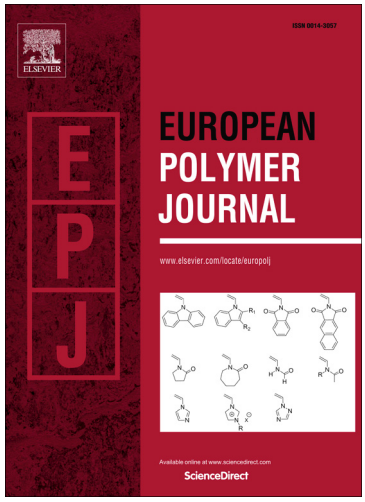
Accepted Manuscript



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František Ivanič, Daniela Jochec-Mošková, Ivica Janigová, Ivan Chodák

PII: S0014-3057(16)31210-1
DOI: http://dx.doi.org/10.1016/j.eurpolymj.2017.04.006
Reference: EPJ 7818

To appear in: *European Polymer Journal*

Received Date: 13 October 2016
Revised Date: 31 March 2017
Accepted Date: 7 April 2017

Please cite this article as: Ivanič, F., Jochec-Mošková, D., Janigová, I., Chodák, I., Physical properties of starch plasticized by amixture of plasticizers, *European Polymer Journal* (2017), doi: http://dx.doi.org/10.1016/j.eurpolymj.2017.04.006

Physical properties of starch plasticized by a mixture of plasticizers

František Ivanič, Daniela Jochec-Mošková, Ivica Janigová, Ivan Chodák*

Polymer Institute of the Slovak Academy of Sciences, 845 41 Bratislava, Slovakia,
upolchiv@savba.sk

Keywords: Corn starch, plastification, mechanical properties, crystallinity, gelation

Introduction

Starch is an inexpensive and abundantly available material received from renewable resources by biotechnological procedures. Concerning its availability from renewable resources, starch seems to be fully suistainable plastics. Starch is applied in a broad range of products, such as different applications in food, pharmaceutics, textiles and adhesives, to name just a part of it [1] and also as a plastics from renewable resources, either as the basic material but more often as an addivite [2] to other natural or synthetic, especially biodegradable, plastics [3]. However, to be used as plastics material, it must be processable by standard plastics technologies.

At present, number of investigations and applications of starch are aimed to its thermoplastic modification which is achieved by mixing natural starch with plasticizers under increased temperature and certain shear stress so that the original starch structure is completely or partially destroyed mainly due to the loss of crystallinity and destruction of intra- and intermolecular hydrogen bonds keeping the overall solid structure of native starch together. The loss of crystallinity occurs in two steps, the first one corresponds to swelling of the starch particles, observed at temperature of 60 – 70 ^{o}C. as a loss of birefringence indicating that the orientation of macromolecules has been lost, in spite that no significant viscosity increase occurs. The second step, observed above 90 ^{o}C results in excessive swelling and solubilization indicating complete decay of the integrity of the starch granules. If at this stage an appropriate shear is applied, the swollen granules are usually destroyed to form thermoplastic material [4, 5].

The properties of prepared TPS depend on several factors, the most important are the structure of the starch determined also by the origin of the native starch and parameters of the preparation procedure of the TPS, but the composition of the final TPS is extremaly important considering the additives present in the mixture [3]. If preparing thermoplastic starch, an inevitable step consists in an addition of plasticizers. The role of plasticizer consists in elimination of hydrogen bonds and the increase of free volume, leading to higher mobility of the starch chains [6] and a decrease of Tg [7]. Consequent substitution of hydrogen bonds formed directly between starch molecules results in destroying the original structure. The content of plasticizers has a direct influence on glass transition temperature. While the Tg of dry native starch is 227 ^{o}C, the value for starch with moisture cointent 13 % is about 56 ^{o}C [8] and similar effects have been reported also for other water concentrations or different plasticizers [3]. Water is the simplest option for TPS preparation, however, starch plasticized with water exhibits poor mechanical properties mainly due to extensive brittleness [9]. Besides water which is always present as primary plasticizer, glycerol is the most frequently used plasticizer, but number of other species are applied, such as polyols, glycols, formamide, urea, acetamid, citric or mellic acid, phosphorous compounds and others [10].

The selection of plasticizer is important considering physical properties of TPS which are crucial for all aspects of application, such as processing, ultimate properties, long term