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UTILIZATION OF MODERN AUTOMATION EQUIPMENT IN CHROMIUM RECYCLING TECHNOLOGY

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ABSTRACT
This contribution deals with implementation of new computer system for measurement and control in our laboratory for recycling chromium from tannery waste. The laboratory is used for verification and further research of unique chromium-recycling technology developed at our institute. Since the original control equipment became relatively out-of-date it was decided to rebuild the technology with modern means of automatic control. This paper focuses on one particular part of the technology and describes the process of implementing new computer control from choosing the devices to final activation of the system describing the problems and challenges faced during such a process as well as the means we used to solve them.
Keywords: chromium recycling, Advantech, Control Web

1. INTRODUCTION
Chromium still remains the main agent used for hide-tanning in tanning industry even though one of the variants – hexavalent chromium is highly toxic and is proved to cause cancer. Unfortunately attempts to find substitute that would give comparable results as to the quality of the product and production costs were not successful so far. Therefore it seems unlikely that in the near future the chromium in tanning industry would be replaced.
The amount of waste is very high in the tanning industry as only about 20% of raw hide is transformed into the final product and the rest is waste in various forms. The part of this waste that contains chromium then presents great burden for the environment and in the result, due to the cost of disposal, significantly affects the effectiveness of the production.
As already stated, it seems unlikely that chromium will be replaced in the tanning process and therefore it is useful to look for options of effective disposal of chromium containing waste or even better of recycling chromium from this waste. The main problem nowadays is not the technological solution to recycling chromium form the tannery waste but the economical side of the problem. It is required that the process is as effective as possible. At our institute a method was proposed for hydrolyzing chromium waste [1] which produces relatively expensive protein hydrolyzates and also chromes sludge. If any new method is to be successfully implemented in industry it needs to be optimized in the means of investment and operating costs. For this reason the method is realized in small scale in our laboratory. Recently, when the laboratory was moved into a new building it was it decided to upgrade the equipment of this laboratory.

2. THE TECHNOLOGY

Enzymatic hydrolysis appears to be the best method for processing chromium-containing tannery waste both from the economic and ecologic point of view. Technology for this processing is realized in our laboratory. This technology yields protein hydrolyzates that contain virtually no chromium while the dose of expensive enzyme is less than 1% and the filter cake can be recycled.

The complete process for tannery waste recycling can be divided into four workplaces that we named as follows: fermentation, filtration, evaporator and recycling. First step of the process is chemical reaction in bioreactor (fermenter). Product of this reaction is then filtered and the resulting product is dried in under pressure evaporator. In this article we will focus on the realization of the evaporator workplace.

3. MODERNIZATION

As the equipment in the laboratory has been built over a period of years and many of the original devices became relatively outdated, it was decided to rebuild the laboratory with new means of automatic control. Moving the laboratory into a new building provided good opportunity for this.

3.1. Requirements

The aim of the modernization was to equip the laboratory with modern computer systems and other means of automatic control. It was intended to choose this equipment not only based on technology need but also so that it can be helpful for demonstrating the automatic control equipment to students of our university.

The aims were defined as follows:

- Use modern computer technology for the computers that control the technology
- Use intelligent sensors whereas useful
- Connect the components using industrial buses
- Connect the technology with parent system
- Use modern programming equipment with visualization

In the following text the solution we proposed will be described. Due to the complexity of the technology we will limit the description only to basic information in general and focus on one part of the technology in detail.

3.2. Conception of the new control system

Scheme of the complete technology from the control equipment point of view can be seen in Figure 1. The whole technology in the laboratory is divided into 5 workplaces, 4 of which are directly connected with the technology and one is supervising. The conception is based on hierarchical structure with a central computer on top, connected with the workplaces by industrial Ethernet and alternatively also using Wi-Fi or GSM. The main components of the system are based on devices manufactured by Advantech [4].

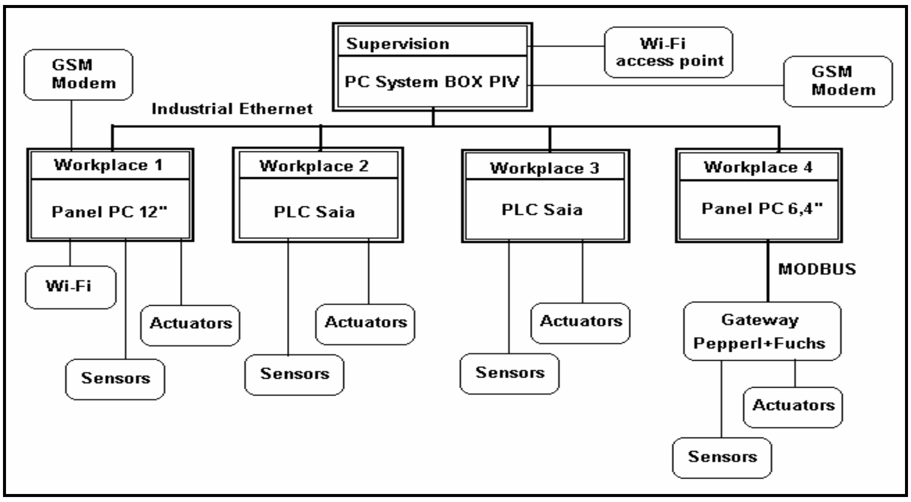

Figure 1. Scheme of the complete control system.

3.3. The evaporator workplace

Figure 2 shows the schematics of the control system of the evaporator workplace. In Figure 3 you can see the picture of the control system.

The technology on this workplace is controlled by industrial computer TPC 650 T –CE. It is a panel PC with 5,7” touch screen. This kind of computer is sometimes referred to as “industrial PDA” as its configuration is very similar to that of a Portable Digital Assistants. The main features of TPC 650 include Intel Pentium 266 MMX CPU with 32 MB DRAM, touch screen, support for Compact flash memory cards and operating system Windows CE. For communication the computer is equipped with one PC/104 slot, Ethernet port, PS/2 port for mouse and keyboard and 2 serial ports, one of which can be configured to run in RS422 or RS485 mode.

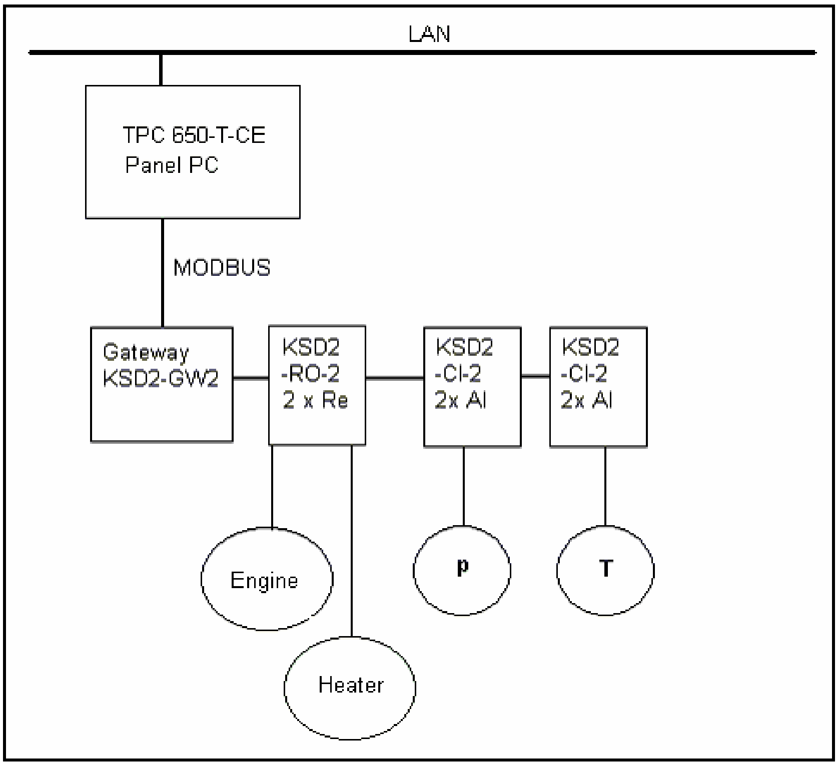

Figure 2. Scheme of the evaporator workplace control system.

The sensors and actuators are connected with the computer through a modular system made by Pepperl+Fuchs which includes gateway KSD2-GW2, relay modules KSD2-GW2 and analog input modules KSD2-CI-2. The analog modules can be used to connect sensors with current output 4-20 mA or smart sensors which support HART protocol. The gateway communicates with the computer via RS 485 line using MODBUS protocol and with the input/output modules using CAN protocol. As can be seen in Figure 2, the technology requires measurement of pressure and temperature and control of a heater and a small engine. These requirements dictated the number and types of the modules connected to the gateway. Of course other modules can be easily added. At the lowest level we use sensors with 4-20mA output.

3.4. Program equipment

Even the best hardware cannot perform satisfactorily without proper software. Due to variety of devices and required flexibility in the programs we chose Control Web development system to create the software for the technology. Control Web [3] is a RAD (Rapid Aplication Development) system which allows easy development of control systems running in real time including visualization. The main advantage of a RAD system is that the application is developed by putting together existing components and parameterizing them instead of writing all the required code from a scratch in lower level programming languages. This makes the development easy and quick. Control web supports many devices and basically all Windows platforms, including Windows CE.

For the evaporator workplace we used Control Web 2000 with Windows CE runtime builder and Modbus driver for Windows CE.
Figure 3 shows the main window of a simple test program for manual control of the evaporator workplace running on the TPC-650 with Windows CE operating system. The program allows viewing four input values and controlling two outputs through the relay modules. The final program will include visualization of the measured values and also support for communication with the supervising computer via Ethernet.

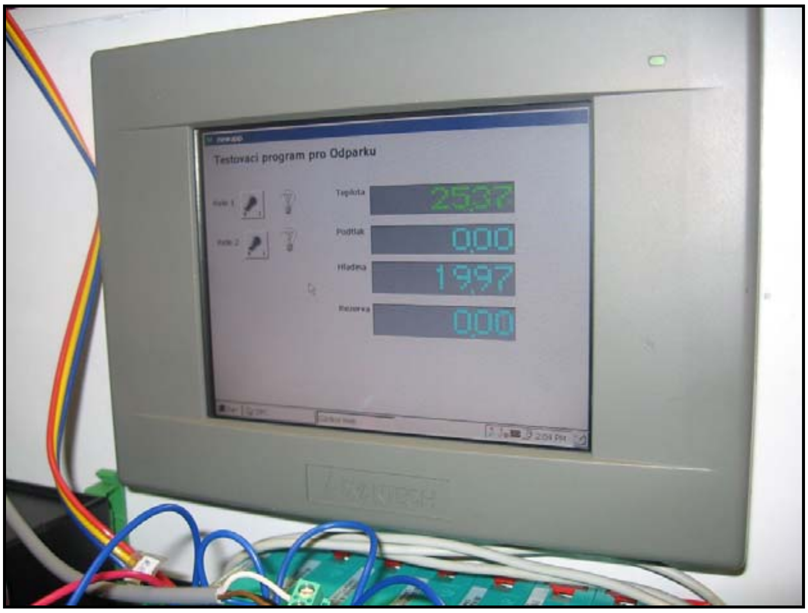

Figure 3. Main window of a test program running on TPC-650

6. CONCLUSION

This paper describes one part of a project of modernization of laboratory for recycling chromium from tannery waste. Aim of the modernization is to replace relatively outdated equipment with modern means of automatic control. The devices were chosen also with intended use of the laboratory for students as an example of modern automatic control in real application. The complete technology is divided into 5 workplaces; 4 directly connected to the technology and one supervising. Workplaces are connected with Industrial Ethernet and optionally also via Wi-Fi and/or GSM modems. In this article we focused on the evaporator workplace. This workplace is based on industrial computer Advantech TPC-650T with touch screen which is connected to the process via Pepperl+Fuchs gateway and I/O modules using Modbus protocol. As the main programming system for the whole laboratory we use RAD system Control Web. At present also the other workplaces are being put together and the software is being developed, also in the course of several diploma works.
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7. REFERENCES

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