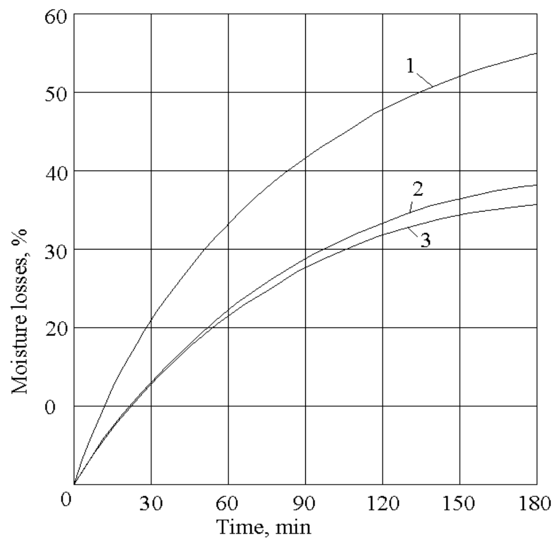

Figure 3. Kinetics of moisture loss of concrete conditions of dry hot climate (M / C = 0.50; consumption of cement, 370 kg / m3)

1-without the additive; 2-with the addition of 0.40%; 3-with the addition of 0.60%

The evolution of gas, in particular hydrogen, resulting in reactions of organic fatty acids with Ca (OH) 2, accompanied by the formation of closed pores and air entrainment in concrete mixture, if properly managed, this process should contribute to the positive in terms of durability, the concrete structure.

The results of studies of the effect obtained plasticizer on the kinetics of the loss of mobility of the concrete mix (Figure 2) and the kinetics of moisture lossof concrete (Figure 3) under conditions of high temperature and low relative humidity of environment show that the implementation of additives FAM (fatty acid-modified) in concrete mixtures leads to substantial improvement of the technological and physical properties. The mobility of the concrete mix increased from 6 to 12-15 cm, and is retained for longer time. The moisture loss of concrete samples during 6 hours hardening under dry hot climates with an additive comprised of 35-37% and -60% without additive.

Data on the effect of the new plasticizers for the relative change in growth concrete strength depending on hardening conditions show that concrete with the addition of FAM in conditions of dry hot climate in initial hardening time have higher strength as compared with concrete without the additive and further curing is more intense that explains the relatively less moisture loss. Implementation to the concrete mix supplements has a positive effect on the formation of the structure of cement stone, increasing the density of the concrete, as evidenced by an increase in frost resistance by 25 to 30% and water resistance by 20-25%.

As you can see from Figure 4 the introduction of plasticizers of FAM reduces the initial plastic shrinkage of concrete in a dry hot climate, due to slow moisture loss.

Pilot run obtained supplements tested in the factory for the production of building products, as well as on construction grounds (GOST 24211-91, GOST 30459-96-2008). It is found that the implementation of the concrete mix additive in an amount of 0.35 - 0.5% by weight of cement reduces the amount of binder to 10 - 12%, increasing the quality parameters of the concrete, as well as improves the conditions of technological operations of transportation of concrete, laying and seal it and care for the concrete in a dry hot climate.

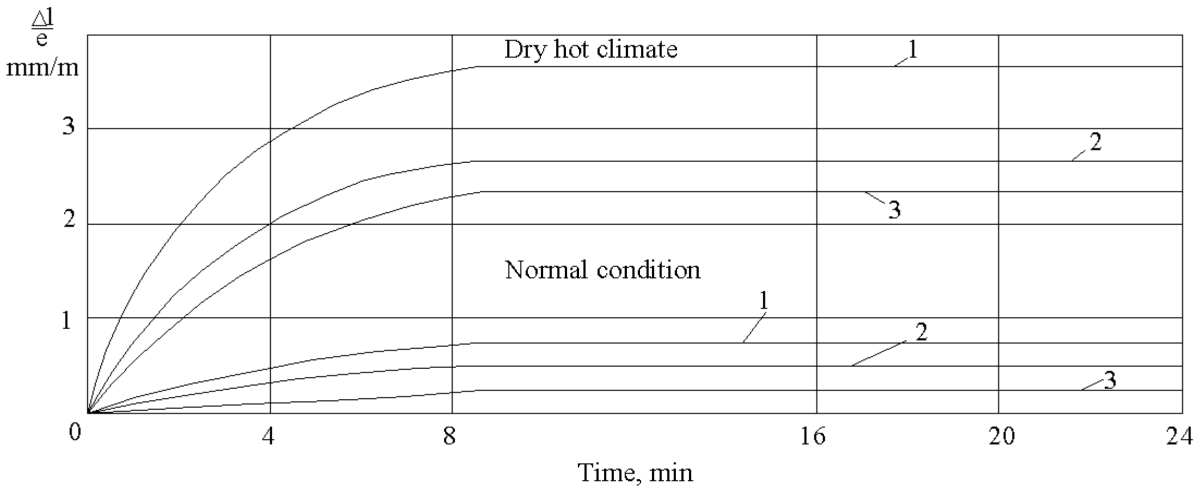

Figure 4. Kinetics of the variation of the initial plastic shrinkage (M / C = 0.50, the consumption of cement, 370 kg / m)

1´ and 1 - without additives; 2´ and 2 - with the addition of -0.40%; 3´ and 3 - with additive 0,60%.

5. Conclusion

Monitoring of waste oil industry has shown that today tar distillation of fatty acids waste of oil industry is used in small quantities that create the environmental problems in the cotton-growing regions. Therefore, the development of technology for production of plasticizers and multifunctional additives for concrete and mortars on the basis of waste oil industry will help to solve the problem of getting the best quality and cheap domestic additives for concrete and improve the ecological situation in the region.

On the basis of physical-chemical studies of gossypol pitches established that GP has reactive functional group such as C = O, - COOH,-OH, and nitrogen compounds which are necessary for various surfactants and additives on their basis, and easily modified.

Research process thermoalkaline processing and modification of gossypol pitches showed that on the basis of waste oil industry can be obtained by plasticizing chemical additives and multifunctional action that enhance the basic characteristics of the concrete mix and the physical and mechanical properties of concrete.

It is determined that the implementation of the resulting additive in concrete mix and mortar mix increases mobility, reduces the consumption of cement increases the frost and water resistant and does not attack the steel reinforcement.

It is determined the possibility of modifying additives of multifunctional action derived additives which, along with a plasticizing effect lets shorten the incubation period of hardening concrete.

Expansion of varieties of raw materials for the production of vegetable oil, improving the technology of oil affects the composition and quality of gossypol pitches that requires more in-depth study based on obtaining of plasticizer features of gossypol pitches for effective supplements.

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