Automatic mould level control in Bokaro Steel Plant

- In Bokaro steel plant, we are committed to continuously build a culture of automation, innovation and being updated.
Two identical twin strand slab casters
Slab width 950-1850 mm
Slab thickness 225 mm
Some salient features:

a) Automatic mould level control
b) Air mist secondary cooling
c) Propane based online slab cutting
d) Online marking and slab weighing
Requirement of mould level measurement and control

- It is extremely necessary to control the molten steel in mould at a constant level over time throughout casting to produce quality steel and to ensure man and machine safety.
How to measure molten steel level?

Two most popular methods:

- Nucleonic type
- Eddy current type

In Bokaro Steel Plant, we use Eddy current based, suspended type mould level sensor.
• EDDY current sensor senses the molten steel level and sends it to PLC (VIA its own amplifier panel)
• PLC reads the level and sends command to proportional valve to close/open the slide gate accordingly to maintain level constant, and that’s how the loop continues.
• There is operator desk for manual intervention in case of any possible failure.
What is an Eddy current?

**Eddy currents** are loops of electrical current induced within conductors by a changing magnetic field in the conductor, flowing in closed loops within conductors, in planes perpendicular to the magnetic field.
Basic principle

• It consists of a pair of air core coils arranged in parallel.

• Constant alternating current (251 mA, 100 KHz) is sent through primary coil.

• Consequently a voltage is induced in secondary coil.

• If the molten metal surface is near to the coils, Eddy current flows to the molten metal, causing variation in secondary induced voltage, thereby making secondary voltage a direct proportional indication of molten metal level.

• Induced voltage = f (distance, conductivity, permeability)
Sensor parameters

- Transmission current 251mA, 100kHz, variable in the range 247 to 255mA
- Output signal: 4-20 mA DC and 1-5 VDC
- Measuring range: -150 mm to -20 mm
- Self diagnosis functions: a) Coil open
  b) Sensor over temperature
  c) CPU over temperature
  d) Air cooling drop
- Reproducibility: +/- 2mm
- Linearity: +/- 2 mm
- Coil bobbin material: Ceramics
- Coil: 50 +/- 1 turn chrome wire
- Response time 0.3 seconds
MOULD LEVEL CONTROL

- Mould level signal is fed to PLC
- PLC has a PI control program which decides how much the slide gate should open or close to maintain a constant level.
- Accordingly a command is sent to proportional valve to control metal flow through slide gate
A slide gate is a movable plate in between two stationary plates. All the three plates have a fixed diameter hole so that when the middle plate moves front and back, either the holes are

a) fully mismatched (Gate full closed)
B) Fully matched (Gate full open)
C) Partially matched (In between)
Tundish slide gate (Phase one modernization)
## Modernization of slide gate system in BSL

<table>
<thead>
<tr>
<th>Before modernization</th>
<th>After modernization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obsolete ABB MP 200 PLC was used</td>
<td>Latest Siemens S7 PLC is used</td>
</tr>
<tr>
<td>Dedicated flow control card was used</td>
<td>Simple PLC AO card is used</td>
</tr>
<tr>
<td>Slide gate holes match at 73%</td>
<td>Slide gate holes match at 100%</td>
</tr>
<tr>
<td>Online SEN changing facility was not available</td>
<td>Online SEN changing facility is available</td>
</tr>
<tr>
<td>Single cylinder slide gate operation</td>
<td>Dual cylinder slide gate operation</td>
</tr>
<tr>
<td>Only feedback control system</td>
<td>Feedback + feed forward control system</td>
</tr>
</tbody>
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Double Loop Control

- Set level
- PLC
- Proportional valve
- Mould level signal
- Slide gate position
- Set gate position
- Temposonic
- MOULD
Feed forward control

Casting speed variation

Set level

PLC

Set gate position

Proportional valve

Mould level signal

Slide gate position

Temposonic

MOULD

Set gate position

Casting speed variation
Real time trend of mould level
Actual photographs
Proposed phase 2 modernisation

- Procurement of new mould level sensor
- Auto cast starting
- Better handling
- Better spare availability and reliability
Thank you

It’s a beginning