Aspects Concerning the Automation of the Mechanical Expansion Process for Large Welded Pipes

TUDOR MACREA
IPROLAM S.A.
ROMANIA
tudor.macrea@iprolam.ro

DORIAN MACREA
IPROLAM S.A.
ROMANIA
dorian.macrea@iprolam.ro

COSTIN CEPISCA
Politehnica University of Bucharest
ROMANIA
costin.cepisca@upb.ro

SORIN DAN GRIGORESCU
Politehnica University of Bucharest
ROMANIA
sorin.grigorescu@upb.ro

HORIA ANDREI
Valahia University of Targoviste
ROMANIA
h_andrei@yahoo.com

MARIAN MORCOVESCU
Politehnica University of Bucharest
ROMANIA
marian.morcovescu@yahoo.com

Abstract - The paper presents new solutions in the field of the expansion process automation and control for longitudinally welded pipes. The mechanical expansion is a dimensional calibration technology process frequently encountered in the manufacturing this type of pipes, where forces between 600 and 1200 tf, as well as positioning precision in the range of tenths of mm, must be accurately controlled. The assembly of the electro-hydraulic automation and expansion process control includes dedicated measurement systems to achieve the technical parameters prescribed and to protect efficiently the technology assembly components.

Key-Words: - Mechanical expander, process automation, LOGICAD, iba AG.

1 Introduction

The mechanical expander is complex equipment composed of the following main subassemblies: hydraulic traction cylinder, support column and traction head, expansion head, pipe support and traction mechanisms –figure 1, [1], [2], [3]. The classical automation variant, using a PLC, has hardware and software structure of the type presented in figure 2, [4], [5]. The application is constructed on the platform of a programmable logic controller, connected in a PROFIBUS network with the data concentrators, the sensors and the actuators of the automation assembly, and connected through ETHERNET network to the process-operator interface console (HMI). This variant has serious limitations both in terms of performance of the electro-hydraulic position adjustment, with the subordinated adjustment of the force, as well as regarding the analogic variables and their reactions in the process.

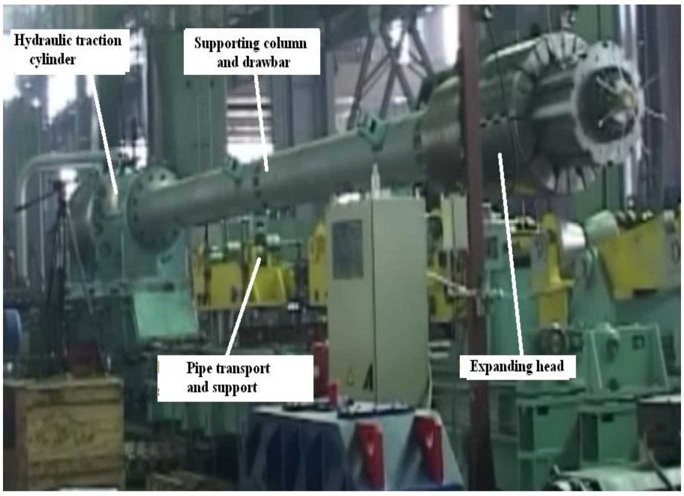

Fig.1 The mechanical expander

The requirements imposed by the expansion of high-strength steels X80, X100 and in the immediate perspective X120, as well as the increase of the wall thickness up to 50 mm have determined the modification of the entire solution, both hardware and software [6], [7].

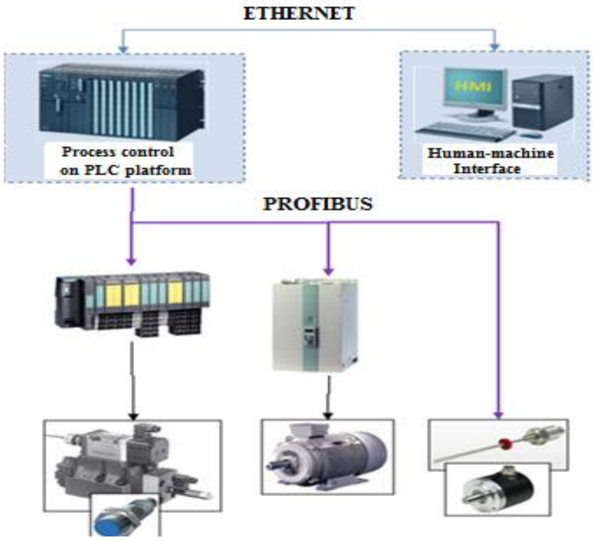

Fig. 2 Initial automation block diagram

2 The structure of the new automation assembly

This new approach has determined the creation of dedicated measurement systems allowing for the automated acquisition, online, of the main pipe parameters before and after expansion. Previously, all these values were obtained through manual measurements taken by polling by the production or inspection personnel in the plant. The research in this field materialized in the design, execution and experimenting of automated measurement systems for the following pipe parameters:

- Outer diameter;
- Cross-section ovality and polygonal shape;
- Linearity;
- Wall thickness;
- Expansion tool temperatures.

A block diagram of the system is presented in Figure 3. The new solution brings improvements both on the hardware and the software parts of the system. The hardware part is represented by an industrial PC platform, connected to the process through PROFIBUS network for non- time-critical signals, and connected directly through fiber optics to the sensors and actuators whose reading and command, respectively, must be achieved extremely fast – such as in the case of positions and forces.

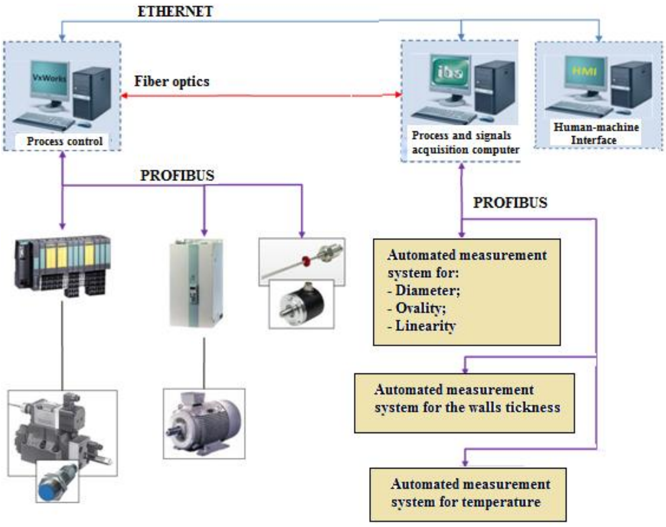

Fig. 3 Automation block diagram

A programming environment was selected – LogiCAD, which besides facilities allows the dynamic allocation of the process task priorities [8]. The system is completed by a real-time signal acquisition and analysis assembly, also on a PC platform - equipped with the ibaPDA acquisition and analysis software [9].

LogiCAD is a high-performance programming environment for industrial automation. Programming is done within a graphic editor, based on IEC 61131-3 applicable for automation elements and structures. Graphical programming allows the elaboration of programs in PLC representation, which are not connected specifically to any certain hardware or manufacturer.

LogiCAD offers two testing possibilities: „On-line" testing – OLT and „Off-line" Simulation – OLS.

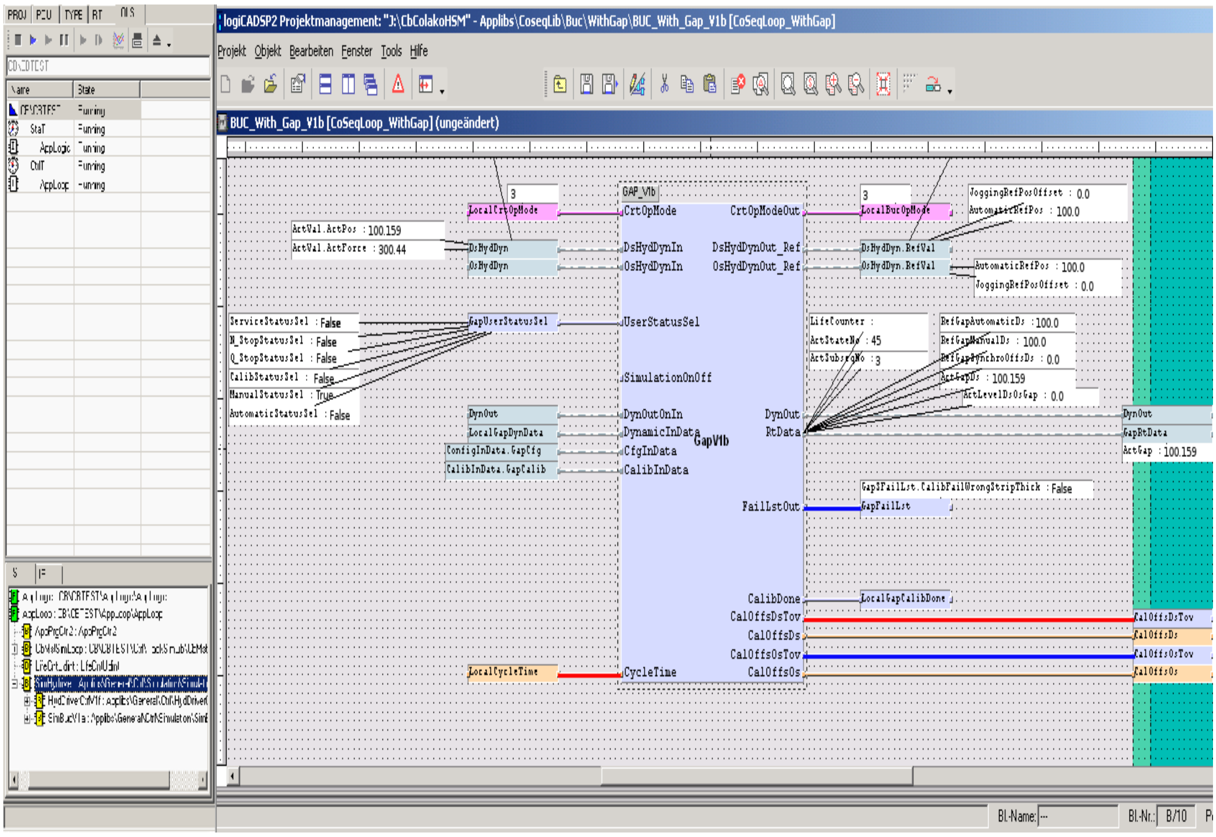

Fig. 4 LogiCAD Window for „Off-line" Simulation

Figure 4 presents the LogiCAD windows for „Off-line" Simulation. The difference consists in the fact that the „off-line" simulation is done directly in the workstation (the computer on which the programming was done), while the „on-line" testing is done on the target system.
The basic software package has been completed with a high-performance system for the acquisition, recording and analysis of process data. The ibaPDA is a hardware/software system sensing and analyzing the measurement values and is built on a PC platform. It consists of decentralized hardware components for the process signal detection, connections through fiber optics or other means for example PROFIBUS-DP, removable cards for PCs, as well as from an „on-line" recording software and an „off-line" analysis software.

The measurement data detected are stored as files, and they can be evaluated with the help of the iba analyzer (see figure 5).
The adjustment module nucleus is formed from a PI regulator, which can operate as P, I or PI regulator.
The following adjustment concepts were retained:

- Adjustment: position, force, position with the subordinated adjustment of the force;
- Command: direct servo-command, acceleration and braking depending on the stroke;
- Auto-adaptive properties of the module:

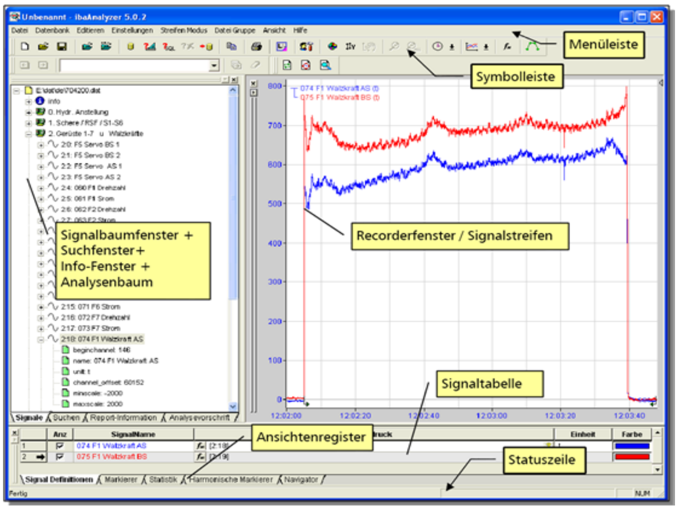

Fig. 5 ibaPDA – Analysis screen

- Switching with slope limiter;
- The servo-output value is set as part start value;
- Smooth switching (without shocks), by setting the slope reference start value;
- Smooth switching (without shocks) with corrected slope start value;
- Symmetric output signals.

Figure 6 presents the diagram of the regulator for position adjustment with the subordinated adjustment of force, a representative function of the mechanical expansion automation.

Figure 7 presents the integration diagram of the new auto-adaptive driver module for hydraulic positioning in LogiCAD representation.

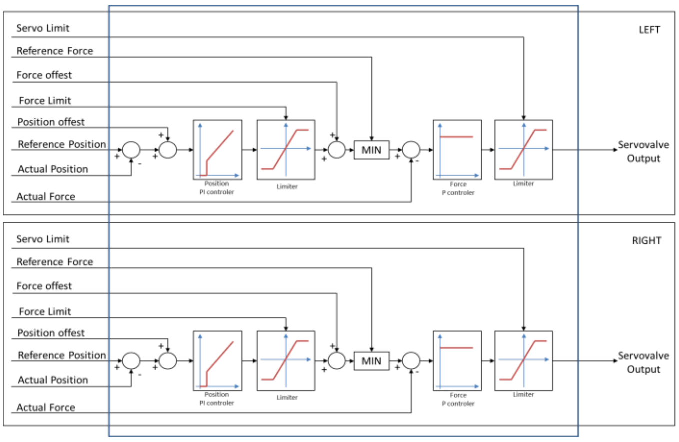

Fig. 6 Position adjustment with the subordinated adjustment of the force

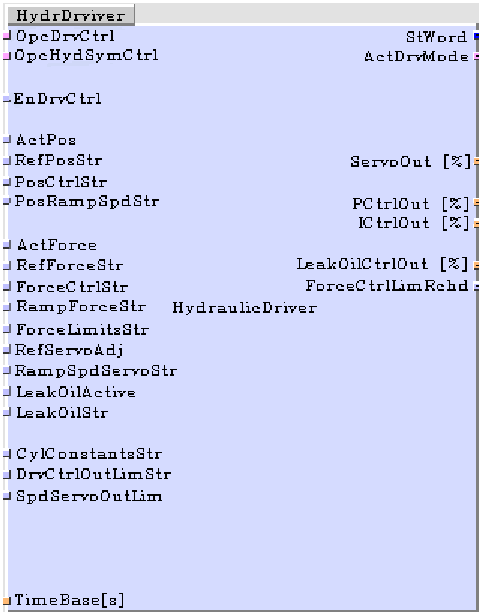

Fig. 7 Integration diagram of the new auto-adaptive driver module for hydraulic positioning in LogiCAD representation

3 Conclusion

The paper presents the technical and experimental developments related to the execution of a new automation system for a mechanical expander.

The old and the new automation systems were presented, the designing and execution of dedicated measurement systems for the main technology process parameters, as well as the designing of new hardware-software automation structures capable of managing in real time the above-mentioned parameters.

Acknowledgments

This work was performed with partially financial support, for new solutions to identify power consumption, from Project no.30/2012 Romanian Research Authority. This support is acknowledged with thanks.

References:

[1] Proctor J.S., The stretch mill, *Journal of the Iron and Steel Institute*, February, 1973, pp. 115-122

[2] Mopetti C., Montelatici L., Stretching-Reducing Mill: the effect of the factors of influence on thickened ends, *La Metallurgia italiana*, nr. 4, 2002, pp. 35-38

[3] Brensing,K.H., Sommer, B., *Steel Tube and Pipe Manufacturing Process*, www.smrw.de

[4] Macrea,D., Cuida,O., Macrea,T., Iordanescu,T., Considerations regarding the mechanical expanding of LSAW pipes with thick walls, *Mettallurgy and New Materials Research*, Vol. XVIII, No.1/2011

[5] Macrea,T., Macrea, D.,Cuida, O., Simion, M., Algorithm and calculation examples of the forces involved in the expanding Process of SAWL pipes, *Metalurgia International*, Vol. XV, No.12/2010, pp 5-12.

[6] Macrea, D., Cepisca, C., Grigorescu,S.D., Required Energy Calculation by Hot Rolling of Tubes and of the Main Drive Motors Power for a Stretch Reducing Mill, *WSEAS Transactions on Power Systems, Issue 5, Volume 3, May 2008, pp.320-329*

[7] Manig G., Muehle U., Rueckert G., *Quality Management in Tube Production with Online Measuring and Control Systems*, Ed. Mannesmannrohren-Werke Sachsen GmbH 1998, pp. 45

[8] *** *Logicad*, Handbuch V 5.2, Bikenbach, 2009

[9] *** *IBa Analyser, Analyseprogramm*, Handbuch V 4.2 de/ ibaAnalyser V 5.8, 2008