

## PROJECT OF AUTOMATION AND INFORMATICS SYSTEM IN POLYMER DEGRADATION STUDY

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### **ABSTRACT**

*This paper presents concept of Small Automation and Informatics System (SAIS) in research laboratory. Described system enables remote control and monitoring of polymer thermal degradation processes. In this study are compared present obsolete measurement system and a new designed SAIS, which derives benefit from modern informatics technology and Internet connection. All software and hardware components fulfil user demands and due to modular architecture is system very flexible and well disposed to possible future modifications.*

**Keywords:** measurement system, Internet, remote control, polymer thermal degradation, polyvinyl chloride

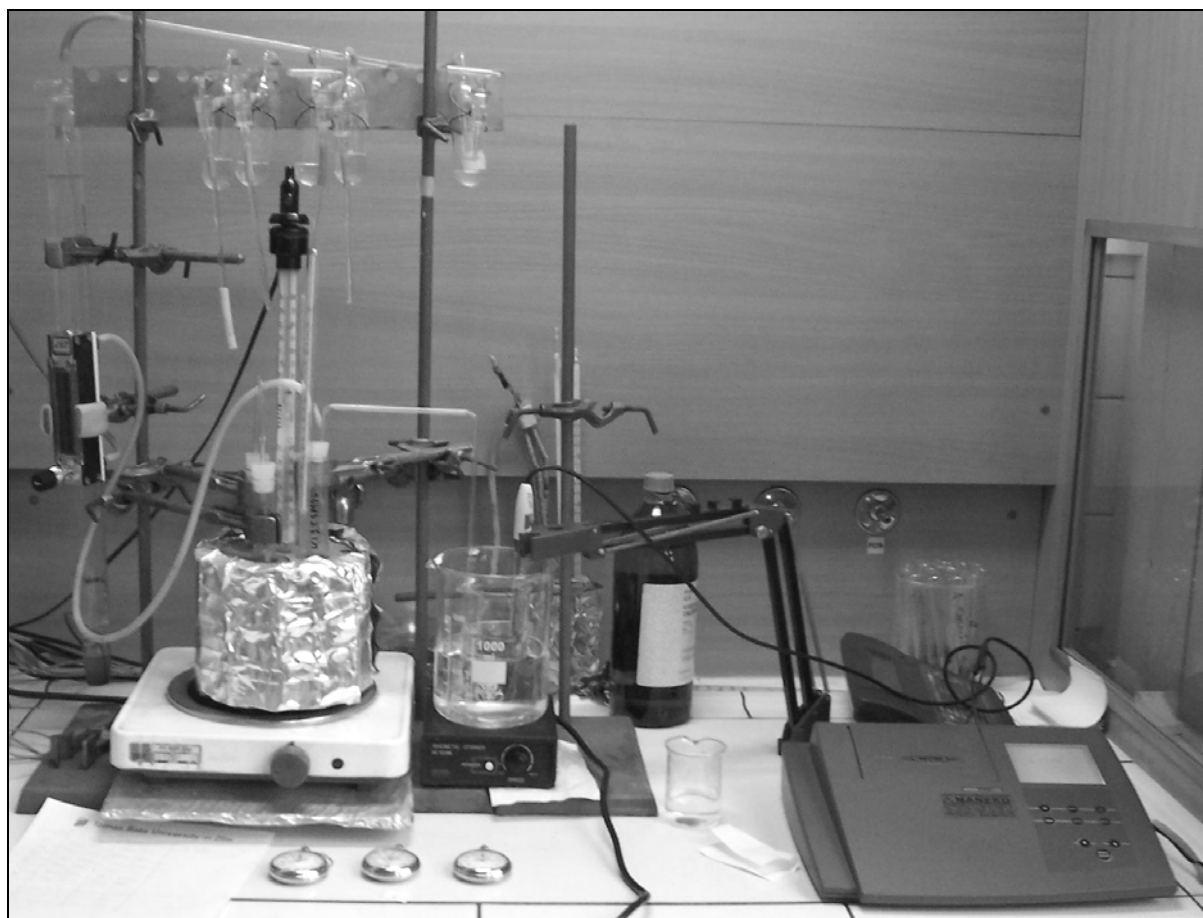
### **1. INTRODUCTION**

Recently, lots of laboratories have been upgraded using new information technologies (IT) and development in automation. Automation and IT systems improve operating of different technological processes or bioprocesses, minimize operating staff mistakes and enable faster and more accurate data processing.

One way, how to apply automation to laboratory, is transferring industrial automation technology to the laboratory [1]. This practice is logical and usually very useful, but is not flexible in specific laboratory conditions. Another option is modification of disused software or data handling [2]. This technique is flexible and cheap, but depends on installed hardware. Finally, laboratory renovation can utilize a mixture of both techniques. There are used old parts of exiting laboratory system and combined with new IT or automation systems [3]. New system is connected via modern network infrastructure (hardware) and software application.

This study describes a laboratory measurement system utilized by Department of Polymer Engineering. Due to old system (described in experimental part) has several negative factors, new SAIS installation (presented in result part) has been elaborated.

## 2. EXPERIMENTAL



*Figure 1. Present arrangement of measurement system.*

Figure 1 displays existing measurement system in chemical laboratory. Test tubes with polymer sample (polyvinyl chloride) are inserted into heated insulated metal block (on the left hand site). Heat is supplied by common electric cook-stove. Thermal destructed polymer evolves gaseous hydrogen chloride, which is carried by nitrogen.

Gas mixture is piped into a standard sodium chloride solution. Hydrogen chloride is absorbed into the solution and as a result level of pH sinks down. The temperature is constant about 210°C. Data from pH-meter is manually recorded in set time interval. The gas (nitrogen) flow is set up at the beginning of each measuring.

This scheme can measure maximal four test tubes (samples) at the same time, theoretically. Unfortunately, there are only two pH-meters, each for one sensor. Furthermore, only one pH-meter has a RS232 port for transfer measured data directly into PC/notebook. Limited number of pH-meters requires staff presence for long time (up to hours – dependence on the type of experiment). Moreover, the acid gas can escape during long experiments. This combination caused small but not marginally health risk.

In addition, temperature regulation is very simple. Actuating device is Vertex thermometer, which just switches on/off the electric cook-stove according to set up temperature. Regulation like this is acceptable for current experiments but is not suitable for continuing regulation of temperature.

### 3. RESULTS

Figure 2 shows scheme of new Small Automation and Informatics System. Basic instruments (heating unit, water bath and nitrogen pressure cylinder) are the same as in the old system. Other parts, like thermometer in heating unit or pH-meters and pH sensors, are replaced with new devices. DATALAB IO<sup>®</sup> unit and personal computer are new parts of measurement system.

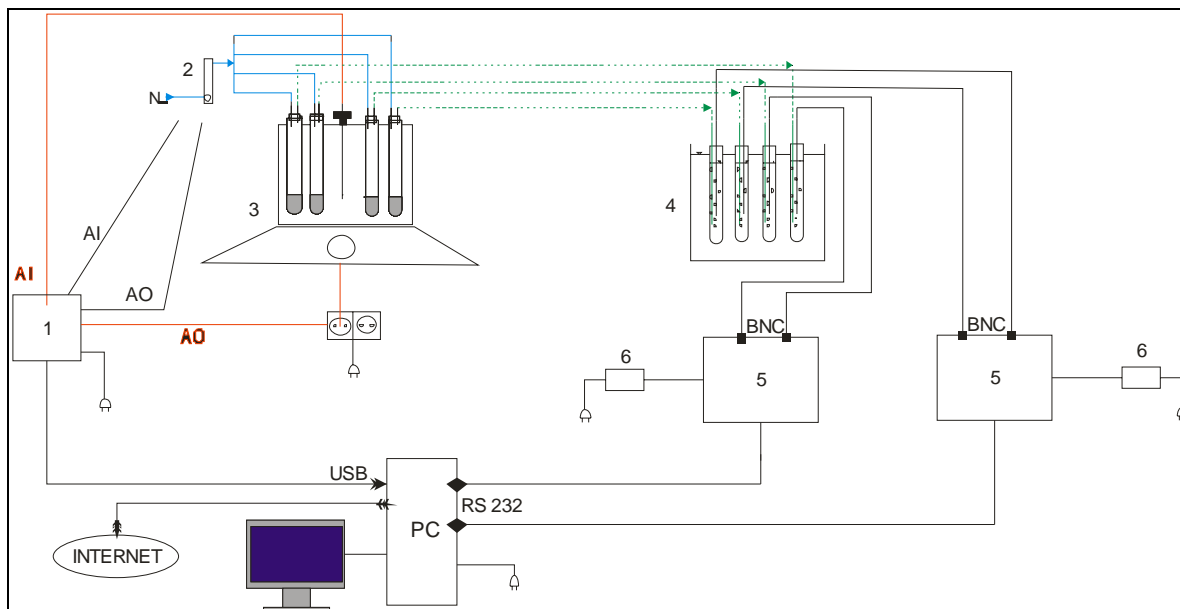


Figure 2. Scheme of SAIS arrangement. 1-distributor box with DATALAB IO<sup>®</sup> unit and power source; 2-flowmeter; 3-heating unit; 4-water bath and test tubes with absorption solution; 5-pHmeter; 6-voltage adapter

DATALAB IO<sup>®</sup> unit is a combined analog input/output and digital input/output module. Type AD2 applied in this project contains 4 analog input channels, 2 analog output channels and 2 digital channels, which can be configured either for input or output. Gas flow system (flow-meter and control valve) occupies one analog input and output. Second analog input is reserved for output from thermometer data convertor, which is installed in the same distributor box as DALAB IO<sup>®</sup> unit. This convertor is connected with new Pt100 thermometer measuring temperature of heating unit. Actuating device for temperature is a socked outlet, which can continuously change output voltage. Consequently, the power of electric cook-stove (heating unit) will be full under control.

Group of four combined pH sensors is connected to two modern pH meters. Used pH-meters have two advantages compare to old devices. First, there can be connected two sensors at the same time. Each sensor measures pH and temperature of absorption solution. The temperature is measured to neutralize temperature influence on measured pH level. Second, the pH-meters are connected to PC via RS232 cable. Standard ASCII protocol is used for communication between pH-meters and PC.

Minimal requirements on PC are two RS232 ports, one USB and one Ethernet port. Supported operation system is only Microsoft Windows<sup>®</sup>. Personal computer hosts the control application ControlWeb<sup>®</sup> developed by Moravian Instruments, Inc.. This application provides software background for automation, data handling and remote control via the Internet. The same application runs Laboratories of integrated automation (LABI) [4]. ControlWeb<sup>®</sup> provides web server with graphical user interface. Internet interface in this project will be similar to LABI's interface ([www.labi.fai.utb.cz](http://www.labi.fai.utb.cz)).

Internet connection and web server running on the PC enable remote control, measurement and data handling. Operating staff just prepares all solution and the apparatus, then, it will start experiment and can leave the laboratory. If the experiment is finished, the control system automatically sends a SMS or e-mail.

#### **4. CONCLUSION**

The purpose of this contribution was to present designing of new automation system in research laboratory. This system is now prepared to be approbated by grant commission. After realization phase, it will be utilized in polymer thermal degradation studies. Future upgrading will be focused on hardware, if will occur demand from researchers, or on internet interface. Internet sites of SAIS could be rebuilt from static into dynamic web-sites [5], which cut down the quantity of data transferred from server to user's computer.

#### **5. ACKNOWLEDGEMENT**

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