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BREAKOUT PREDICTION SYSTEM

PROTIPRŮVALOVÝ SYSTÉM

Abstrakt

Systém Argus je systém pro predikci průvalů v krystalizátoru při kontilití v závodě Saldanha Steel v Jihoafrické republice. Systém interpretuje data z termočlánků, sledujících proces a na základě údajů o licím procesu se snaží předejít vzniku průvalu. V článku je popsán systém zapojení použitého hardware a dále popis obslužného software.

1 Introduction

Argus BOP (Break-Out Prediction) system was developed to reduce the number of sticker break-outs on slab continuous casting machines.

The Saldanha Steel has one slab caster with one casting strand. The machine was originally equipped with sticker detection system but its functionality was problematic. The molds are now equipped with more thermocouples than they were for the old system. These purposes were the main reasons to replace them with the new BOP Argus.

The main features of the Argus are:

❑ reliable sticker detection

❑ adaptable heat removal model

❑ standard HW configuration, easy to maintain

❑ comfort user interface

❑ features for analysis of various problems at the caster (historical data)

❑ low sensitivity on change of casting condition and machine changes.

2 MTM – mould temperature monitoring

Very basic for sticker detection is MTM (Mould Temperature Monitoring) system. The system consists of thermocouples mounted in copper mould faces. To reduce the price of the new BOP installation it was decided to use existing Profibus network with distributed I/O modules.

The mould consists from four copper faces, two broads and two narrows. The thermocouples are mounted in the two broad faces. Measuring points are placed on the crosses of:

❑ measuring axes (vertical)

❑ measuring rows (horizontal)

Measuring axis:

Complete mould contains in total twelve (12) measuring axes:

❑ every broad face contains six (6) measuring axes with 300 mm between each other

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Measuring rows:

Thermocouples are placed in four (4) measuring rows. Number of thermocouples in each row corresponds to the number of measuring axis; it means twelve (12). The measuring rows are located: 165 mm (the first row), 285 mm (the second row), 405 mm (the third row), 525 mm (the fourth row) from the top edge of the mould faces.
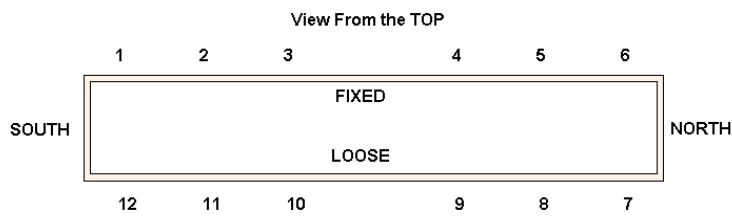
Fig.1 Thermocouples in the mould

3 ARGUS HW CONFIGURATION

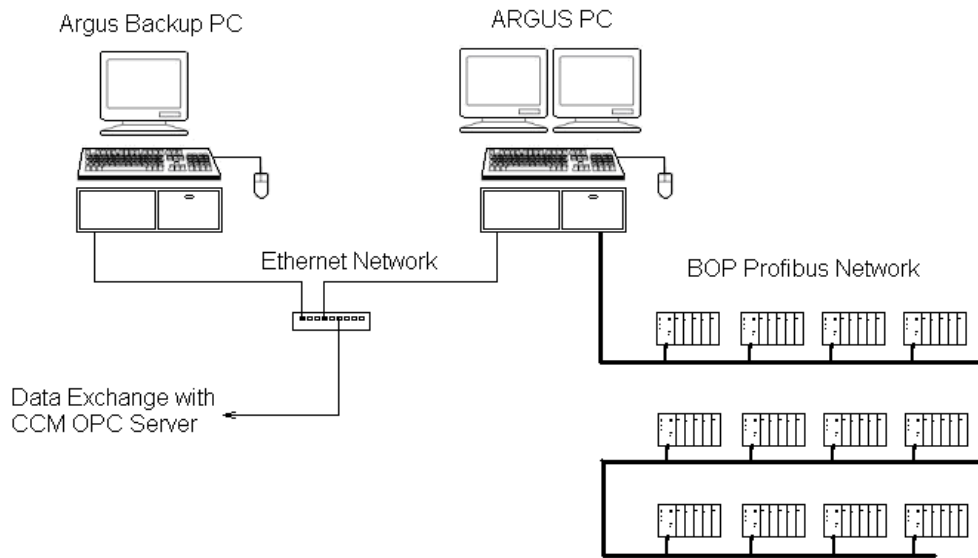The schema of HW configuration is on the following picture:

Fig.2 HW Configuration

Main HW components:

❑ ARGUS PC: Industrial PC with disk array, equipped with industrial Profibus communication Card (Siemens CP5611) and two displays, located at the CCM pulpit

❑ ARGUS Backup PC: Industrial PC with disk array, located at the PLC room

❑ BOP Profibus Network: interconnects Argus PC (master) and distributed I/O modules (Siemens ET200B)

❑ Ethernet network: interconnects Argus PC, Argus Backup PC and CCM OPC Server

3.1 BOP Profibus Network

The main purpose of this network is to provide Argus BOP algorithm with the fast process data. The most important process data for BOP system are:

❑ signals from all the thermocouples mounted in the mould copper plates (48 pieces).

All these signals are connected to distributed I/O modules (Siemens ET200B) connected to the Profibus network. Besides that some Profibus modules provides signal interface to caster control system. The most important signals sent from caster control system to Argus are:

❑ casting speed, mould level, actual mould width, binary flags (Caster Status, Mould Level in Auto etc.).

Argus sends following signals to caster control system: Sticker alarm, Mode Flags (Automatic or Manual mode), Heartbeat.

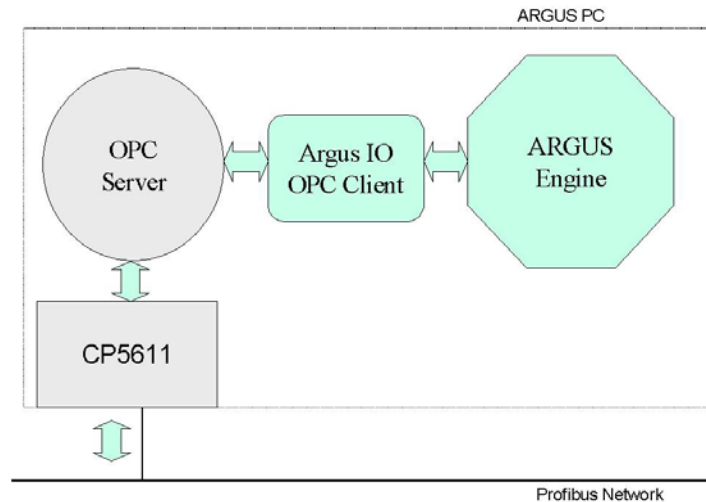The following schema shows data flow between the Argus Engine (BOP Application) and Profibus network:

Fig.3 Schema between IPC and Profibus network

3.2 Communication to CCM OPC Server

The Argus system works with more data than it can get via the Profibus network. All the rest of the necessary data are read from the CCM OPC Server. Both Argus PC and Argus Backup PC are connected to the same Ethernet network as the CCM OPC Server.

The Level 2 OPC Client was developed to communicate with the CCM OPC server and provide the Argus Engine with all necessary data (Cast ID, tundish weight, etc.).

All the data Argus reads from CCM OPC Server are related to heat transfer and if the communication fails it has no influence on Sticker detection logic of Argus. OPC **S7** protocol was used for communication.

4. User Interface

The user interface was designed to view maximum information in real time and to include powerful tools for the historical data analysis. Main features of Argus user interface are:

❑ maximal usage of the area of the screen

❑ intuitive control and safety (to avoid operator mistakes)

❑ closes relation between graphical form of displayed information and their physical basis.

To fulfill all mentioned criteria two individual applications were designed for Argus user interface: *real-time BOP view* and *historical data viewer*

Features of these applications and the way of their control are in detail described in following chapters.

4.1 "Real-time BOP"

This application is graphical user interface for MTM and sticker detection part of Argus system. It shows in real-time all related measured values: temperatures in mold plates (signals from thermocouples) [deg C], casting speed [m/min], mould level [mm], mould width [mm].
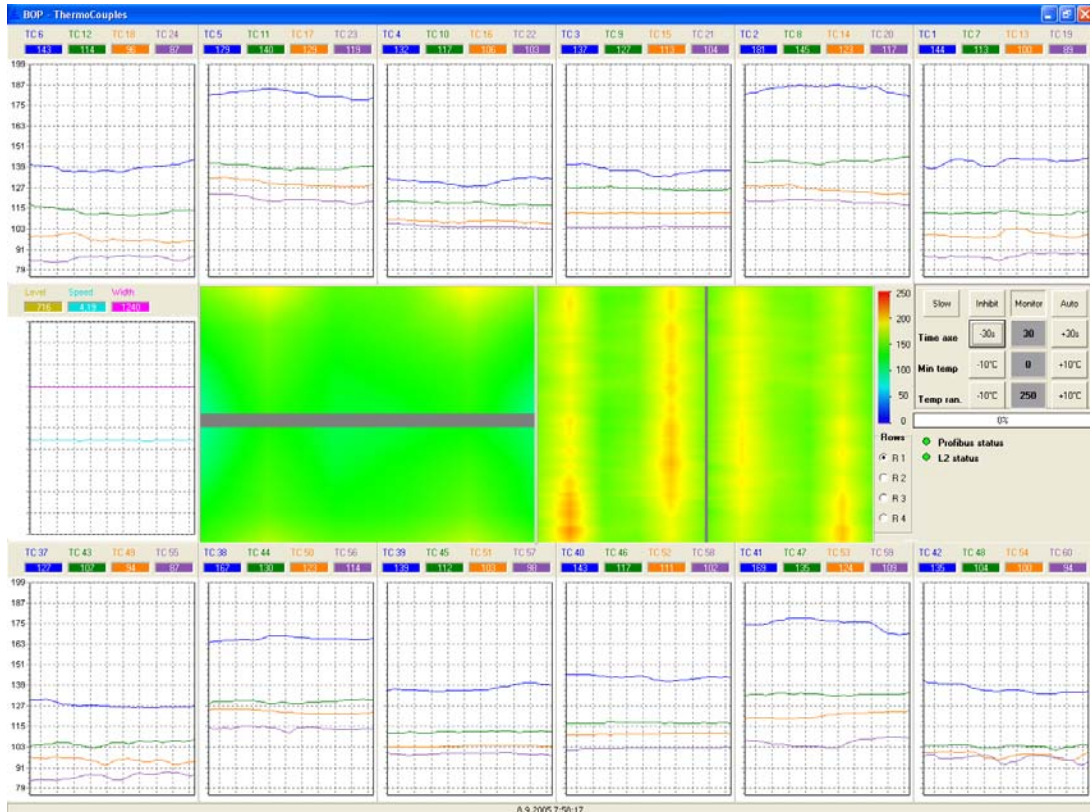
Fig.4 "BOP real-time" window

The window contains one trend chart for each MTM measuring axis. These trends are situated in the way to correspond with their real position in the mould plates.

Temperatures trends:

On the top of each trend is horizontal bar graph to display the alarm of the individual axis in the range 0-100%. The normal value is 0%. The alarm rising is indicated both by number and red bar.
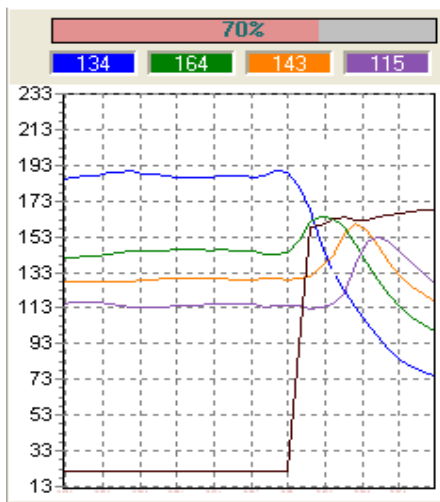
Under the alarm bar graph are arrays to display actual values in individual thermocouples in he axis. Each display is labeled with the number of the thermocouple. The first number is for the top thermocouple, the second for the bottom one. The background color of the display corresponds with the color of the trend line. The display background is changed to red in the case of system recognize the fault of the thermocouple. The display background is changed to gray in the case of operator disables the thermocouple. Most of the trend is the graph with trend lines and the grid.

4.2 "Historical Data Viewer" window

The window includes Menu, Toolbar, historical trends, temperature maps and status bar.
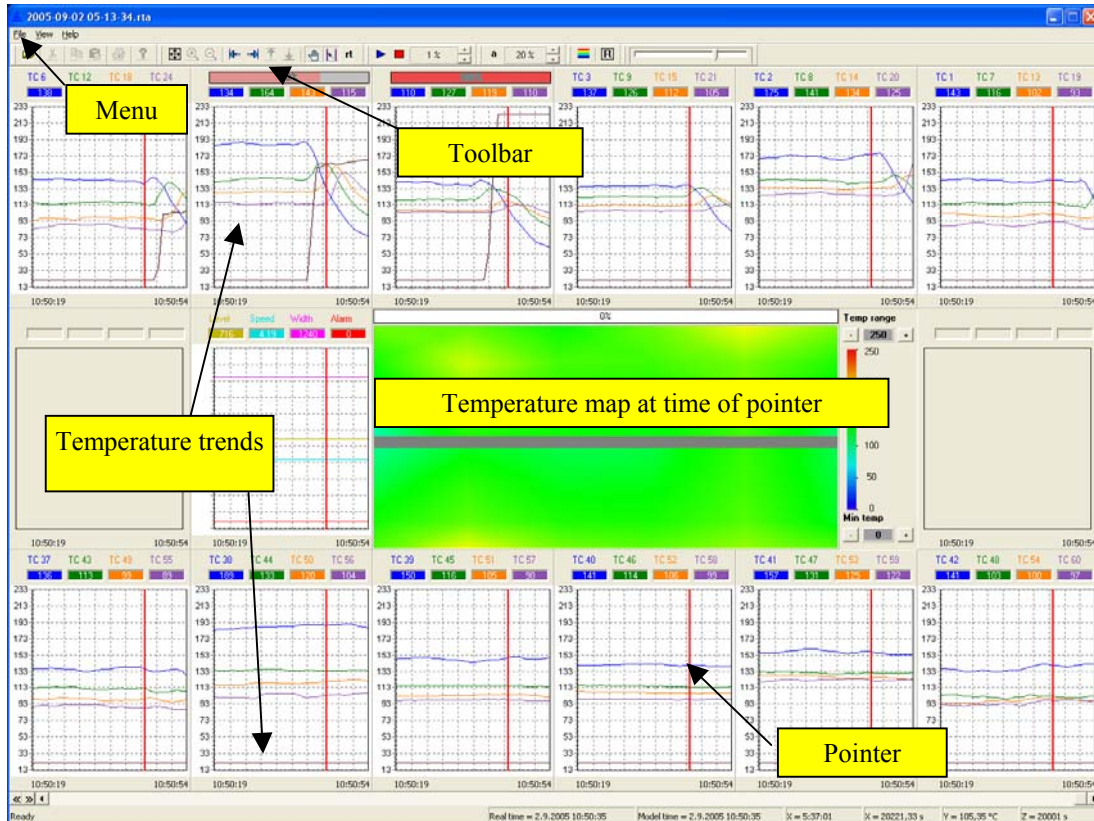
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Fig.5 "BOP history viewer" window

5 SUMMARY

In this document was described special breakout prediction system called Argus. This system is based on monitoring temperatures, casting speed, level of the steel in a mould and casting width. All values are measured by sensors which are connected to modules situated at the PROFIBUS. These modules are presented as slaves with different addresses. All of them are connected to the master PC via PCI card CP 5611. Another backup PC was added to improve the security. They communicate via Ethernet.

PROFIBUS offers the most important data for breakout prediction system but it doesn't contain basic data about the casting. These data are sent via Ethernet as well from CCM OPC Server situated at a computer in a PLC room.

For this system was designed the user interface which presents all necessary and important information. If the system detects a sticker, the system will send a signal to slow down the casting speed whereby it avoids the breakout.

Argus has been working reliably without any problems. During two months Argus detected the sticker three times.

Literature

[1.] Siemens. Industrial communication with PG/PC manual. 2003, 698p.

[2.] Teixeira, S. Mistrovství v Delphi 6. Translated by B. Kiszka, B; Edited by P. Klima Praha: Computer Press, 2002. 820p.,ISBN 80-7226-627-6

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