Measuring of liquid steel temperature in secondary metallurgy

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Introduction

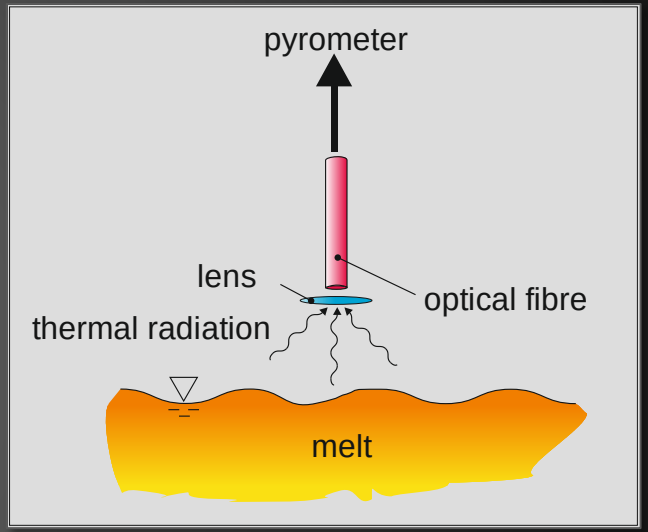
- Precise knowledge of temperature evolution during heating, alloying and cooling operation is important for:
  - Product quality
  - Energy consumption
  - Raw material efficiency
  - Product yield

State of the Art - Thermocouples

- Quick, precise and inexpensive measurement sensor
- Over 120 years of use in steel industry with continuous minor improvement
- Maximum thermo wire tolerance only ± 1,5°C (0,1 %) at Palladium point
- Tolerance of total measuring chain ± 3,5°C
- But no instantaneous continuous representative measurement possible

State of the Art – optical measurement

- Contactless measurement
- Free field of view necessary
- Only surface temperature can be measured
- Exact surface emissivity unknown → big errors likely



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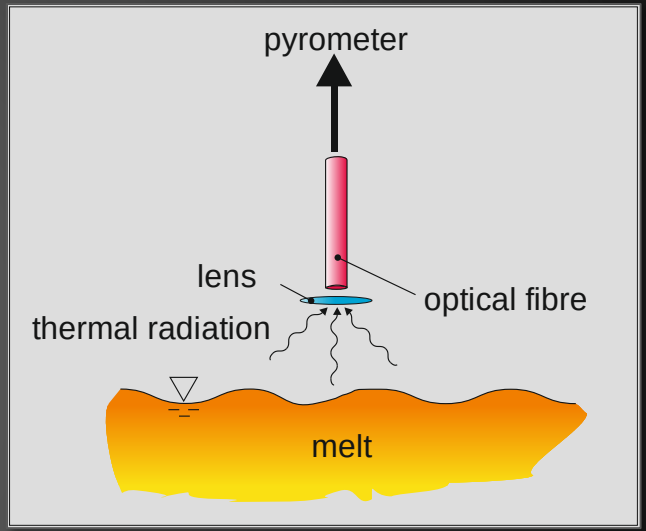
State of the Art – New Future



- DynTemp® combines high thermocouple accuracy with fast and instantaneous optical measurement capabilities

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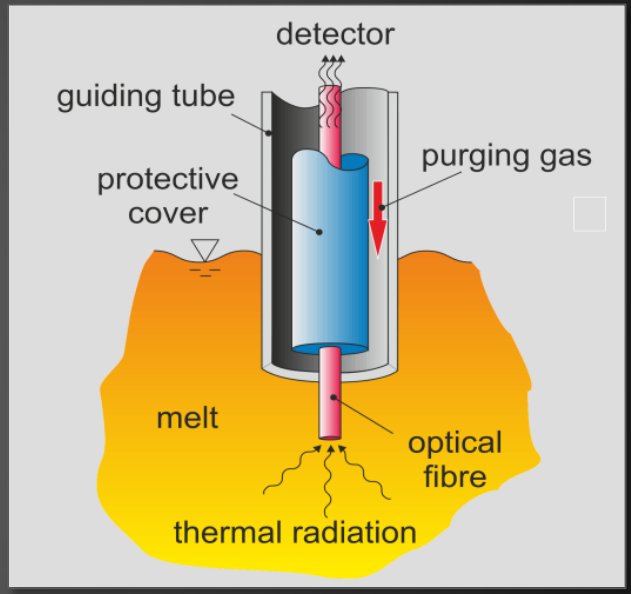
Measuring Principle of DynTemp®

- Optical temperature detection
- Continuous immersion of optical fibre into liquid metal
- Instantaneous transmission of thermal radiation
- No emissivity losses
- No influence of slag and oxides
- No electromagnetic measurement influences



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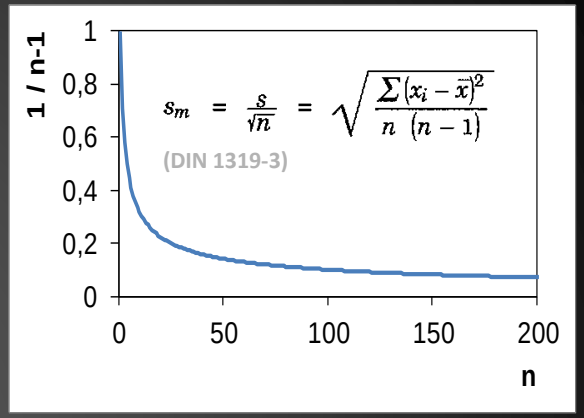
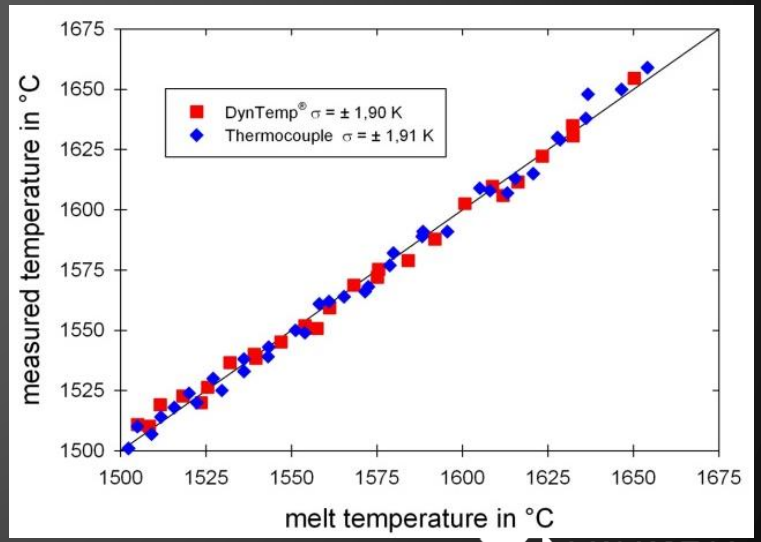
DynTemp® accuracy comparison

- Comparison with thermocouple measurement in 300 kg laboratory induction furnace
- DynTemp® spot measurement based on hand lance
- Alternating dipping of DynTemp® and TE
- Reproducibility comparable to TE
- Better reproducibility with continuous DynTemp® operation





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Argon stirring station

- Optical fibre temperature measurement through stirring lance
- Flexible extended measurement duration
- Temperature measurement without process interruptions
- Minimises stirring gas consumption
- Optimises process time

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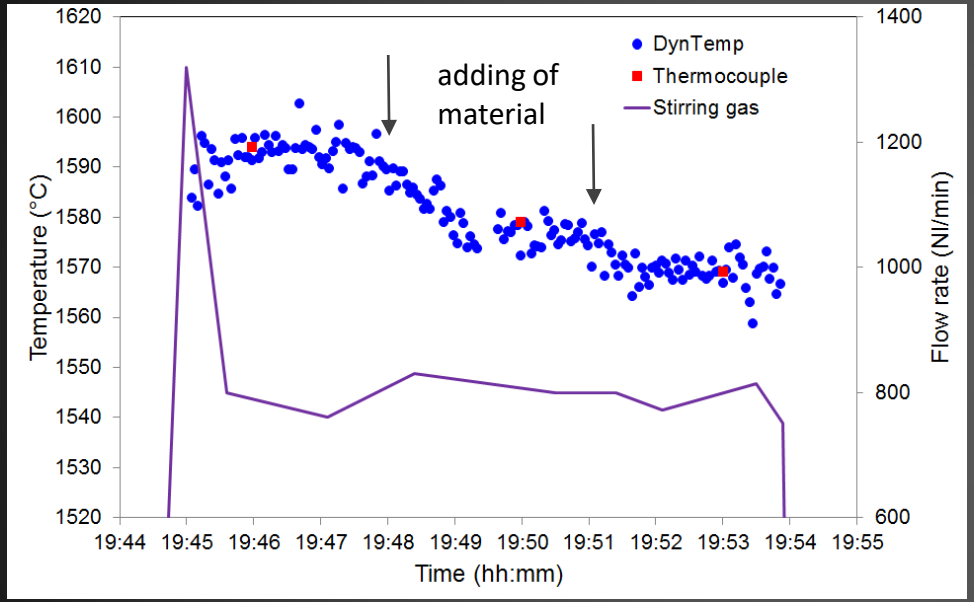
Argon stirring station



Liquid steel temperature evolution during gas stirring using an adapted stirring lance as measured by fibre optical and thermocouple measurements.

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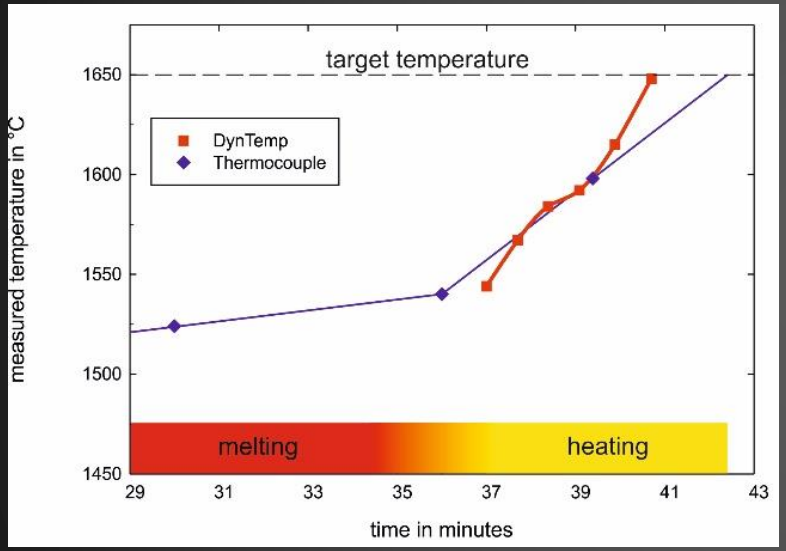
Optimisation of process time by continuous measuring of melt bath temperature



- Measurement in 100t ladle furnace
- Linear interpolation of power off time using manual thermocouple measurements (blue line)
- Continuous measurement detects required tapping temperature two minutes earlier
- Minimises tap-to-tap time
- Avoids excess temperature/energy/materials

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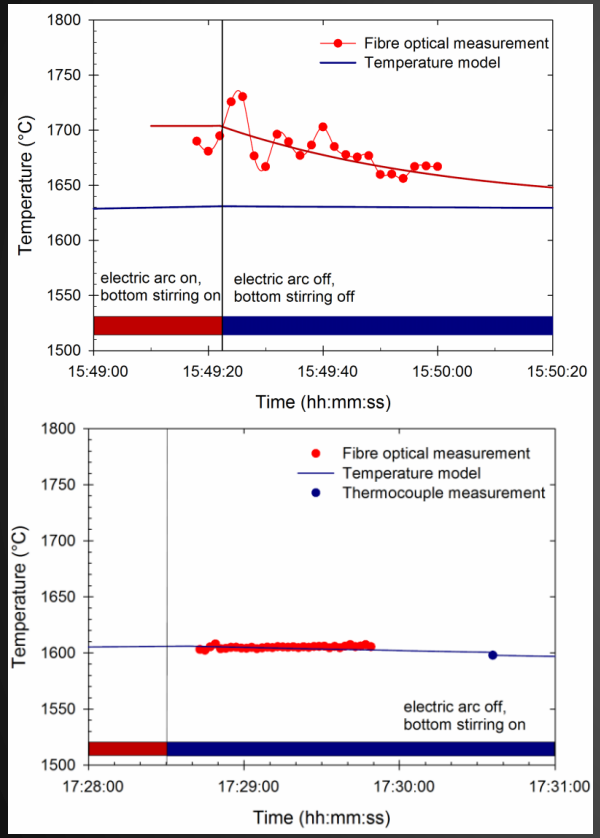
Efficiency of bottom stirring tuyeres at ladle furnace



- Without bottom stirring temperature homogenisation approx. 50 seconds after powering off the electric arc
- With bottom stirring temperature homogenisation approx. 10 seconds after powering off the electric arc

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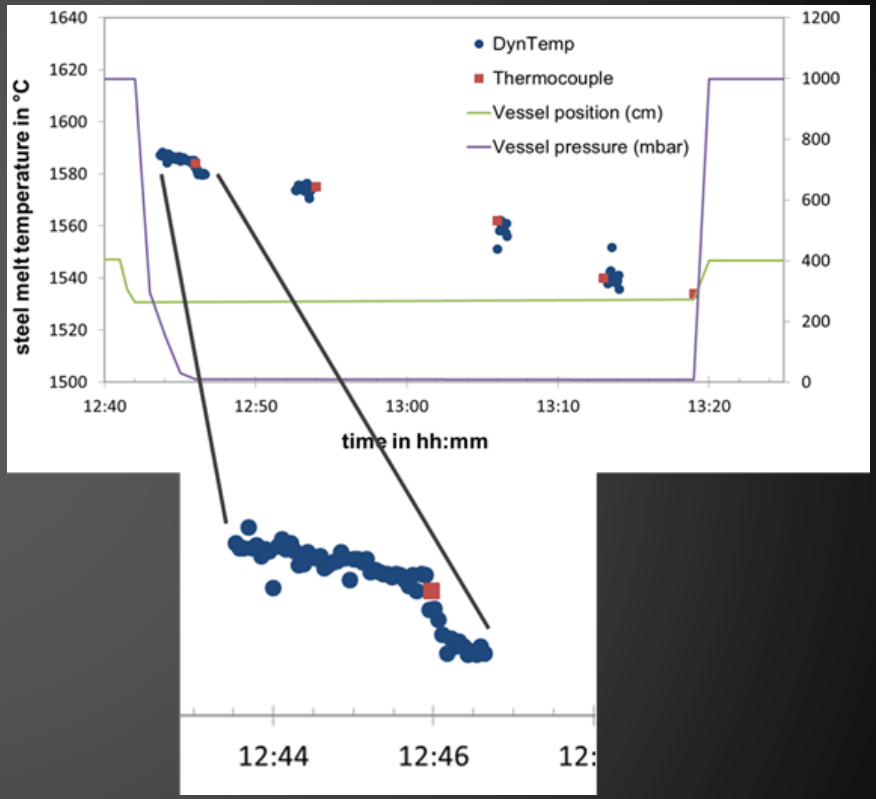
RH-Degassing

- Manual lance with heavy duty probes
- Measuring duration 4 to 6 minutes
- RH process can be monitored in detail, e. g.:
  - Temperature drop during vacuum build up
  - Temperature response to alloying procedure



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Conclusion

DynTemp® technique for melt bath temperature measurement:

- Reliable spot and continuous temperature determination
- Manual and manipulator application with special measuring probes
- Direct integration into stirring lances and bottom tuyere

Conclusion

DynTemp® benefits:

- Instantaneous detection of melt temperature
- Process time reduction
- Cost optimisation
- Process in control

Thank you!

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