Mechanical descaling
by high pressure water jet

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Workshop on Pickling Solutions Technology
13th of November 2019, Düsseldorf
Introduction

- Brno University of Technology, Czech Republic
- Hydraulic descaling of coils of wires
- Laboratory experiments
  - Impact pressure distribution measurement
  - Hydraulic descaling
  - EDX Analysis with a Scanning Electron Microscope
- Conclusion
Brno, Czech Republic
Brno University of Technology

Faculty of Architecture
Faculty of Business and Management
Faculty of Chemistry
Faculty of Civil Engineering
Faculty of Electrical Engineering
Faculty of Fine Arts
Faculty of Information Technology
Faculty of Mechanical Engineering

Total students: 19,240

Founded 1899
Experimental research of heat transfer and heat treatment
Numerical models of continuous casting, rolling and heat treatment

Continuous Casting

Rolling and heat treatment
Descaling of coils of wires – outer diameter 1.4 m
Impact pressure distribution measurement

- **DAQ**
- **PC**
- **Nozzle**
- **Impact area**
- **Pressure Sensor**
- **Moving Plate**
- **Pressure**
- **Position**
Spray comparison – High and low pressure but same water flow rate

45 MPa

5 MPa
Spray comparison – High and low pressure but same water flow rate

45 MPa

5 MPa

Video
Distance 300 mm - No wires

Nozzle A at 45 MPa
Catalogue spray angle 45°

Nozzle B at 5 MPa
Catalogue spray angle 40°
Impact pressure measurements without dummy wires

![Graph showing impact pressure measurements for Nozzle A and Nozzle B at 200 mm and 300 mm spraying distances.]

- At 200 mm:
  - Nozzle A: 45 MPa (92% of 50 MPa)
  - Nozzle B: 5 MPa (100% of 5 MPa)

- At 300 mm:
  - Nozzle A: 45 MPa (79% of 58 MPa)
  - Nozzle B: 5 MPa (100% of 5 MPa)
Cleaning graphite coating

Nozzle A at 45 MPa

Nozzle B at 5 MPa
Cleaning graphite coating - Video
Impact pressure distribution while spraying through wires

1 layer  
6 layers
One layer of wires

45MPa

5MPa
Distance **300 mm** - with 6 layers of wires – 5 MPa
Distance **300 mm** - with 1-6 layers of wires – smaller nozzle, 45 MPa

**1 layer**

![Graph 1 layer]

**2 layers**

![Graph 2 layers]

**4 layers**

![Graph 4 layers]

**6 layers**

![Graph 6 layers]
Distance 300 mm - with 1-6 layers of wires - Video
Spray distances during hydraulic descaling
Distance of descaling header from wires is 200 mm
Reduced spray angle

Spray angle 45°

Spray angle 30°
Hydraulic descaling

Wire descaling using smaller nozzle at 45 MPa for steel grade 1.4571

* This is not the final surface of the product. This is surface during pickling program.
EDX Analysis with a Scanning Electron Microscope
EDX Analysis with a Scanning Electron Microscope

backscattered (BSE)  secondary electrons (SE)
## EDX Analysis with a Scanning Electron Microscope

<table>
<thead>
<tr>
<th>Element</th>
<th>Wt %</th>
<th>Inte. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>27.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Si</td>
<td>0.4</td>
<td>16.0</td>
</tr>
<tr>
<td>MoL</td>
<td>3.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Cr</td>
<td>32.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Mn</td>
<td>0.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Fe</td>
<td>31.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Ni</td>
<td>4.0</td>
<td>5.3</td>
</tr>
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EDX Analysis with a Scanning Electron Microscope

Steel grade 1.4404

<table>
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<tr>
<th></th>
<th>Fe</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>Mn</th>
<th>Si</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data sheet</td>
<td>16.5–18.5%</td>
<td>10–13%</td>
<td>2–2.5%</td>
<td>≤ 2%</td>
<td>≤ 1%</td>
<td></td>
</tr>
<tr>
<td>Measured</td>
<td>66.4%</td>
<td>17.6%</td>
<td>11.1%</td>
<td>2.9%</td>
<td>1.3%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

![Image of steel grade 1.4404 analysis](image-url)
EDX Analysis with a Scanning Electron Microscope

Scale layer on 1.4404

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<th>Ni</th>
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</thead>
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<tr>
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<td>31.3%</td>
<td>27.8%</td>
<td>32.2%</td>
<td>4.0%</td>
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<td>1.3%</td>
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EDX Analysis with a Scanning Electron Microscope

Scale layer on 1.4404

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<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured</td>
<td>32.7%</td>
<td>20.8%</td>
<td>28.7%</td>
<td>13.5%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

The image shows a micrograph with the following parameters:

- Accelerating voltage: 20.0 kV
- Spot: 4.1 m
- Magnification: 1000x
- Detector: BSE
- Working distance: 9.4 mm
- Exposure: 16967
- Sample: vzorek 4
Conclusion

- **Big spraying distance (200 mm and more)**
  - **Free** space
    → Use **bigger nozzle** and **smaller pressure**
  
- Spraying **through wires**
  → Use **smaller nozzle** and **bigger pressure**

- Hydraulic descaling is effective during pickling.

Thank you for your attention…

[www.heatlab.cz](http://www.heatlab.cz)