Experimental investigations and analyses of the thermal behavior of a moving pantograph's strip

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Main objectives

- Define the thermal behaviour of the pantograph strip during the motion
- Describe the influence of all the different parameters on the heat sources in the strip
- Obtain the times where the thermal configuration can generate strip degradations, premature wear and breaks

Figure: Mass losses of carbon strip with the temperature increase
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Test bench presentation

- Situated at Polimi (Politecnico di Milano)
- It can reproduce a real configuration of a pantograph/catenary system during a real travel
Strip instrumentation

- 19 thermocouples are inserted inside the strip at specific positions
- Electrical insulation and signal filtering are necessary
## Experimental parameters

<table>
<thead>
<tr>
<th>Strip impregnation</th>
<th>Strip thickness</th>
<th>Velocity</th>
<th>Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 %</td>
<td>32 mm</td>
<td>140 km h⁻¹ constant</td>
<td>60 N</td>
</tr>
<tr>
<td>25 %</td>
<td>18 mm</td>
<td>140 km h⁻¹ constant</td>
<td>90 N</td>
</tr>
</tbody>
</table>

Variable profile

### Graph:

- **P1**: A start
- **P2**: A positive slope
- **P3**: A negative slope
- **P4**: A stop
Results and interpretations: Matter change

Figure: Comparison between the thermal response of the pantograph strips A and B, for thermocouples 2-3 with a velocity of 140 km/h, a force of 60N and a normal current profile.
Results and interpretations: Stagger motion

- Amplitude differences between the two strips
- Possibility to characterize the strips
Results and interpretations: Velocity profile

Figure: Thermal response of the pantograph strip B for the thermocouples 2 with a force of 60N and a normal current profile: Comparison between a constant velocity of 140 km/h and a variable profile.
Thermal distribution

![Thermal distribution diagram](image)
Conclusion

- The strip matter characteristics have an important influence on the temperature of the strip and its thermal diffusivity
- A high part of impregnated copper generates:
  - Low temperatures and high diffusivity
  - Less wear on the material, more problems on the glue joint
- A velocity change creates:
  - Temperature peaks
  - Convection variations and then cooling variations
- Possibility to understand the thermal effect with accuracy
- Possibility to control the strip validity from a thermal point of view with only two thermocouples