

e-Learning Solutions for Polymer Science Education

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Abstract: Computer programs for implementation like modules in e-learning environment in chemical technology fields are developed. The aim of the present work is a development of programming solutions for virtual training studies. This makes possible to exchange real experimental work in every e-learning shell with simulation exercises. This simulation stuff is fully operational in borders of electronic education system. The developed virtual laboratory exercises are stage of Web-based education system global building.

Key words: e-learning, computer simulation, polymer science, education.

INTRODUCTION

The actuality of the problem of e-learning (particularly distance learning) was prompted mainly by the globalization of society worldwide, and by the incredibly high rates, which are developing communication technologies, especially the global network Internet. The aim of distance learning is to adapt existing teaching approaches and resources for learning and communication between trainers and learners to modern electronic means and methods for virtual communication between people [2,7].

There are some projects for polymer e-learning consist of different types of tools for performing e-learning (Excel Macros) which are suitable for education of topics such Materials Rheology, Processing Methods etc. [10]. Some authors use the attractive technologies such Flash Active Content and Shockwave Objects to illustrate some basic principles of polymer synthesis and processing. The main characteristics of the polymer materials are described too [11].

There are some electronic content that covers some aspects of polymer education (the main part is video content) [12]. There is and a good source of polymer content suitable in university education [13]. Some interesting projects covering story of polymer science and glossary with main terms explanation are available on [14].

The interest may be focused and on organization like POLYED that is a consortium of groups interested in science education in general and polymer education in particular [15]. Information on plastics used in our modern world is available on [16].

All of the described projects use a web tools in the development process but there's some difficulties when they are used for the real experiment simulations. The need an Internet connection too.

The purpose of this work is a development of application software suitable for incorporation as a module in a electronic-based training system for conducting e-learning in the field of technical sciences in particular – polymer technology. The developed computer programs are Internet independent applications which every teacher can use on a single computer not connected to others in a network. For their execution computer programs need only installed operating system on the computer.

LAYOUT

The proposed computer programs were developed using the environment for rapid develop of application programs MS Visual Basic. NET Standard Edition, designed by MICROSOFT Corporation, which contains within it the tools that allow to significantly speed up the process of development and creation of application software [4,8,9]. The choice of MS Visual Basic is by the following reasons:

- MS Visual Basic is object-oriented language, i.e. language, which operates sites on which to act;
- Programming environment has opportunities to carry out close monitoring on the construction of the project;

- MS Visual Basic has amended the programming approach to its predecessors (Basic, Qbasic, etc.), namely Decomposition of the code of procedures and classes that could be called a random spot in the program.

As a further advantage can be emphasized and the possibility of establishing a convenient installation modules for each application facilitating an easy installation on every computer system.

In terms of users involved with the process of e-learning benefits of the graphic interface is indisputable: there is a unified environment containing controls inherent in all applications - buttons, menus, etc., making all programs working by a similar rules.

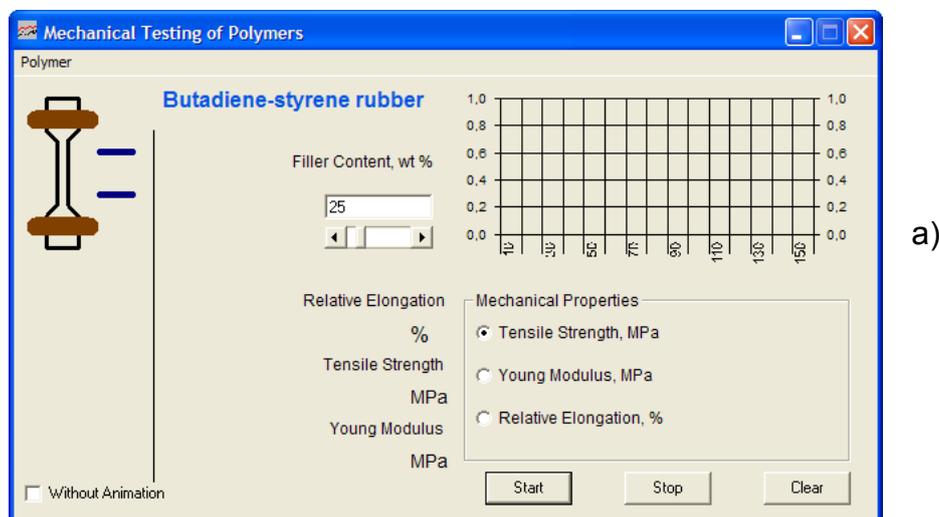
The first demonstration program (or module in the system of e-learning) is designed to enable implementation of virtual laboratory exercises in the field of mechanical testing of reinforced polymers [6].

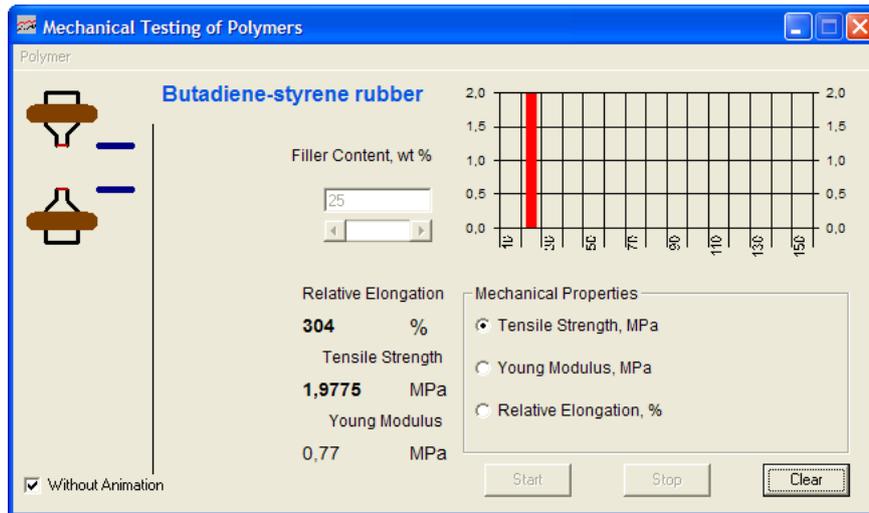
The study of the mechanical characteristics of filled polymers is an important step in studying of their technological behaviour. These experiments need many hours, which could find hardly in a limited period of time, as are laboratory exercises. For this and other reasons, it is appropriate to develop computer programs that demonstrate the conduct of such tests and interpretation of results obtained from them. The development of such a program is possible only in the presence of extensive and accurate experimental material selected on the basis of which, by the methods of mathematical modelling to analyze the necessary functional dependencies and the mathematical models derived for the main stress-strain characteristics (tensile strength, modulus at 100 % elongation, relative elongation). On the basis of the values students could get acquainted with the technological problem of determining the optimums of reinforcing.

In the computer program are considered three different in their chemical nature and properties rubbers: SBR, EPDM and NBR. Based on these rubbers, for the preliminary stage of development of the program vulcanizates reinforced with phosphogypsum are prepared. The content of the mineral filler varies from 0 to 150 wt % [1, 3].

After extraction of the mathematical models for the mechanical properties [3] demonstration program was developed. This application includes the models that describe the change of the values during the stress-strain tests. As a visual model for such analysis is the approach in the tests conducted using an electronic dynamometer of company "INSTRON"-England (INSTRON-402). Like most computer programs this application consists of one main window, which through its various components includes all the functionality of the application.

The main window of the program that conduct virtual laboratory exercises in the polymers reinforcing and their mechanical testing is shown in Figure 1.





b)

Fig.1. Main window of module for stress-strain testing:
a) At test start; b) At test end

In the left side of the window the tested sample is presented. It is visually the same as the most used samples in the experiments in practice. In the menu the student can choose the specific type of rubber which will participate in tests. The program menu for choosing the type of studied rubber is shown in Figure 2.

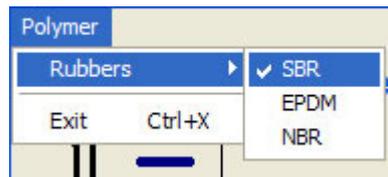


Fig.2. Main menu of module for stress-strain testing

This approach is appropriate because in the course of implementation can be assigned different values of this interval, leading to a change of speed (in this case the deformation speed of the test sample, which can also be defined by different values in tests performed by an electronic dynamometer).

Border, which should continue this deflection is determined by the relative values for extensions obtained from the mathematical model derived for the vulkanizate under the relevant degree of filling.

The degree of filling with phosphogypsum set at the beginning through the slider below the corresponding text box labelled in the working window of the program. After starting the test (by pressing the *Start* button) animation begins. Upon reaching 100% relative extension, the label indicating the module in this extension gets its value, calculated as set out in model. Upon completion of the analysis (i.e. after the destruction of the sample) in the respective record labels are the values of tensile strength at break and the relative elongation which actually defines the end of the test. Finally the test is completed by pressing the *Clear* button, which leads to recovery of the starting shape and size of the sample and reset the value of the degree of filling.

In the right part of the application stays a graphical component visualizing the variation of a property in the range of filling. The choice of this property is through radio buttons placed within study parameters. The presence of such a graphical control leads to full and easy discover of filling optimum with phosphogypsum.

It is also possible to stop the trial has already begun by *Stop* button. This is necessary in case of wrongly entered or repetitive value for the degree of filling. The return to the starting position of the model here is by the *Clear* button.

The code and the program in general are optimized for operation of each computer system operating in terms of Windows XP/2000 operating system with installed .NET Framework.

The program is based on a huge experimental material obtained investigating possibility of phosphogypsum using as light mineral filler for polymers [1, 3]. The main used approach is systematic collecting of experimental data and their processing with an author developed programming tools (statistical and experimental design modules). After these steps developed equations are turn into algorithms used in the subsequent programming process.

The second program developed concerns the possibility of conducting a simulated study of the process of ionic-coordination polymerisation of ethylene (polymerisation using the catalysts of Ziegler - Natta) [5, 6].

The polymerisation is a process that requires a long and strict observance of technological parameters for its implementation. Some of technological conditions are slightly dangerous for students too. Therefore, in developing methods for its study is necessary to resort to search for opportunities to facilitate the visualization of the parameters affecting it.

The developed demonstration computer program allows monitoring of the effects of seven parameters influencing the progress and products of ionic-coordination polymerisation of ethylene.

The technological parameters are:

1. Mixing frequency, rounds/minute;
2. Reactor temperature, °C;
3. Heating speed, l/min;
4. Catalyst amount, g;
5. Isobutylene amount, vol. %;
6. Hydrogen amount, vol. %;
7. Ethylene amount, depending on pressure, MPa.

In calculating process of the characteristics of the product of polymerization - polyethylene have been used different functional dependencies.

The part of source code for the final parameters calculation written in Visual Basic is shown below in Listing 1 (see *Appendix*):

It is very important to mark that the simulation of the ionic-coordination polymerisation can work in two different conditions: permanent or variable. Depending on the process state the final results obtained by students have different values.

The parameters whose effect is examined by the proposed program are represented by labels and text boxes located adjacent to them. The values that they represent introduced through sliders in a limited space ahead. There is a possibility for eliminating errors by the student which may occur when entering unbecoming values.

The determination of baseline parameters is by pressing the *Calculate* button. It is also possible to check the zero input values for certain parameters, which may lead to different programming errors (e.g. division by zero if the parameter involved in the denominator as a dependency).

In this case the user is prompted for entering of right value. To the text box showing the values of the yield of polymer, the density and melt index of progress, are bands that give a visual idea to what extent the resulting values are compared to the minimum and maximum values for the parameter.

The main window of the program and has an appearance shown in Fig. 3:

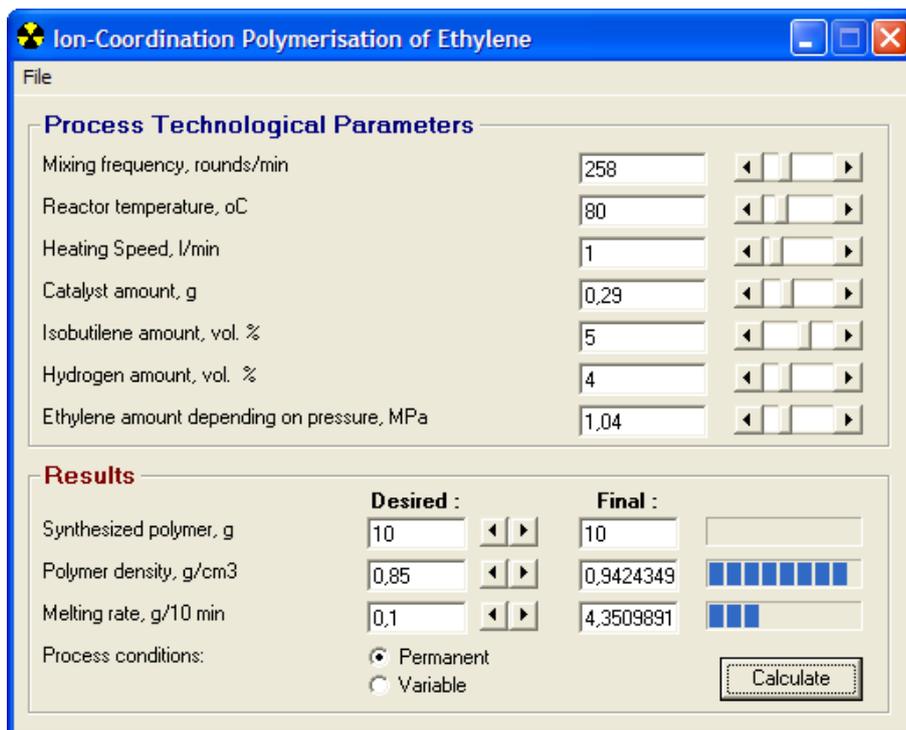


Fig.3. Main window of the simulation application for the process of ionic-coordination polymerisation of ethylene

The final stage at this process examination can be the investigation of the optimal values for technological parameters by experimental design methods. For this purpose different type of statistical software can be used.

CONCLUSIONS AND FUTURE WORK

1. Demonstration computer programs simulating the stress-strain tests of reinforced polymers and ionic-coordination polymerization of ethylene have been developed.

2. Using available software and modern approaches for developing and programming design modules have been created, providing basic functionality for incorporation within the training system for polymer science education.

3. The developed modules are subject to a logic embedded in their functionality, which is a guarantee for their excellent timing in the course of their joint work within the e-learning system.

4. The developed computer programs make possible education within two fields of polymer science which requires many hours experimental work that is impossible in the laboratory learning conditions.

5. The proposed computer programs are used experimentally in polymer education of Department of Material Science, Prof. Dr. Assen Zlatarov University – Burgas, BULGARIA.

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APPENDIX

Listing 1

```
P = txtP * 100
S = ((P * txtC) / (203 + txtR * 1000) + 1) * 0.5
txtT
If S > 102 Then
    MsgBox "Lower Temperature",
    vbExclamation, "Correction"
    lblT.ForeColor = vbRed
End If
J = (P - P * 42 / S) * txtC * (1 - 0.005 * (txtH
+ txtB))
J = J * (0.002 * txtY - (0.001 * txtY) ^ 2 +
0.001)
If P / J < 1.3 Then
    MsgBox "Lower Temperature",
    vbExclamation, "Correction"
    lblT.ForeColor = vbRed
    Stop
End If
Q = 0.94 * J / txtC
n = Q * txtC
J = (0.0007 * S / 4 - 0.01)

D = J + (1 + Q) / ((0.01 * txtB + 1.05) * Q +
'Check <>
If n < 10 Then
    n = 10
End If
If n > 100 Then
    n = 100
End If
If J > 15 Then
    J = 15
End If
If D > 0.95 Then
    D = 0.95
End If
txtN.Text = n
txtJ.Text = J
txtD.Text = D
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