

**Раздел 5. «Химия»**

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G.M. Zhumanazarova<sup>1</sup>, E.M. Tazhbayev<sup>1</sup>, J. Hraníček<sup>2</sup><sup>1</sup> Ye.A. Buketov Karaganda University, Karaganda, Kazakhstan<sup>2</sup> Charles University in Prague, Prague, Czech Republic  
(E-mail: [gaziza.zhumanazarova@mail.ru](mailto:gaziza.zhumanazarova@mail.ru))**Environment pH influence on behavior of p-PFP copolymer-based gels with AA and MAA**

This article looks into influence of environment pH change on behavior of polypropylenefumaratephtalate copolymers with acrylic and methacrylic acids. It was found that synthesized gels are stimulus-sensitive polyelectrolyte «smart»-polymers. It was demonstrated that initial polyester molecular mass increase improves expansion rate of copolymers synthesized on its base.

*Keywords:* unsaturated polyesters, «smart»-polymers, expansion, collapse, acrylic acid, methacrylic acid, polypropylenefumaratephtalate.

*Introduction*

Some of promising chemicals for creating polymer compounds are unsaturated polyesters which are products of polyatomic alcohols and polybasic acids polycondensation. Main feature of unsaturated polyesters is ability to easily enter into copolymerization reaction (cure) with vinyl monomers (styrene, methylmethacrylate etc.) at room temperature without high pressure as well as without emission of volatiles and other byproducts [1-5]. This being said, there are almost no references on unsaturated polyesters and ionogenic monomers copolymer synthesis.

Previously the authors have published a number of works on polymeric gels synthesis based on unsaturated polyesters with several ionogenic monomers of vinyl type [6-12]. Due to high sensitivity to external conditions change these copolymers qualify as «smart»-systems, which suggests prospects of carrying out further research in this area.

*Experimental*

Synthesis of initial polypropylenefumaratephtalate (p-PFP) and copolymers based on it and acrylic acid (AA) is described in works [13]. Copolymerization with methacrylic acid (MAA) was performed in identical conditions.

In order to determine copolymers expansion rate considering impact of acidic/alkaline environment properties we prepared buffer solutions with various pH levels. Equilibrial expansion rate of copolymers based on p-PFP with AA and MAA in solutions with various pH levels was defined by gravimetric method. To do this, a copolymer sample weight was prepared and then exposed in a buffer solution (pH 2–9) until fixed mass was reached. Equilibrial expansion rate of copolymer samples was calculated according to the formula:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n},$$

where n – number of measurements;  
X<sub>i</sub> – outcome of i-th measurement;  
i – measurement ordinal number.

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## Result and discussion

Due to polymeric gels ability to react to even slightest changes of environment by switching to expanded or collapsed state their use is defined as that of «smart»-polymers [14]. This being said, «smart»-systems may expand, collapse or express both types of behavior under outside impact depending on chemical composition [15].

Reference sources suggest that ionogenic hydrogels are notable for high sensitivity to outside solution pH change. This way, gels containing acidic groups in their polymeric chain expand in alkaline environment and collapse in acidic environment. On the contrary, gels with basic groups in their polymeric chain expand at solution's lower pH values and collapse in alkaline environment [16].

Figures 1 and 2 show experimental data of studying environment pH impact on behavior of p-PFP:AA and p-PFP:MAA copolymers while changing initial p-PFP molecular mass.

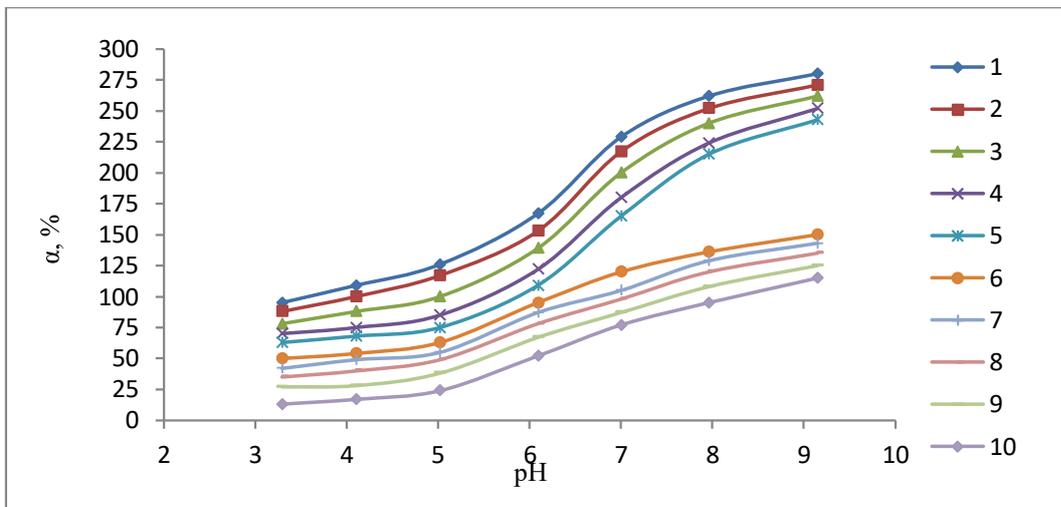
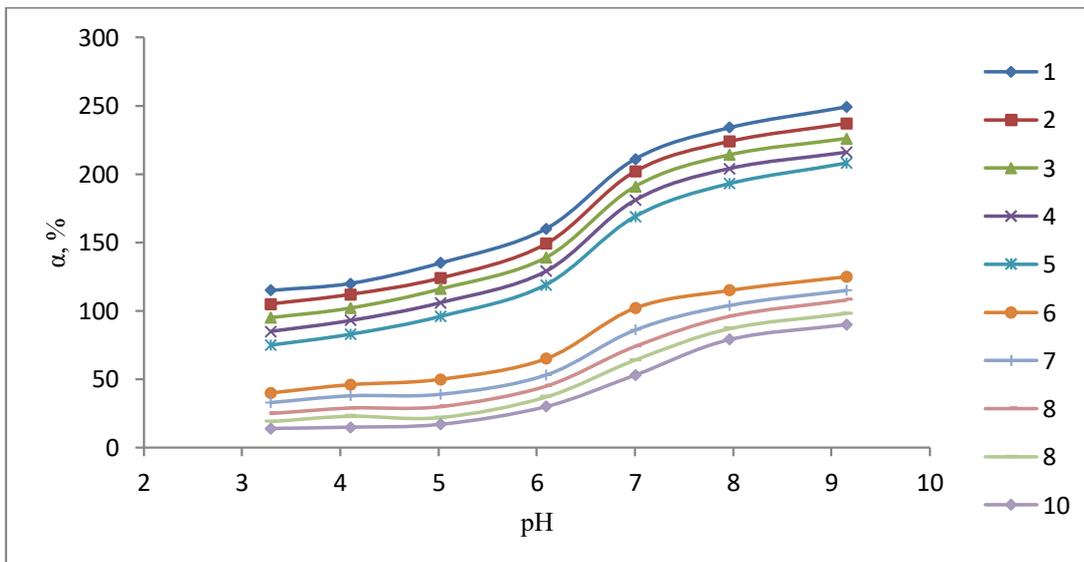


Figure 1. Dependency of p-PFP:AA expansion rate on environment pH

1 – 6,77:93,23; 2 – 20,34:79,66; 3 – 44,17:55,17; 4 – 68,42:31,58; 5 – 86,67:13,33;  
6 – 6,77:93,23; 7 – 20,34:79,66; 8 – 44,17:55,17; 9 – 68,42:31,58; 10 – 86,67:13,33;  
1-5:  $M_w=2500$ , 6-10:  $M_w=9000$ .



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Figure 2. Dependency of p-PFP:MAA expansion rate on environment pH

1 – 6,65:93,35; 2 – 19,25:80,75; 3 – 42,09:57,9; 4 – 69,17:30,83; 5 – 89,98:10,02;  
6 – 6,65:93,35; 7 – 19,25:80,75; 8 – 42,09:57,9; 9 – 69,17:30,83; 10 – 89,98:10,02;  
1-5:  $M_w=2500$ , 6 –10:  $M_w=9000$ .

Primary aspect that influences dependency of p-PFP and AA/MAA copolymers expansion ability on solution pH and its curve flow is comonomer nature. This way, electrostatic repulsion of likely charged carboxylic groups covalently attached to primary polymeric chain in synthesized polymers appearing as a result of their ionization facilitates polymeric grid expansion in alkaline environment. On the contrary, in case of outside solution's lower pH acidic groups ionization inhibition occurs, which facilitates gel switching to compact conformation, i.e. gel sample collapses. Such behavior is typical for polyelectrolytic gels.

It should be noted that p-PFP copolymers with initial polyester molecular mass ~9000 a.m.u. display higher sorptive capacity comparing to similar parameters for p-PFP and AA/MAA copolymers with initial polyester molecular mass ~2500 a.m.u.

### Conclusion

This way, carried out research show high sensitivity of synthesized polypropylenefumaratephthalate and acrylic/methacrylic acid copolymers to environment pH change, which makes them available for use as «smart»-systems.

#### Dedication:

Dedicated to the memory of Meiram Burkeev, who passed away while pursuing his scientific studies.

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Г.М. Жуманазарова, Е.М. Тажбаев, Я.Граничек

**Қанықпаған полиэфирлі шайырлар негізіндегі сополимерлерге рН мәнінің әсерін зерттеу**

Бұл мақалада ортаның рН өзгеруінің акрил және метакрил қышқылдарымен полипропилен фумараты фталатының сополимерлерінің мінез-құлқына әсері қарастырылады. Бізбен синтезделген гелдер ынталандыруға сезімтал полиэлектролиттік «ақылды» полимерлер екені анықталды. Бастапқы полиэфирдің молекулалық массасының ұлғаюы оның негізінде синтезделген сополимерлердің ісіну дәрежесін арттыратыны көрсетілген.

*Түйін сөздер:* Қанықпаған полиэфирлер, «smart»-полимерлер, ісіну, коллапс, акрил қышқылы, метакрил қышқылы, полипропиленфумаратфталат.

Г.М. Жуманазарова, Е.М. Тажбаев, Я.Граничек

**Исследование влияния внешних факторов на сополимеры на основе ненасыщенных полиэфирных смол**

В данной статье рассмотрено влияние изменение рН среды на поведение сополимеров полипропиленфумаратфталата с акриловой и метакриловой кислотами. Установлено, что синтезированные нами гели являются стимулчувствительными полиэлектролитными «smart»-полимерами. Показано, что увеличение молекулярной массы исходного полиэфира повышает степень набухания синтезированных на его основе сополимеров.

*Ключевые слова:* ненасыщенные полиэфирсы, «smart»-полимеры, набухание, коллапс, акриловая кислота, метакриловая кислота, полипропиленфумаратфталат.

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