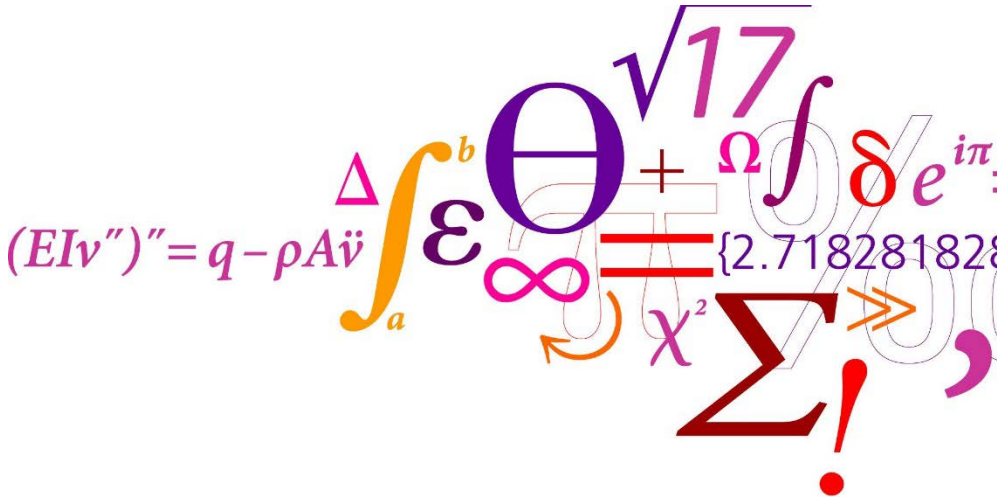
# Limits of Lubrication in Industrial Ironing Processes

Esmeray Üstünyagiz




DTU Mechanical Engineering
Department of Mechanical Engineering

# Outline

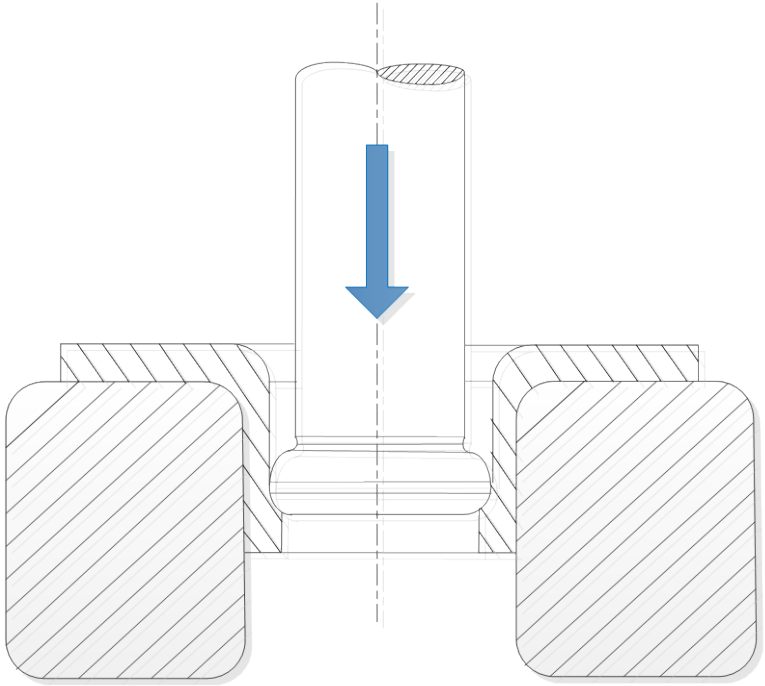
- Introduction
- Strip Reduction Test (SRT)
- Screening Test
- Production Platform
- Conclusion

# Outline

- **Introduction**
  - Ironing Process
  - Design of Laboratory Test
- Strip Reduction Test (SRT)
- Screening Test
- Production Platform
- Conclusion

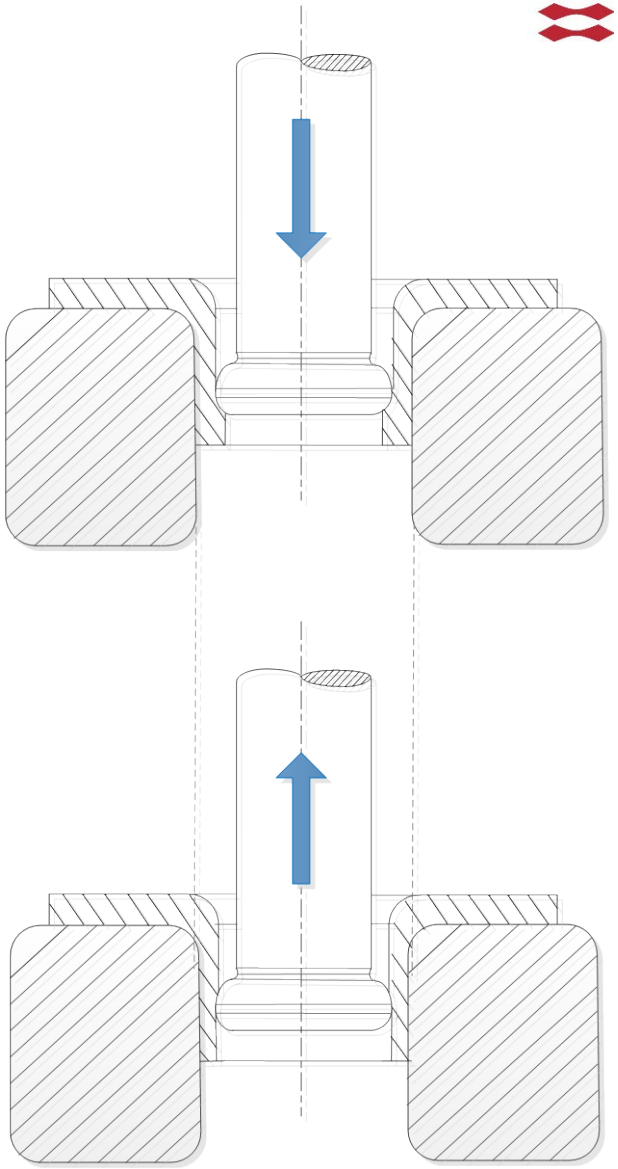
# Ironing

- Severe Process
  - –High contact pressure
  - –High surface expansion
  - –High temperature
- Problem
  - –Lubricant breakdown
  - –Pick-up and galling
- Solution
  - –Chlorinated paraffin oil

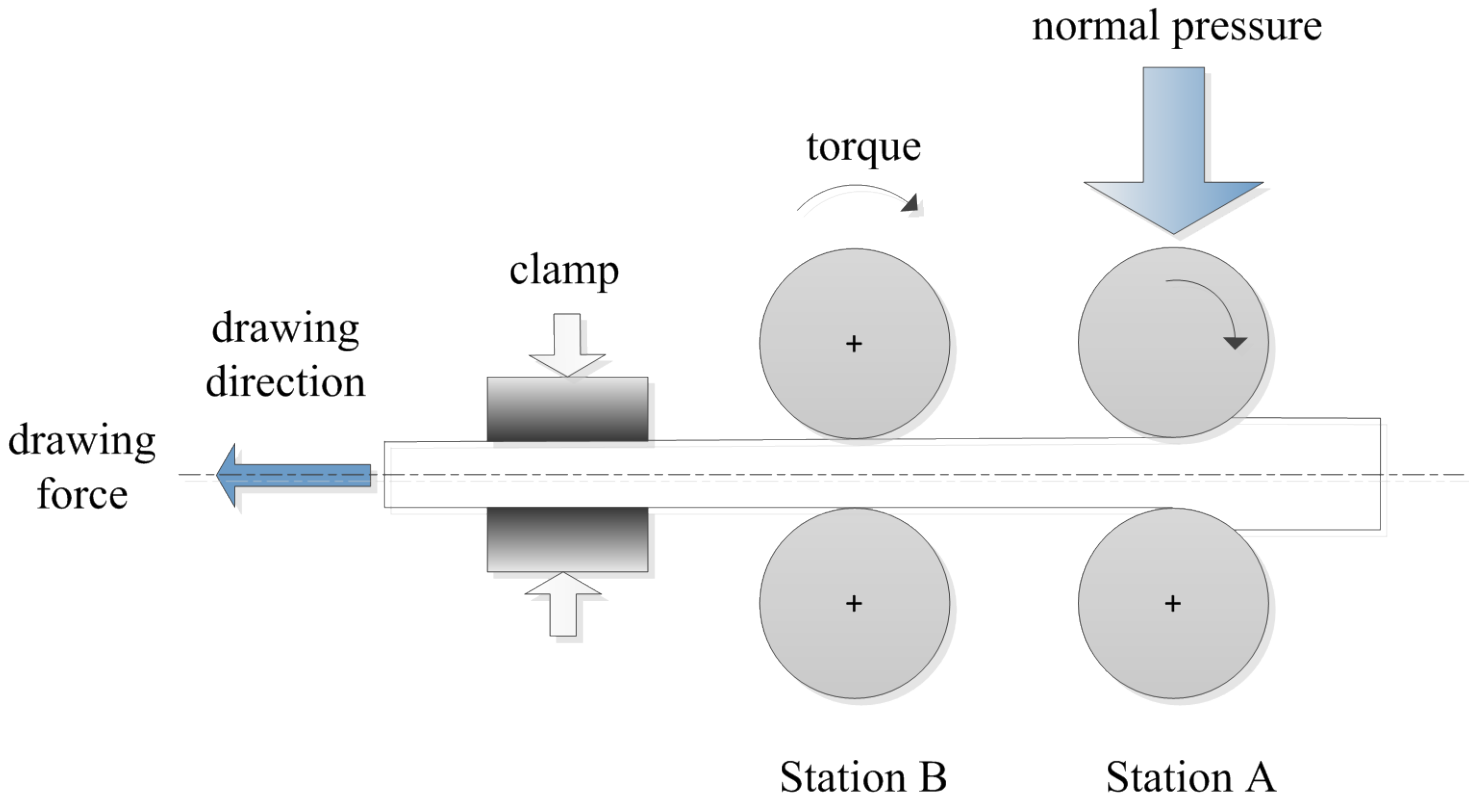


# Ironing

- Solution
  - substituting hazardous lubricants with environmentally friendly ones



# Tool Sketch



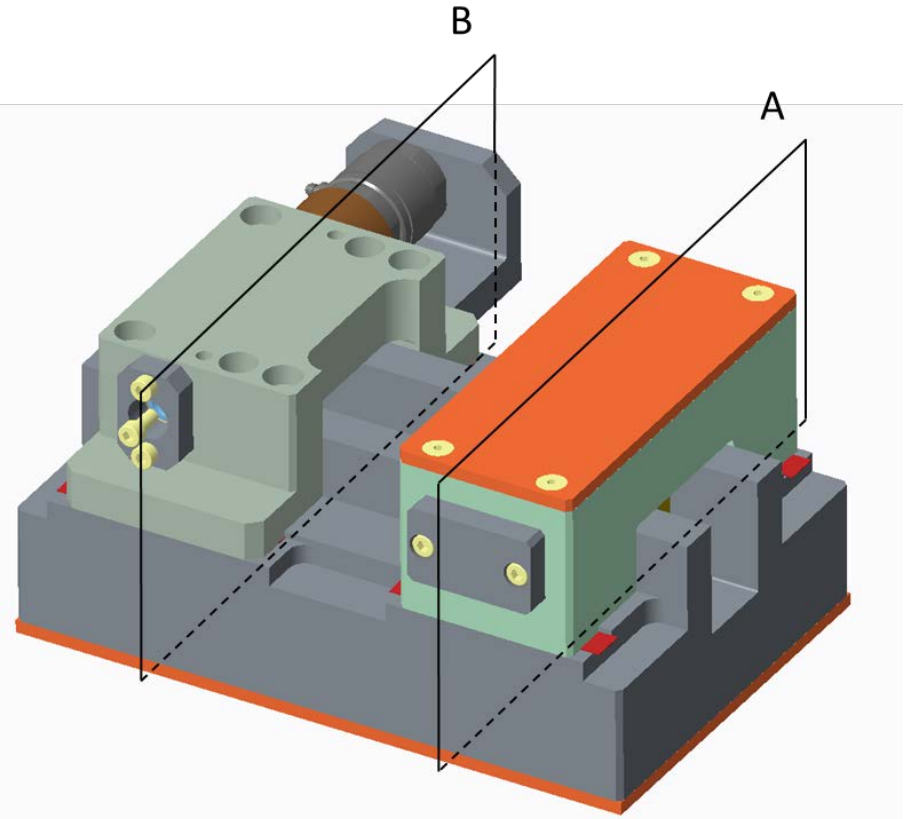

- Investigation of limits of lubrication in ironing process not only during forward stroke but also during backward stroke

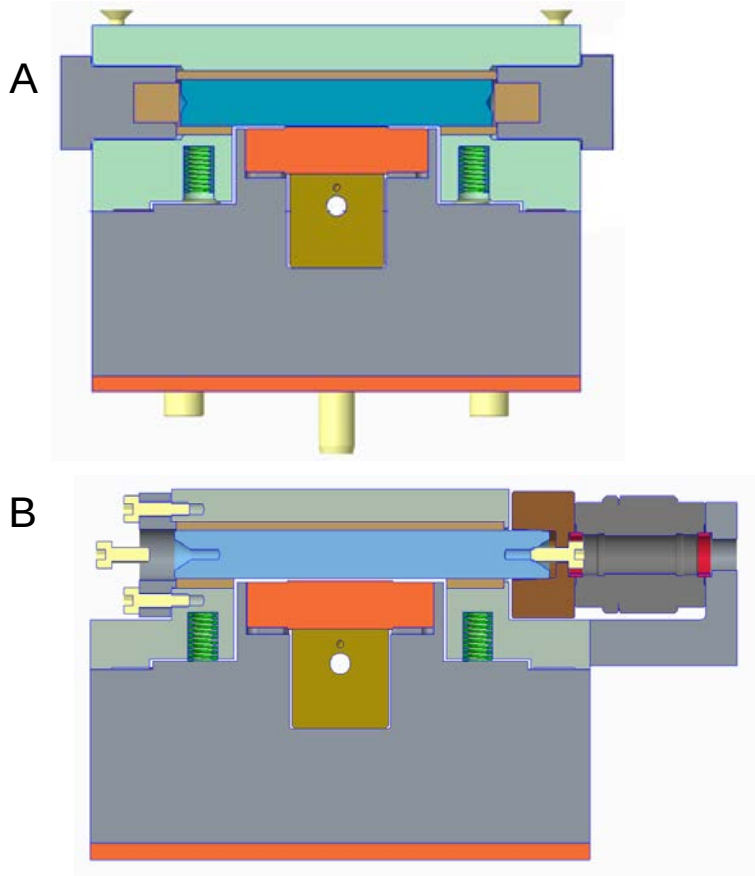
# Outline

- Introduction
- **Strip Reduction Test (SRT)**
  - Tool Design
  - Implementation
- Screening Test
- Production Platform
- Conclusion

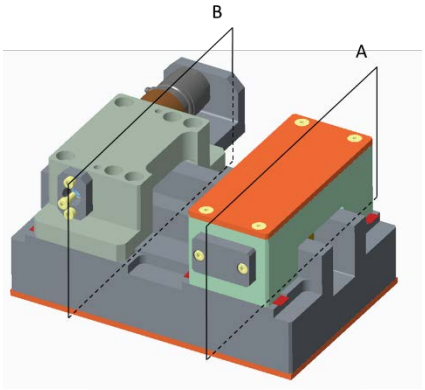
# SRT Tool

- Adjustable reduction
- Implementation of torque measurement

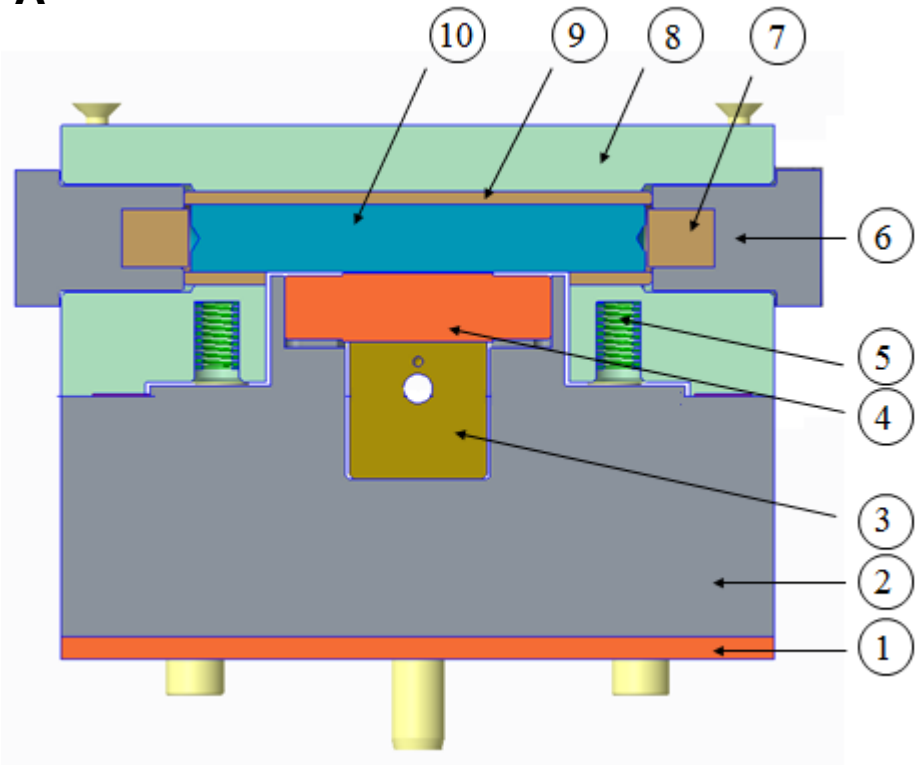


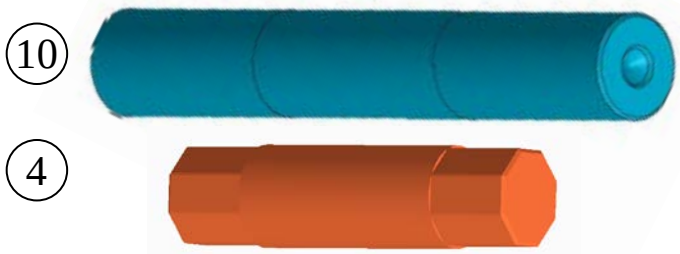



# SRT Tool – Station A




A

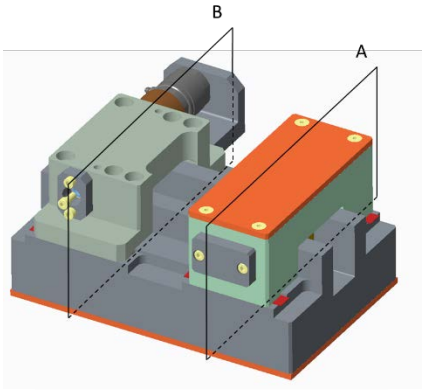


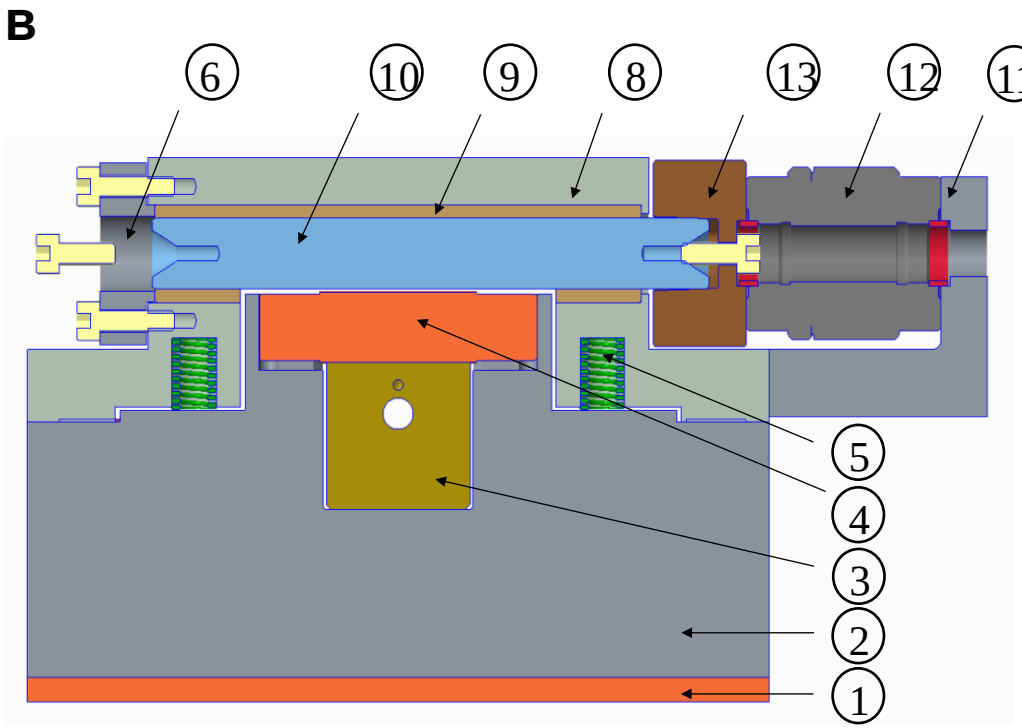



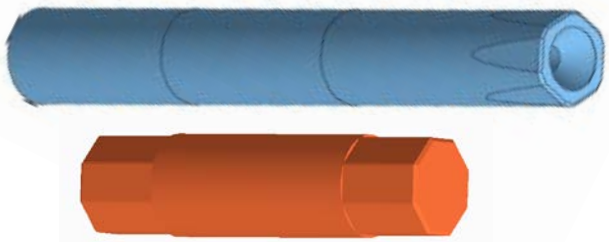

- 65% reduction of 1 mm thick blank

1-isolation plate, 2-base, 3- heater block, 4-lower tool, 5-spring, 6-end holder, 7-cylinder stop, 8-upper housing, 9-bearing, 10-upper tool

# SRT Tool – Station B



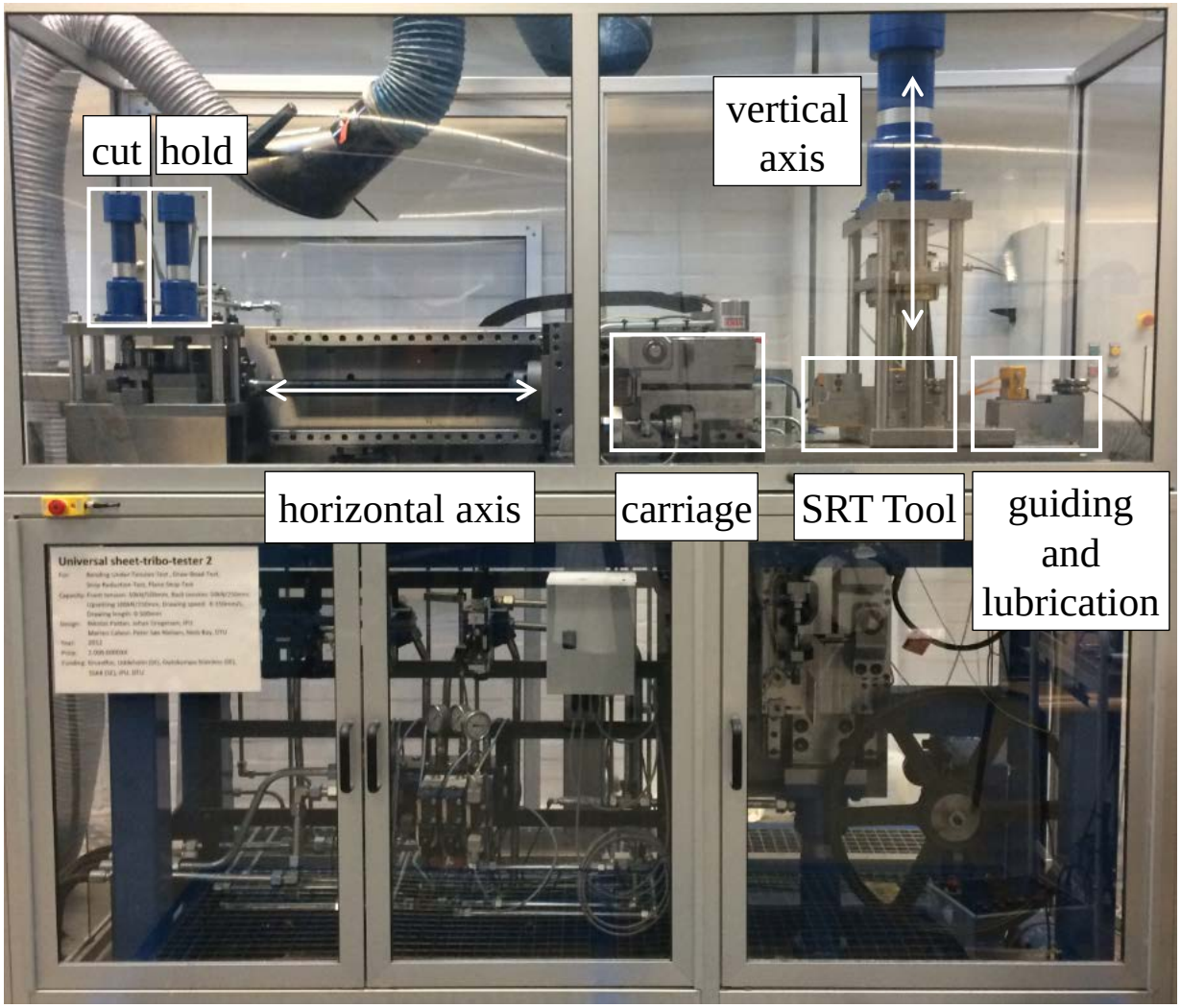



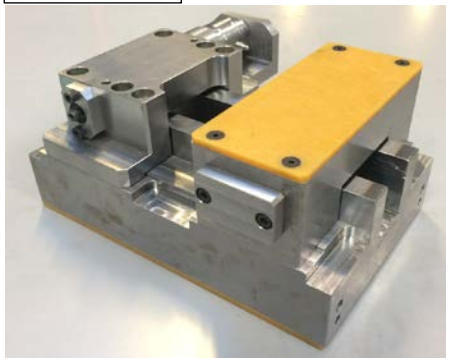
- Kistler Reaction Torque Transducer with measuring range ±25 Nm

1-isolation plate, 2-base, 3- heater block, 4-lower tool, 5-spring, 6-end holder, 8-upper housing, 9-bearing, 10-upper tool, 11- torque transducer base, 12- torque transducer, 13-adapter.

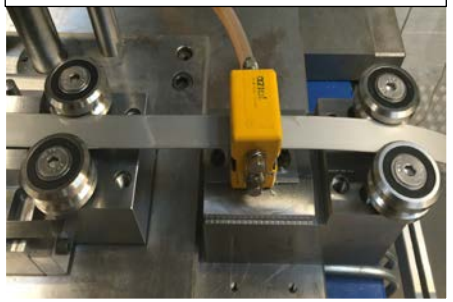
# Tribo-tester




SRT Tool



guiding and lubrication



# SRT Tool Capabilities

| Parameter | Value |
|---|---|
| pin diameter *[mm]* | 15 |
| pin material | VANADIS 4, hardened to 63 HRC and polished to Ra=0.06 mm |
| reduction *[%]* | 0-65, for strip thickness of 1 mm |
| drawing speed *[mm/s]* | 0-150 |
| sliding length *[mm]* | 0-500 |
| strip dimensions *[mm]* | [0-30]x[0-2]x[limited by the coil length] |
| number of stroke | limited by the coil length |

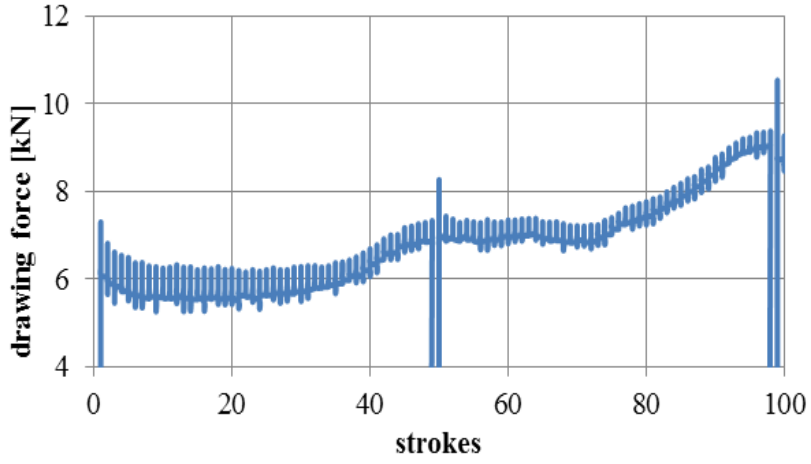
# Outline

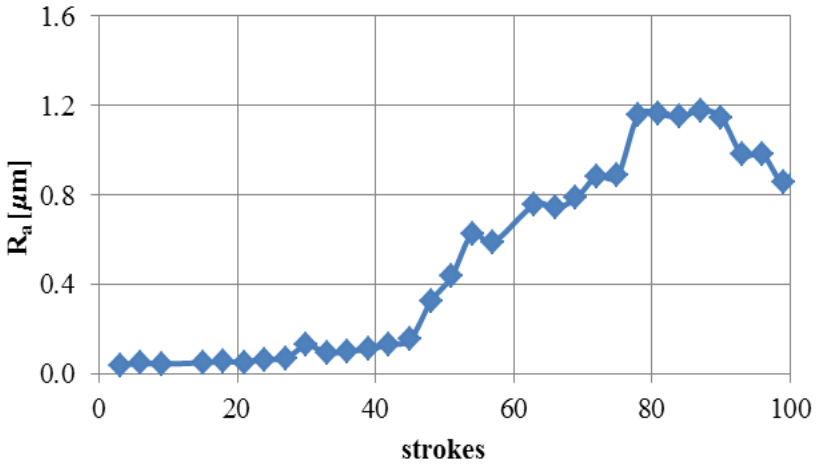
- Introduction
- Strip Reduction Test (SRT)
- **Screening Test**
- Production Platform
- Conclusion

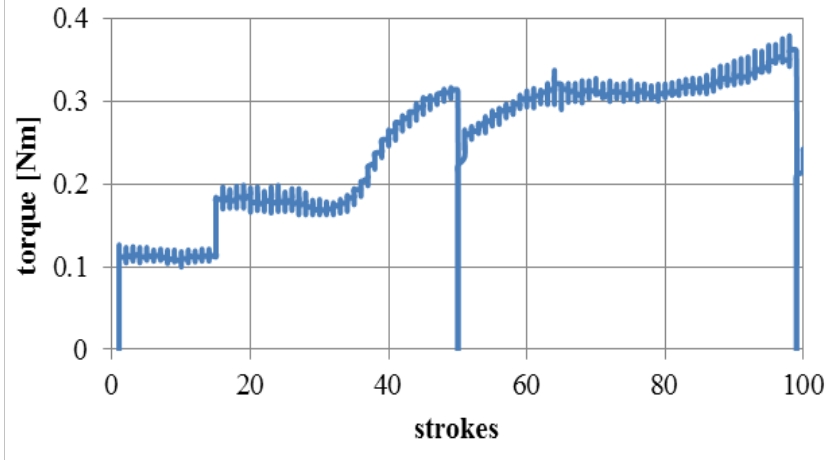
# Screening Test Conditions

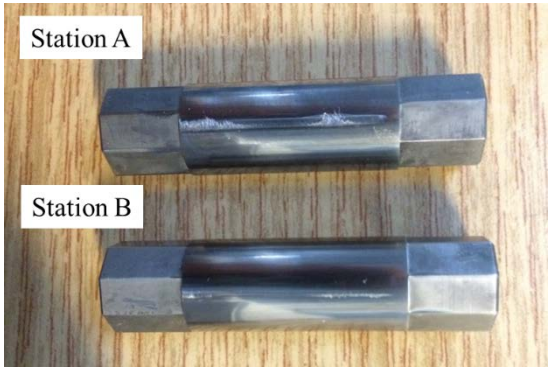
| Parameter | Value |
|---|---|
| strip material | EN 1.4307 |
| reduction *[%]* | 20 |
| drawing speed *[mm/s]* | 50 |
| sliding length *[mm]* | 10 |
| strip dimensions *[mm]* | 30x1 |
| number of stroke | 100 |
| lubricant | Rhenus (LA 722086) |

# Screening Test Results



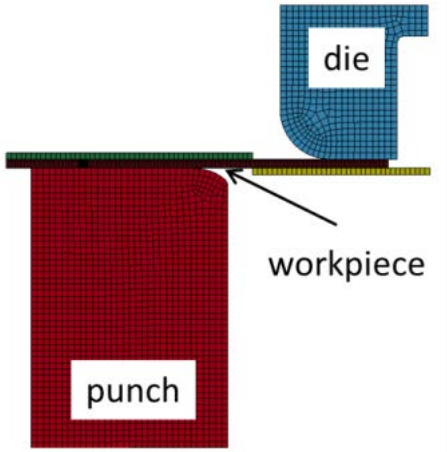



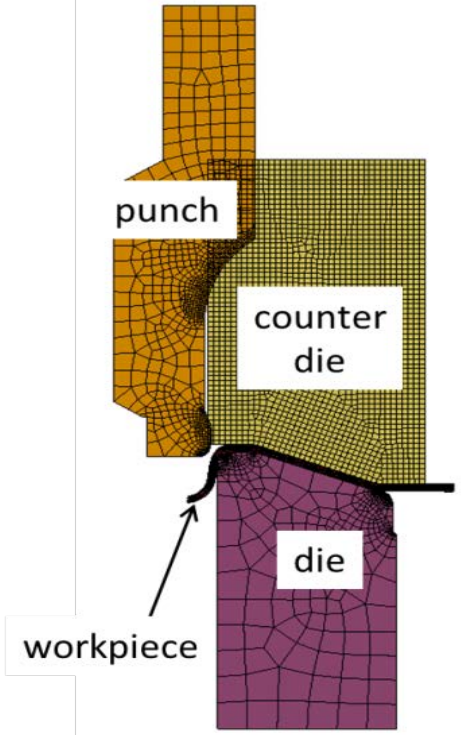
# Outline

- Introduction
- Strip Reduction Test (SRT)
- Screening Test
- **Production Platform**
  - Numerical Simulations and Validation
  - Comparison with SRT
  - Thermocouple Design
- Conclusion

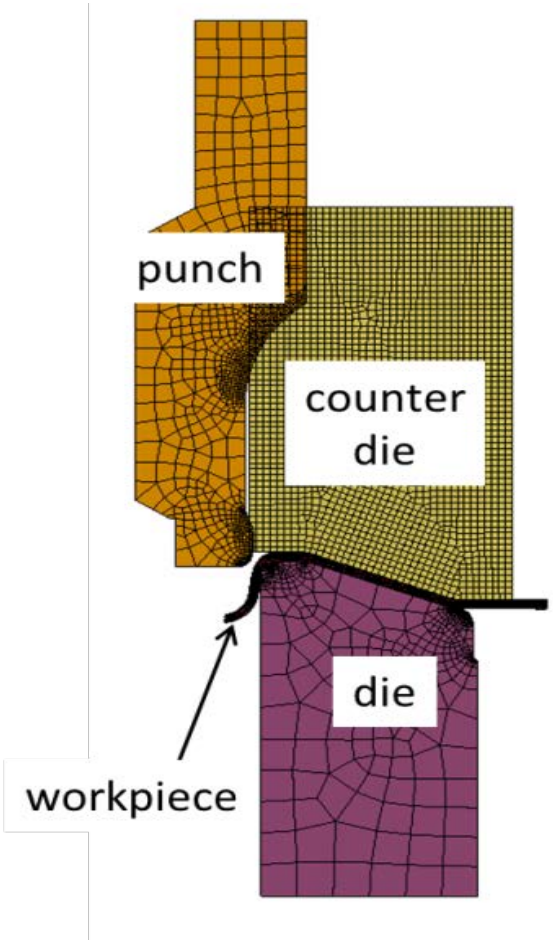
# Case Study

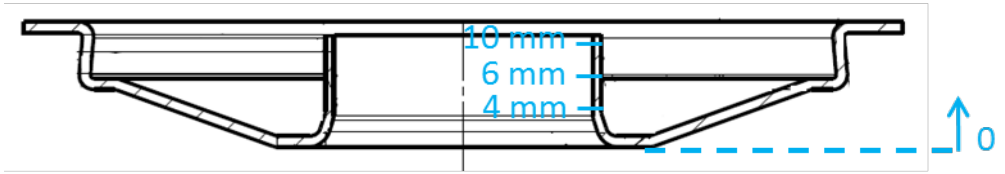




1. Deep Drawing
2. Reverse Drawing
3. Re-Drawing
4. Blanking
5. Ironing



# Validation of the Simulation

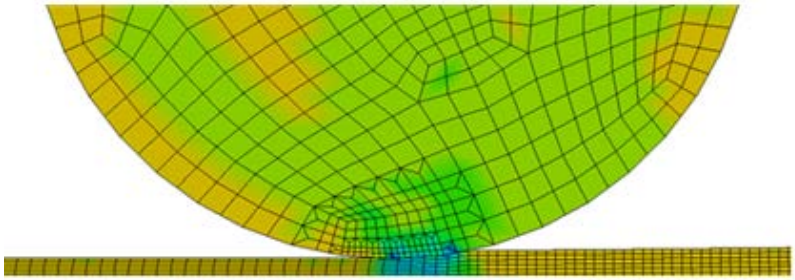


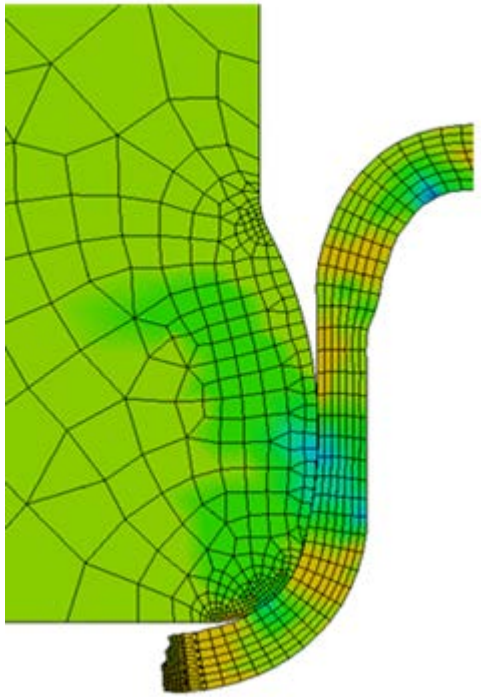

| Measurement level *[mm]* | *4* | *6* | *10* |
|---|---|---|---|
| Experimental thickness *[mm]* | 1.04 | 1.04 | 1.03 |
| Numerical thickness *[mm]* | 1.05 | 1.05 | 1.02 |

# Comparison of Local Normal Stress

SRT

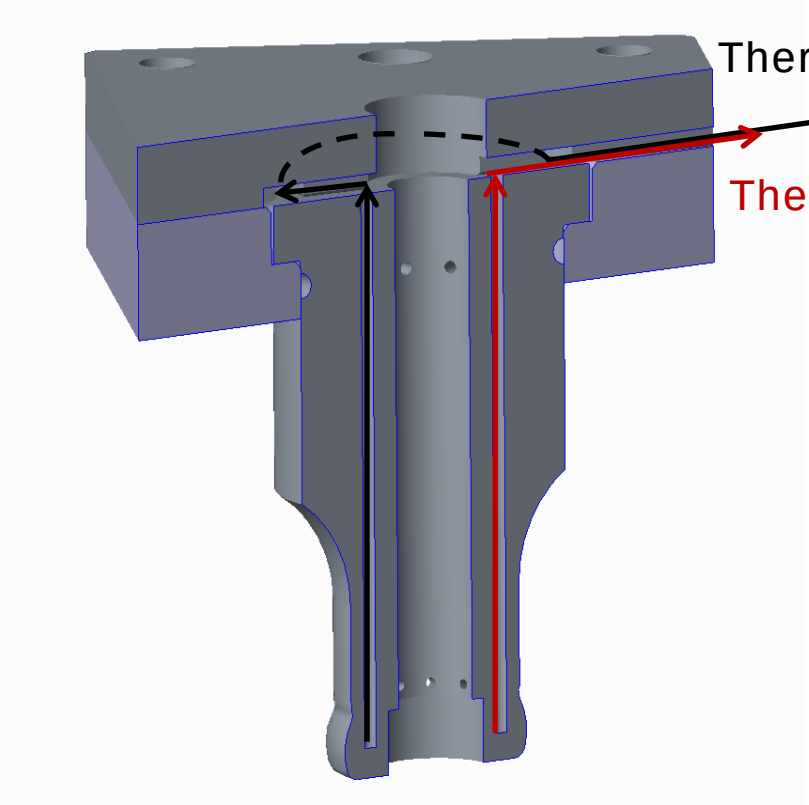


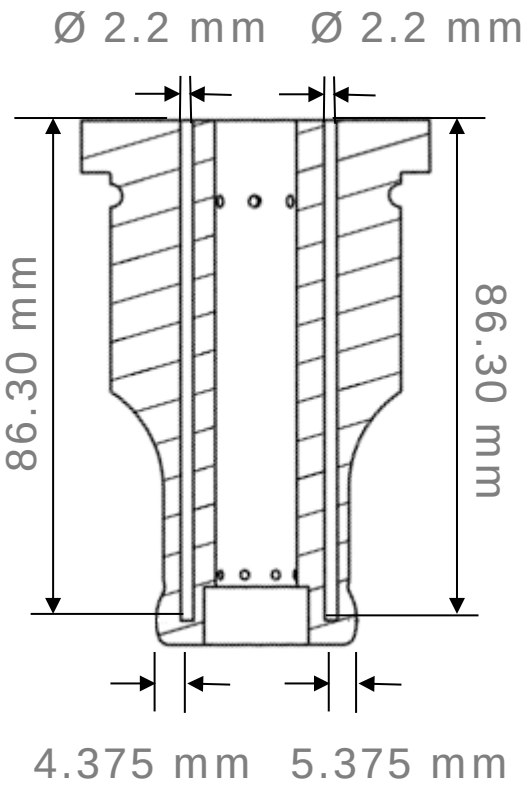
Ironing



# Thermocouple Design

## Production Platform



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- Screening Test
- Production Platform
- **Conclusion**
  - Summary
  - Future Work

# Summary

- Design of a new SRT tool to emulate the ironing process
- Implementation of the new tool to tribo-tester
- Screening tests
- Determination of the parameters at the production platform

# Future Work

- Testing of the selected production platform
- Testing of promising tribo-systems using simulative laboratory tests
- Thermocouple design and temperature measurement