Researches Regarding the Influence of Some Concrete Protection Polymeric Products

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This paper presents the results of the experimental researches regarding the influence of the composition of some film-forming polymeric products for the protection of concrete on certain of their characteristics. Thus, there have come into prominence the film-forming products based on acrylic resins with superior characteristics by comparison to the film-forming products based on acrylic-styrene resins.

Keywords: film-forming product, acrylic polymers, concrete, covering system, acrylic-styrene polymers

In order to choose a film-forming product for concrete protection, it is necessary to know the environmental conditions to which it will be exposed during exploitation, after applying it on the support surface, and hence the properties it must have.

The choice of a composition of a film-forming product is the key to obtain of a superior quality product that would fully satisfy the user necessities. The difference between these products can be noticed by testing them as such, as well as applied on the support surface and by exposing them to different environmental conditions.

The film-forming products are made up of three fundamental elements:

- an element that ensures the forming of a film after aplying the paint on the support surface, generally called binder or resin and which is usually represented by a natural or synthetic polymer that significantly influences the properties of the end product;
- the pigment, solid particles, that ensures the coloring and texture of the paint and significantly improves the product performances;
- additives, added in very small quantities, can improve some properties such as: water resistance, hardness, resistance to weathering etc. Their purpose is to reduce the superficial tensions between the particles, to improve the aspect of the end product and the pigment stabilization and to confer antifreezing properties. The types of additives used are: catalysts, thickening agents, stabilizers (the use of reactive surfactants in the fabrication process of paints is of great importance in the stability of the polymeric emulsion and the improvement of the properties of the film applied on the support surface), emulgators, biocides. The additives do not modify the action of the other components of the film-forming products;
- the solvent, which can be water or a mixture of organic solvents.

The film-forming concrete protection products are acrylic resin or acrylic-styrene resin polymer emulsions in water which are used in the interior and exterior finishings of civil and industrial construction, new or old, on masonry surfaces and exterior concrete surfaces. These products have an esthetic function as well as a protective one, the durability and performance obtained depending on the structure of the polymers, the formulations elaborated by the formulator and the production technology.

Generally speaking, the performances of a film-forming system can be anticipated if the aspects of certain features of the system composition products are known. The characteristics are specific for each product, as determined by the type and nature of the binder, the nature of the powder materials and the relation between them, the pigment / binder ratio and even the pigment / binder / solvent one and last but not least, by the use of certain types of additives [1].

An acrylic hybrid coating is prepared by the reaction of an acrylic polymer with a large portion of another functional polymer to produce a coating that combines the beneficial properties of both the acrylic and the other functional polymer.

The design of compatible blends of acrylic polymers and other functional polymers should be considered. Once this has been accomplished, acrylic hybrid can be developed to bring the best properties of each polymer [2].

Different compositions were analyzed in order to improve the properties of resistance to weather conditions and UV radiation, as well as acrylic polymers and mixtures of such monomers as alkylacrylate, alkyl methacrylates, cycloaliphatic alkylacrylates, styrene and others [3, 4].

The choice of acrylic monomers for the design of coatings is the determining factor of the final product performances. For example, methyl methacrylate is chosen for gloss and hardness (resistance to impact), styrene is often incorporated for additional hardness and gloss.

In order to increase the flexibility, butyl methacrylate or 2 - ethylhexyl methacrylate is used; when a product with the higher flexibility is desired, the possible choice is to use butyl acrylate or ethyl acrylate co-monomers. Usually a balance should be achieved when choosing the monomers to obtain a film presenting hardness, adhesion to the substrate and durability.

Monomer selection is important for final performance in outdoor application. For example, if more than 20% styrene is initially used, a high gloss of the film will be obtained, but after its exposure to atmospheric conditions, the film turns yellow.

Branched acrylates, 2-ethylhexyl acrylate will lead to extra gloss after exposure to outdoor conditions, when compared to butyl acrylate. In general, acrylates and methacrylates provide the film an excellent, long lasting gloss, particularly the straight chain methacrylates butyl or ethyl methacrylate.

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Functional comonomers selected for physical interaction with other functional polymers are: acrylic acid, acrylamide or dimethyl aminomethylmetacrilate. For chemical interaction with the functional polymer several comonomers are selected according to the requirement of the coupling mechanism.

The molecular weight of the final acrylic polymer is crucial for obtaining final effective hybridization. The products with lower molecular weight are preferred. These polymers require careful selection of initiators. Thus, azonitrile initiators, (2,2' azobisisobutyronitrile), and peroxyesthers (tert-amyl peroxy-2-ethylhexanoate) provide initiation at the desired temperatures for the reaction control.

Heterogeneity of polymer hybrids can be expressed in many different forms.

Differences may occur due to the particle size distribution (PSD), hydrophobicity, glass transition temperature (Tg), molecular weight (Mw), and / or class of polymer, the minimum film forming temperature (MFT) [5] . For example, latex dispersions with a particle size of 80-120 nm can achieve a maximum solid content of about 45%. Large particles of 400 nm will result in a higher solid content up to about 60%. This difference is due to the contribution of the particle electrical double layers, which is more pronounced for the smaller particles. Blends of 80 and 450 nm particle size provide a high content of 60% which is explained by the fact that small particles fit in the gaps between larger particles. It has been discovered that a large/small particle size ratio of 80/20 has the lowest modulus of elasticity, the lowest water absorption coefficient, a decrease of the minimum film forming temperature (MFT), rapid drying due to water content, which generally lower and reduces the dirt storage.

The polymer viscosity is a parameter that controls the rheology, the drying time of paint. Optimum viscosity can be obtained by combining low-viscosity oligomers with high molecular weight polymers. An aqueous dispersion composition has a drying time of 20 min , a viscosity <5000 Pa x s, at any non-volatile-matter content [6].

The classification of the film-forming products is necessary so that the choice of the protection applied on different surfaces (above the surface elements of reinforced concrete and prestressed concrete, thermosystem, lime-cement plasters, plasters and light concrete with an addition of perlite, polishing plaster coat, gypsum-carton boards, masonry) may ensure the lasting maintenance of all the performances that comply with the users exigency, the quality requirements, the technical conditions and the performance criteria applicable to the construction exposed to the action of hostile environments, according to the provisions of the Law no.10/1995 [7, 8].

The support surfaces of concrete or masonry, plaster or plastering coating products can be protected against the action of aggressive agents in the environment, thus increasing the durability of the buildings on which they have been applied. Binder and pigment content of the paint composition influence the water permeability and the water vapors of the film-forming product, as follows: the best protection against liquid water and water-vapour penetration is obtained by increasing binder content and by lowering pigment content [9, 10].

The painting products and the covering systems based on acrylic resins, acrylic-styrene resins, alkyd resins, epoxy resins, silicone resins, polyesther resins, polyurethane resins, vinyl resins, used for the protection of the masonry and exterior concrete support surface, can be characterized according to the SR EN 1062-1:2004 which is based on some criteria that establish the properties of the covering system or product for a particular use. Thus, this characterization, ensures a basis for the communication of this information between the producer and the user.

The European standard EN 1062-1:2004, assumed as a Romanian standard, is generally specific for the characterization of covering products and covering systems used for the outside decoration and protection of masonry surfaces and old or new concrete surfaces.

The aim of the present work is to determine the water-vapour permeability and the liquid water permeability of two types of compositions: paint based on acrylic-styrene resins and paint based on acrylic resins, knowing that these two characteristics significantly influence the durability of films.

Experimental part

Raw materials and materials

The following raw materials were used for the experiment: the primer for masonry, which is an acrylic-styrene emulsion, fillers and additives, used as a first layer, which has the role of improving the adherence of the support product composition system, by filling the pores and surface uniformly; it determines the reduction of the specific consumption and a fast drying at ambient temperature; it is applied on mineral medium, diluted with water in 1:5 proportion by brushing it in two layers at a specific consumption of 80 g/m^2 stratum and an application efficiency of 25 m^2/L/stratum.

The Fassade V 8910 product is an acrylic-styrene resin paint in aqueous dispersion which is applied in two layers, diluted 10% with water, at a specific consumption of 250g/m^2/2layers and with an application efficiency of 6.5m^2/L/2layers, over a first layer of the masonry primer.

The Acrilux V 8911 product is an acrylic resin paint in aqueous dispersion which is applied in two layers, the first layer diluted 5% with water, and the second layer undiluted at a specific consumption of 250g/m^2/2layers and an application efficiency of 6,5m^2/L/2layers, over a first layer of the masonry primer.

The KRAFT WALL PRIMER, is an acrylic resin primer in aqueous dispersion which is applied diluted with water in a proportion of 1:1 to 1:4, in volume, depending on the absorption of the surface, at a specific consumption 50g/m^2/2layers and an application efficiency of 27m^2/L/, undiluted product.

The KRAFT EXTERIOR product is an acrylic resin paint in aqueous dispersion which is applied in two layers, the first layer diluted 10% with water, and the second layer applied undiluted over the first layer of the KRAFT WALL PRIMER, at a specific consumption of 120g/m^2/layer and an application efficiency of 13 m^2/L/layer, undiluted product.

The KRAFT ULTRA WASHABLE product is an acrylic-styrene resin paint in aqueous dispersion which is applied in two layers, the first layer diluted 10% with water, and the second layer applied undiluted, over a first layer of the KRAFT WALL PRIMER, at a specific consumption of 165 g/m^2/layer and an application efficiency of 10 m^2/L/layer, undiluted product.

The application of the products on the dry support is made after its proper preparation, because this stage has a deciding influence on the quality of its covering and its durability. The masonry support is prepared according to the recipe: cement CEM II / A-LL 32.5 R: sand sort (0-4) = 1:3, in gravimetric parts, to which 10% water is added, is smooth, clean and dry, without stains of dirt, dust, mold, oily substance.

Table 1
TECHNICAL CHARACTERISTICS OF COATING PRODUCTS EXPERIMENTALLY DETERMINED

Item. No.	Characteristics	Test method	Product / Value			
Identification characteristics of the product			**The masonry primer**		**KRAFT WALL PRIMER**	
1.	Density, 23^{0}C, g/ml	SR EN ISO 2811-1:2011	1.08		1.01	
2.	Non-volatile-matter content,1hour, 105^{0}C, %	SR EN ISO 3251:2008	31		13.75	
3.	Flow time by use of flow cups, second	SR EN ISO 2431:1997	15 (ϕ 4 mm)		40 (ϕ 4 mm)	
Identification characteristics of the product			**FASSADE V 8910**	**ACRILUX V 8911**	**KRAFT EXTERIOR**	**KRAFT ULTRA WASHABLE**
4.	Density, 23^{0}C, g/ml	SR EN ISO 2811-1:2011	1.57	1.62	1.522	1.522
5.	Non-volatile-matter content,1hour, 105^{0}C, %	SR EN ISO 3251:2008	62.57	67.74	61.15	65.049
6.	Flow time by use of flow cups, second	SR EN ISO 2431:1997	90 (ϕ 8 mm)	not flowing (ϕ 8 mm)	30 (ϕ 6 mm)	not flowing (ϕ 8 mm)
7.	Hiding power expressed at a fixed spreading rate, m^2/l/strat	SR EN ISO 6504-3:2007	9	5.67	5.31	6.92
8.	Wet film thickness, μm/2layers	SR EN ISO 2808:2007	156.39	177.84	130.25	150.49
The characteristics of the products applied on the support surface			**FASSADE V 8910**	**ACRILUX V 8911**	**KRAFT EXTERIOR**	**KRAFT ULTRA WASHABLE**
9.	Specular gloss of non-metallic paint films at 60^0 and 85^0	SR EN ISO 2813:2003	gloss at 60°=2.4 gloss at 85°=4.1 matt	gloss at 60°=2.7 gloss at 85°=6.8 matt	gloss at 60°=2.5 gloss at 85°=5.1 matt	gloss at 60°=2.6 gloss at 85°=7 matt
10.	Pull-off test for adhesion on concrete support, N/mm^2	SR EN ISO 4624:2003	0.83 paint detached from the support	0.85 paint detached from the support	2.25 broken in support	0.83 broken in support
11.	Rapid-deformation (impact resistance) Falling-weight test, large-area indenter 2 kg, cm	SR EN ISO 6272-1:2004	100 mark with the unmodified surface	100 fine cracks	100 mark with the unmodified surface	100 mark with the unmodified surface
12.	Wet-scrub resistance and cleanability of coatings, after 200 wash cycles - loss of weight, g/m^2 - loss of thickness, μm	SR EN ISO 11998:2007	18.44 19.87 Class 2	20.82 17.34 Class 2	30.69 31.76 Class 3	37.60 19.44 Class 2
13.	Durability after exposure to fluorescent UV lamps and water, Method A: -1 exposure cycle (4 h of exposure to UV, 4 h condensation), hours	SR EN ISO 11507:2007	after 192 hours exposure (24 cycles) film does not present changes	after 304 hours exposure (38 cycles) film does not present changes	after 304 hours exposure (38 cycles) film does not present changes	after 112 hours exposure (14 cycles) film does not present changes
14.	Durability after exposure to natural weathering in environment urban-industrial	SR EN ISO 2810:2005	without changes	without changes	without changes	film presents a easy yellowing of the surface

The characteristics of the products were determined and are presented in table 1.

Table 1 presents the characteristics of the film-forming products presented in this work.

The first stage is a characterization of the liquid material that is to be applied on the support surface. The measured parameters are common for the liquid organic and macromolecular materials, density, non-volatile-matter content, flow time. The second stage of the characterization refers to the application properties of the above mentioned film-forming products, in their initial form, the film thickness, covering power. In the final stage, we present the properties of the hardened films as a method of evaluating the performances of the film-forming material in its final form. Basically, these methods consist of reproducing certain types of requests which properly simulate the conditions to which films are exposed during their exploitation.

For the above mentioned film-forming products, applied on the support surface, the water- vapour transmission coefficient and the liquid water transmission coefficient have been established.

Equipment and work procedure

Determination of water-vapour permeability

The equipment necessary for the determination of water-vapour permeability: Climatic room, with temperature range of $T^0=(-20\div60^0C)$, precision of $\pm2^0C$ and maximum relative humidity of 95%, with precision of ±2% and an electronic precision balance of ±0.1mg with a range of $0\div220g$.

The work procedure

The method consists of applying a coating system made of primer and two layers of paint on a mortar support to seal a test cell which contains a water vapor absorption, e.g. $CaCl_2$, the exposure in a wet atmosphere (23^{0}C, 95% relative humidity) and the weighed at regular intervals. The determination is complete when the weight increase does not change noticeably in time.

The factor that characterizes liquid water-vapor permeability is the water-vapor transmission coefficient. The determination of this coefficient is based on the modification of the mass and of the exposure time per area unit.

Fig.1 The weighing of test capsules before exposure to water-vapor

Determination of liquid water permeability

The equipment necessary for the determination of liquid water permeability: The oven with forced convection, with indication of temperature control with a range of 0 to 250^{0}C and Class 1 precision, temperature sensor, Class B, precision of ± 0.1^{0}C, and an electronic precision balance, with range of 0 ÷ 17 Kg, Class 2, precision of ± 0.1 g.

The work procedure

The method consists of applying coating system consisting of primer and two layers of paint on a mortar support, the sealing of the other side of the specimens with a waterproof product, its drying and the immersion of the test specimens into 1 cm of water at a temperature of (23 ± 2)^{0}C, on a support surface, with a downward covered face. After 1, 2, 3 , 6 and 24 h, the test specimens are taken out from the water, dried with absorbent paper and then weighed. The weighting is repeated every 24 h until the mass growth becomes constant.

The factor that characterizes liquid water permeability is the liquid water transmission coefficient. The determination of this coefficient is based on the modification of the mass and of the exposure time per area unit.

Results and discussions

On the basis of the laboratory tests performed, for each coating system used for concrete protection, it is possible to create a unitary classification of these products which enables the users to make a correct choice of the protection system, according to the actual method of exploitation.

The determination of water-vapor permeability and of liquid water permeability on two types of polymeric compositions, acrylic resins and acrylic-styrene resins was performed.

Table 2 presents an example for determining water-vapor permeability and mass modification depending on time and the graphical representation of these data in figure 2 made possible the determination of the Δm/t of their slope.

Figure 2 graphically presents the quantities of retained water-vapour depending on the exposure time to obtain a linear variation by which the slope can be calculated.

The evaluation of the water -vapor transmission coefficient is done by reporting the obtained slope from the mass growth graph on time and surface.

$$V = \frac{\Delta m / \Delta t}{A}, \left[\frac{g}{m^2 \times h}\right] \qquad (1)$$

The results obtained for the determination of the water-vapour transmission coefficient and the calculation values are presented in table 3.

(V) class determination for the water-vapor transmission coefficient is done according to the classification from the SR EN 1062-1:2004 standard, the values obtained being a part of the interval 0.6÷6 g/m^{2}xh, the four products correspond to the V$_2$ class (average permeability).

Table 2
CHANGING OF WEIGHT DEPENDING OF THE EXPOSURE TIME

Item. No.	Time interval, h	The Fassade V 8910 paint based on acrylic-styrene resins		The Acrilux V 8910 paint based on acrylic resins		The KRAFT EXTERIOR paint based on acrylic resins		The KRAFT ULTRA WASHABLE paint based on acrylic-styrene resins	
	t	The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g
		m	Δm	m	Δm	m	Δm	m	Δm
1	0	265.815	-	170.5432	-	152.2570	-	157.0726	-
2	24	266.467	0.652	170.7010	0.1578	152.4136	0.1566	157.5938	0.5212
3	48	266.682	0.867	170.7869	0.2437	152.4914	0.2344	157.9732	0.9006
4	72	266.915	1.100	170.8644	0.3212	152.6892	0.4322	158.3139	1.2413
5	96	267.443	1.628	170.9676	0.4244	152.8801	0.6231	158.6545	1.5819
6	120	267.780	1.965	171.0631	0.5199	153.0592	0.8022	158.9950	1.9224
7	144	267.955	2.140	171.1663	0.6231	153.3557	1.0987	159.3356	2.2630

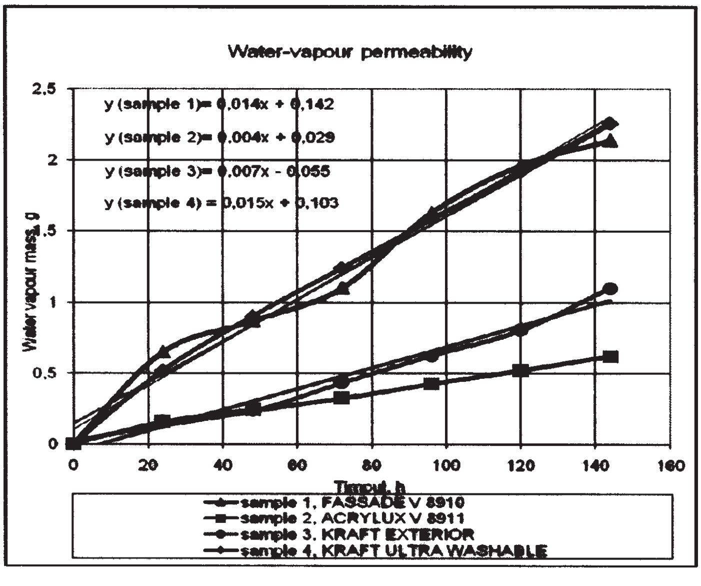

Fig. 2 The variation of the retained water-vapor quantity depending on the exposure time

Table 3
THE RESULTS OF DETERMINING THE COEFFICIENTS OF WATER-VAPOUR TRANSMISSION

Item. No.	Characteristics	Symol	Results			
			FASSADE V 8910	ACRILUX V 8911	KRAFT EXTERIOR	KRAFT ULTRA WASHABLE
1	Weight change, g	Δm	2.140	0.6231	1.0987	2.2630
2	Exposure time, h	t	144			
3	Slope, g/h	Δm/Δt	0.0140	0.0040	0.0070	0.0150
4	Area, m^2	A	$63.585x10^{-4}$			
5	The coefficient of water -vapor transmission, g/m^2x h	V	**2.201**	**0.629**	**1.100**	**2.359**

Table 4
CHANGING OF WEIGHT DEPENDING ON THE EXPOSURE TIME

Item. No.	Time interval, h		The Fassade V 8910 paint based on acrylic-styrene resins		The Acrilux V 8910 paint based on acrylic resins		The KRAFT EXTERIOR paint based on acrylic resins		The KRAFT ULTRA WASHABLE paint based on acrylic-styrene resins	
			The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g	The mass of the sample, g	The quantity of retained water, g
	t	$t^{0,5}$	m	Δm	m	Δm	m	Δm	m	Δm
1	0	0	1662	-	1187.2	-	1295.4	-	1081.7	-
2	1	1	1664	2	1188.2	1.0	1296.6	1.2	1085.2	3.5
3	2	1.41	1668	6	1188.4	1.2	1297.2	1.8	1085.6	3.9
4	3	1.73	1670	8	1188.8	1.6	1297.5	2.1	1086.3	4.6
5	4	2	1672	10	1189.3	2.1	1298.2	2.8	1087.2	5.5
6	5	2.23	1673	11	1189.5	2.3	1298.9	3.5	1090.6	8.9
7	6	2.45	1674	12	1190.4	3.2	1299.7	4.3	1092.1	10.4
8	24	4.89	1682	20	1192.5	5.3	1303.0	7.6	1094.4	12.7
9	48	6.92	1697	35	1194.4	7.2	1305.8	10.4	1098.5	16.8
10	72	8.48	1702	40	1196.3	9.1	1307.9	12.5	1102.2	20.5
11	96	9.79	1707	45	1196.6	9.4	1309.5	14.1	1108.5	26.8
12	120	10.95	1714	52	1197.3	10.1	1311.6	16.2	1112.6	30.9

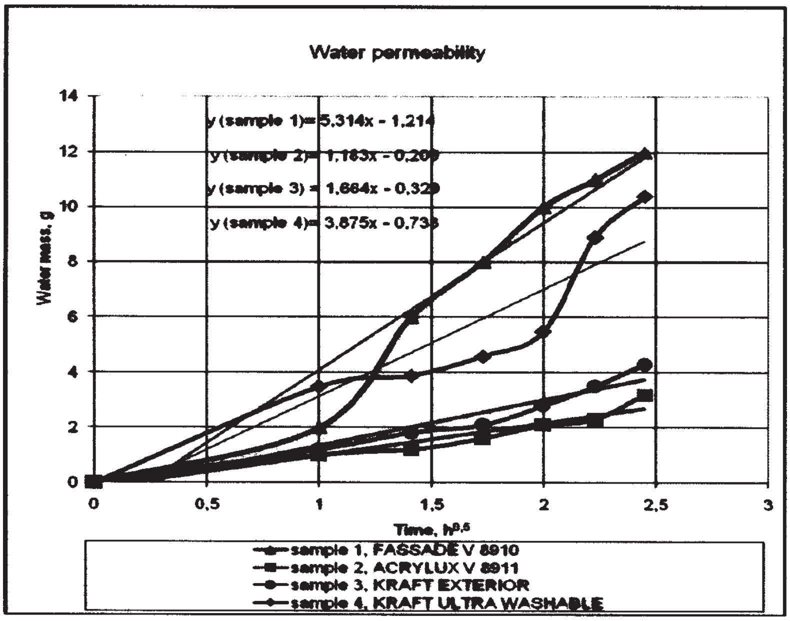

Fig. 3. The variation of the retained liquid water quantity depending on the square root of the exposure time

Table 4 presents an example of liquid water permeability determination and mass modification depending on the square root of the time and the graphical representation of these data in figure 3 enabled the determination of the $\Delta m/\Delta t^{0.5}$ of their slope.

Figure 3 graphically presents the quantities of retained liquid water depending on the square root of the time exposure to obtain a linear variation from which the slope can be calculated.

The evaluation of the liquid water transmission coefficient is done by reporting the obtained slope from the mass growth graph depending on the square root of the exposure time on the surface.

$$W=\frac{\Delta m/\Delta t^{0.5}}{A},\left[\frac{kg}{m^2\times h^{0.5}}\right] \qquad (2)$$

The results obtained for the determination of the liquid water transmission coefficient and the calculation values are presented in table 5.(W) class determination for the transmission coefficient of the liquid water is done according to the classification from the SR EN 1062-1:2004 standard, as follows: for the Fassade V 8910 paint and the KRAFT ULTRA WASHABLE paint, the values obtained are part of the interval 0.1 ÷ 0.5 kg / m^2x $h^{0.5}$, it corresponds to the W_2 class (average permeability), for the ACRILUX V 8911 paint and the ULTRA KRAFT WASHABLE 8911 paint the values obtained being ≤ 0.1 kg/m^2x$h^{0.5}$, it corresponds to the W_3 class (low permeability).

Acrylic emulsions are usually prepared by emulsion polymerization of one or more alkyl acrylates or methacrylates. Acrylic monomers containing polar groups are used for stabilizing emulsions and can be acrylic and methacrylic acid. The introduction of hydroxyl functional groups in acrylic emulsion leads to the formation of thermosetting coatings. Combinations of alkyl acrylates with high Tg and low Tg are generally used. Examples of monomers with low Tg: n-butyl acrylates (Tg -54⁰C), n-butyl methacrylates (Tg 20⁰C) and 2 - ethylhexyl methacrylate (Tg -10⁰C); methyl methacrylate (Tg 105⁰C) is the most frequently used high Tg acrylic monomer. The high Tg monomers with an increasing degree of gloss and

Table 5
THE RESULTS OF DETERMINING THE COEFFICIENTS OF LIQUID WATER TRANSMISSION

Item. No.	Characteristics	Symol	Results			
			FASSADE V 8910	**ACRILUX V 8911**	**KRAFT EXTERIOR**	**KRAFT ULTRA WASHABLE**
1	Weight change , kg	Δm	0.052	0.0101	0.0162	0.0309
2	The square root of the exposure time , $h^{0.5}$	$t^{0,5}$	12			
3	Slope, g/ $h^{0.5}$	$\Delta m/ \Delta t^{0,5}$	5.311×10^{-3}	1.183×10^{-3}	1.664×10^{-3}	3.875×10^{-3}
4	Area, m^2	A	0.0224			
5	The coefficient of liquid water transmission , $kg/m^2 x\ h^{0.5}$	W	**0.237**	**0.0528**	**0.0742**	**0.1729**

film hardness, while the low Tg monomers provide the film the impact resistance and flexibility.

Styrene is incorporated into acrylic emulsions with high Tg monomer (Tg 99^{0}C), used as a cheaper alternative for other monomers. However, acryl-styrene emulsions are often sensitive to UV and therefore have limited use for exterior coatings.

Acrylic emulsions are sensitive to moisture due to the porosity of the film, so it is very important to determine the liquid water permeability and water-vapor permeability of all products in aqueous dispersion.

Tert-butyl acrylates and Tert-butyl methacrylates are high Tg monomers (Tg 73^{0}C, Tg 107^{0}C respectively), temperatures which are substantially higher than those of poly (n-butyl methacrylate), Tg 20^{0}C, and poly (n-butylacrylate), Tg - 54^{0}C. Methyl methacrylate (Tg 105^{0}C) is the most commonly used acrylic monomer. It is known that poly (tert-butyl acrylates) has a lower solution viscosity than that poly (methyl methacrylate). Surprisingly, the use of tert-butyl methacrylate can significantly improve the latex coating resistance to moisture [11].

Polymer emulsions containing zero volatile organic compounds (VOCs), obtained by the copolymerization of flexible monomers with low Tg such as n-butyl acrylates (Tg-54^{0}C), n-butyl methacrylates (Tg 20^{0}C) and 2-ethylhexyl methacrylate (Tg 10^{0}C) together with a vinyl esther monomer comprising a carboxylic acid branched structure with 10 atoms of C, form a hydrophobicity film resistant to water and water-vapour due to the monomer [12, 13].

Water absorption, permeability film affects its performance. When the film absorbs water, surfactants are extracted from the film participating in the polymerization reaction, pigments, oligomers which are soluble in water. An increase in acrylic acid content in the composition of the paint film increases the film porosity, implicitly the permeability to water and water-vapour [14].

The analysis of the data obtained for the two categories of polymers shows significant differences, the acrylic resins having: low water permeability as compared to the acrylic-styrene resins, corresponding to the 3rd class – low permeability, unlike the acrylic-styrene resins which correspond to the 2nd class – average permeability; better adherence to the concrete support, as compared to the acrylic-styrene resins; excellent exterior durability, resulted after the exposure to fluorescent UV radiations and water, and after exposure to aging in environmental urban-industrial conditions, in comparison with acrylic-styrene resins with more than 20% of styrene, in this case a yellowing of the film being noticed. The films obtained from acrylic resins in whose composition styrene is not present, have high washability, superior physical, chemical and weathering resistance.

Conclusions

The aqueous emulsions used for finishing and protection of concrete support surfaces in construction, their chemical composition, can have advantages and disadvantages during exploitation. Taking into account the results of the laboratory tests performed on two types of aqueous acrylic resin emulsions and acrylic-styrene resins emulsions, the conclusion is that the 100 % acrylic emulsions have the best performances.

The pure acrylic emulsions are the best choice for the protection of the concrete support surfaces due to their liquid water impermeability, water-vapour impermeability, good adherence to the support surface and resistance to cycles of exposure to fluorescent UV radiations and to water. These properties confer the product the qualities necessary for the use in outside environmental conditions.

The use of pure acrylic emulsions can lead to the procurement of high quality film-forming products that play both a decorative and a protective role for the support surfaces they are applied on.

References

1. PÎRVU-HARTNER, I., M., HUBCĂ, G., U.P.B. Sci.Bull., Series B, **70**, nr.1, 2008, p.35
2. HUFFMAN, B., SCHMITZ, G., SPIEGEL, M., TAFT, D., “Acrylic hybrid technology”, Paint and Coatings Industry, October 1, 2002, p.132-140;
3. LIN, J., NORDSTROM, D., J. US 5985463 (1999)
4. MEDFORD, G.R., PATEL, G. US 5708048 (1998)
5. OVERBEEK, A., “Polymer Heterogeneity in Waterborne Coatings”, J. Coat. Technol. Res., **7**, 2010, ISSN 15470091, p 1-21
6. MARTIN, E., OVERBEEK, A., GC STEENWINKEL, P., TENNEBROEK, R., “Aqueous Hyperbranched Macromolecule Coating Compositions”, US Patent 7,094, 826, 2006
7. PÎRVU-HARTNER, I., M., HUBCĂ, G., U.P.B. Sci.Bull., Series B, **70**, nr.2, 2008, p.29
8. FIAT, D., LAZĂR, M., BACIU, V., HUBCĂ, G., Mat. Plast. , **47**, no.1, 2010, p.64
9. UEMOTO, K.L., AGOPZAN, V., VITTORINO, F., “Concrete protection using acrylic latex paints: Effect of the pigment volume content on water permeability”, Materials and Structures, **34**, April 2001, p. 172-
10.TOPÇNOGLU, Ö., ALTINKAYA, S. A., BALKO SE, D., “Characterization of waterborne acrylic based paint films and measurement of their water vapor permeabilities”, Progress in Organic Coatings , **56**, ISSUE 4, August 2006, p.269-278
11. HARRIS, STEPHEN, H.; SQUARE, K., POURREAU, D. B., US 06930143 (2005)
12. VANAKEN D. et al. Proc. International Coatings Expo (ICE) 2006 Conf, ‘Futurecoat’, New Orleans, 1-3 November 2006, p.12
13. *** Product Bulletin, HEXION Specyality Chemicalls, VeoVa, Latices for Solvent-Free and Low-Odor Paints
14. REYES-MERCADO, Y., VÁZQUEZ, F., RODRÍGUEZ-GÓMEZ, F. J., YURKO, D., “Effect of the acrylic acid content on the permeability and water uptake of poly(styrene-co-butyl acrylate) latex films”, Colloid Polym. Sci., **286**, nr.5, 2008, p. 603–609

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