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# Investigation of Corrosion Behaviour of Plastic Mould Steels under Oxygen Free and Oxygen Saturated Conditions

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## Introduction

- Steels for plastic injection moulds are available in different alloy compositions.
- Mechanical properties, such as wear resistance and hardness, are the most important properties.
- Corrosion resistance of these steels is also an important property, which is why there are high-alloy steel compositions.
- Open and closed systems for cooling of moulds → influence to the oxygen content.

## Project Idea

- Investigation corrosion behaviour of various typical plastic mould steels under high and low oxygen conditions.
- Developing of a mould tempering device that controls the oxygen content in a closed water-based liquid system

## Experimental

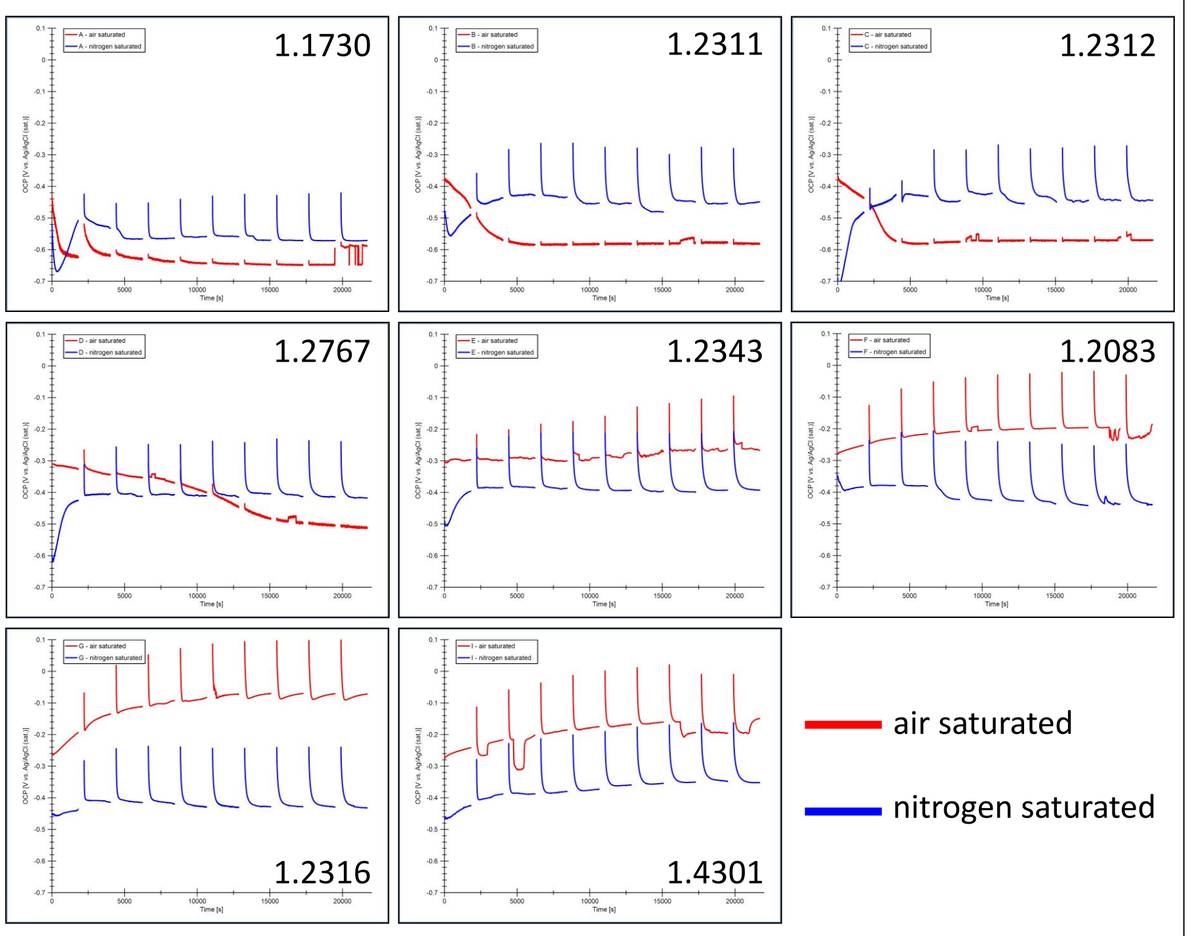
- Investigated plastic mould steels:

| Steel number | | C | Si | Mn | P | S | Cr | Mo | Ni | V |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.1730 | C45W | **0,444** | **0,298** | **0,78** | **0,014** | **0,0013** | 0,036 | 0,016 | 0,036 | |
| 1.2311 | 40CrMnNiMo8-6-4 | **0,378** | **0,265** | **1,5** | **0,022** | **0,0029** | **1,84** | **0,172** | 0,065 | |
| 1.2312 | 40CrMnNiMoS 8-6-4 | **0,369** | **0,32** | **1,67 (1,6)** | **0,019** | **0,07** | **1,85** | **0,216** | 0,025 | |
| 1.2767 | 45NiCrMo16 | **0,418** | **0,244** | **0,363** | **0,0067** | **0,0027** | **1,4** | **0,241** | **4,11** | |
| 1.2343 | X37CrMoV5-1 | **0,363** | **1,0** | **0,402** | **0,012** | **0,0038** | **5,0** | **1,19** | 0,132 | **0,323** |
| 1.2083 | X40Cr14 | **0,358 (0,36)** | **0,329** | **0,574** | **0,026** | **0,0056** | **12,68** | 0,099 | 0,312 | |
| 1.2316 | X38CrMo16 | **0,347** | **0,372** | **0,688** | **0,026** | **0,007** | **15,45** | **0,902** | **0,703** | |
| 1.4301 | V2A | **0,049** | **0,551** | **1,51** | **0,047 (0,045)** | **0,0024** | **18,55** | 0,415 | **7,84 (8,0)** | |

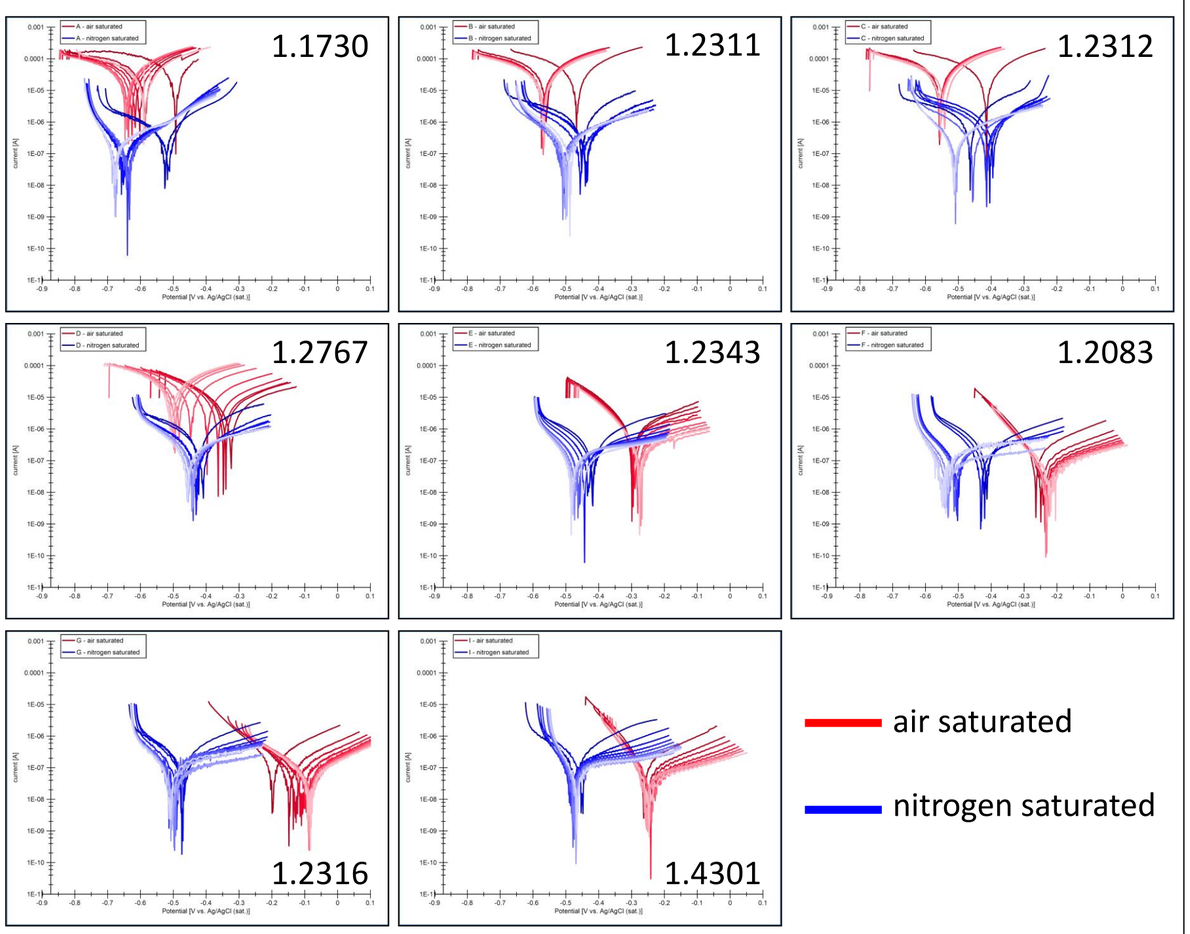
- Electrochemical investigations
  - 30 min OCP with following potentiodynamic measurement
  - 10 times repetition
  - Tap water, water hardness adjusted to dH°=5
  - Temperature 50°C
  - Air saturated → 100% $O_2$-saturation
  - Nitrogen saturated → 0 – 0,5% $O_2$-saturation

## Results

- OCP-Measurements, timerow:

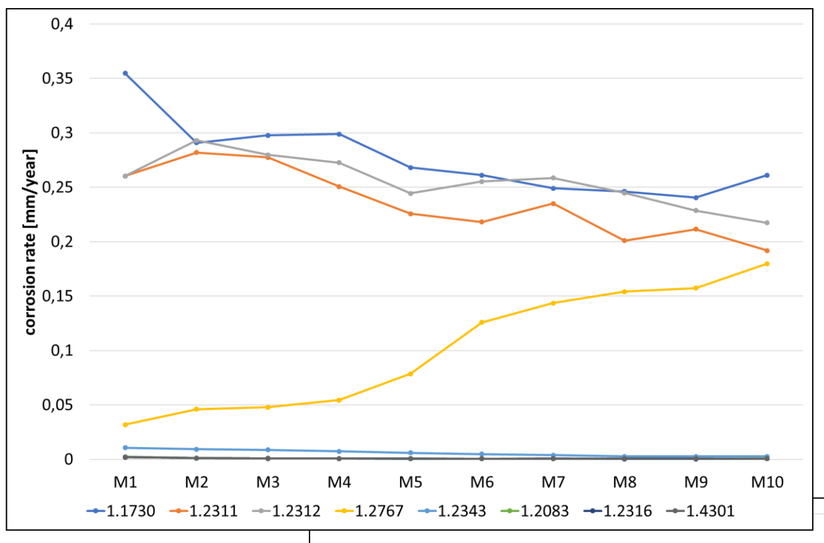



- Potentiodynamic Measurements



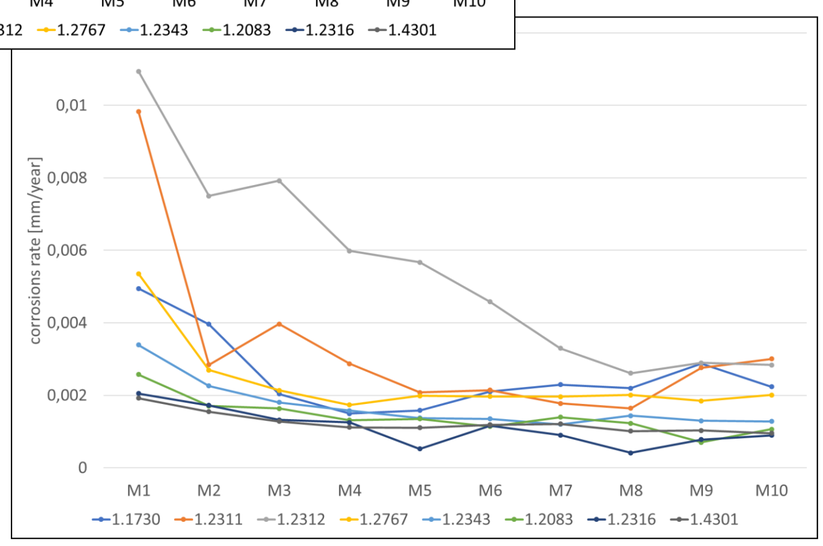
# Results

- Calculated corrosion rate:

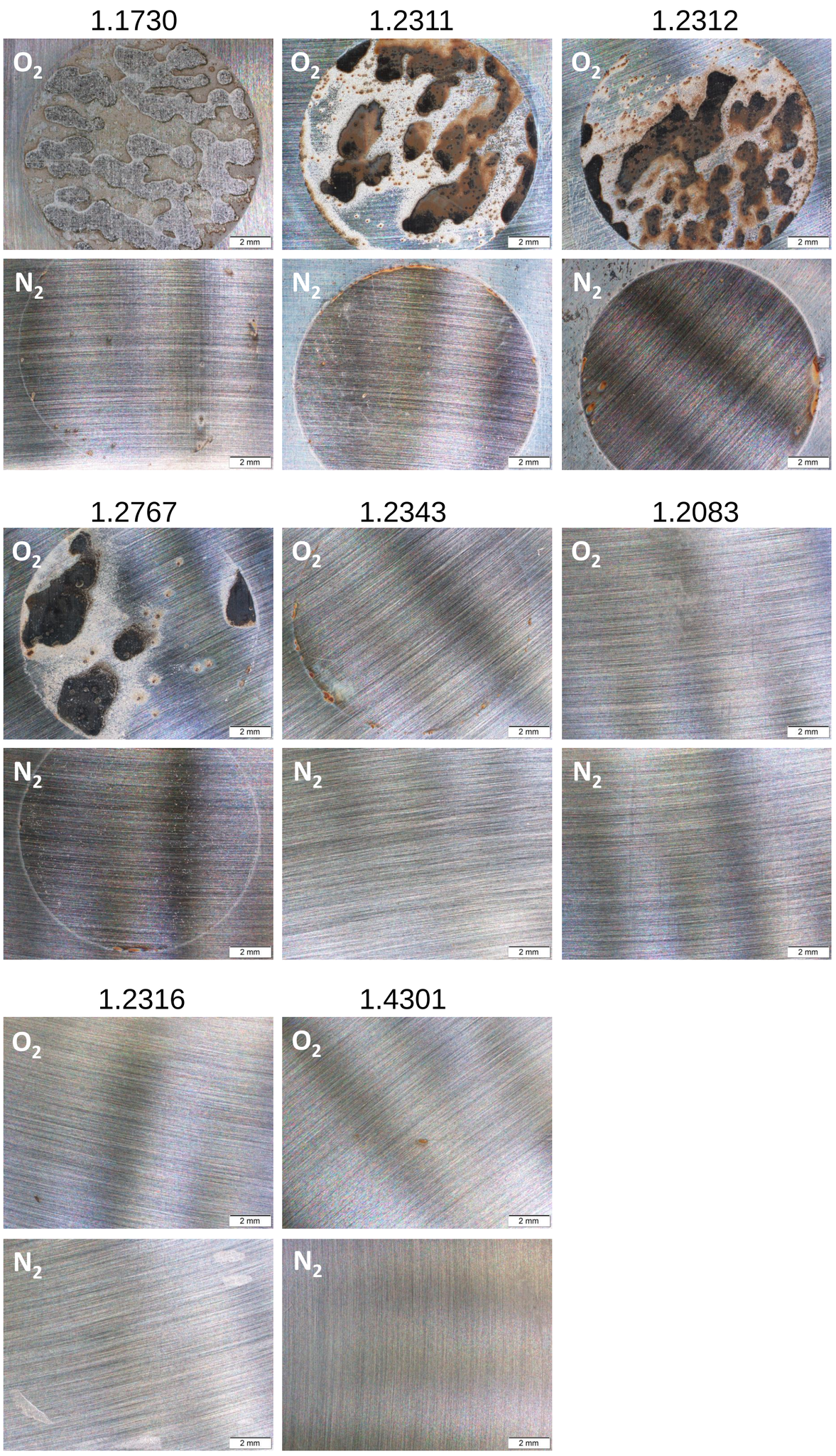



Oxygen saturated

Nitrogen saturated

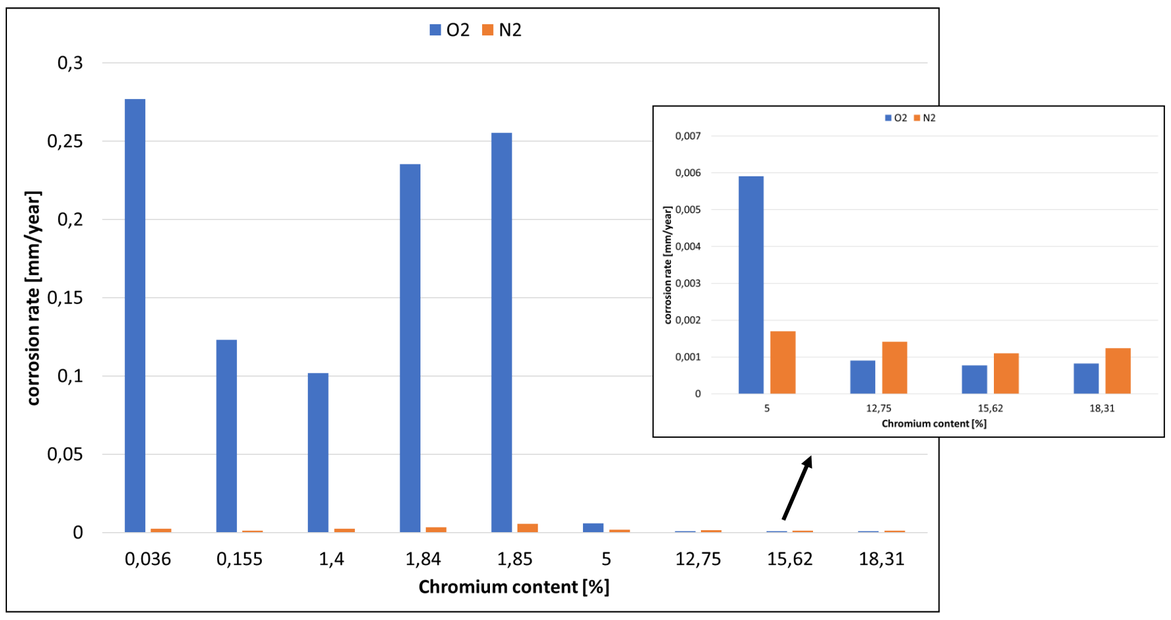



- Measurement Area:

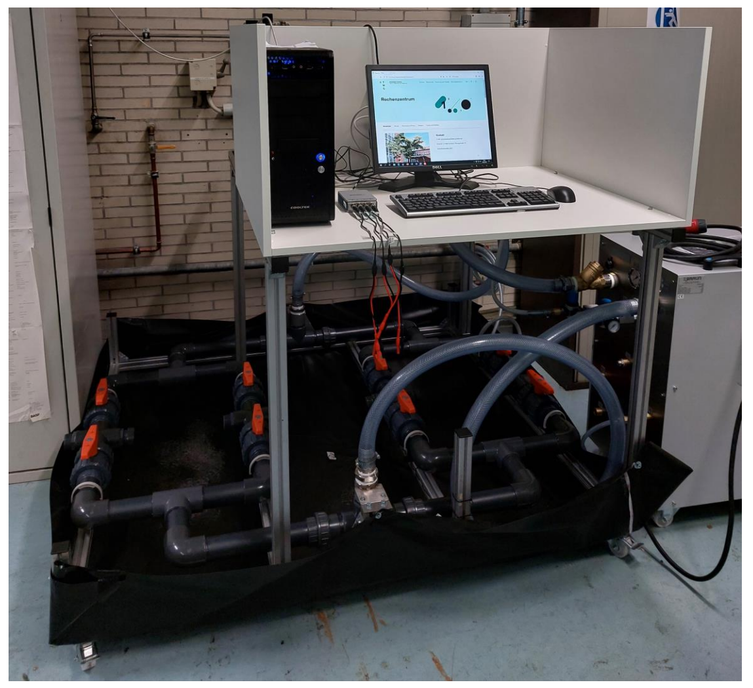



# Results

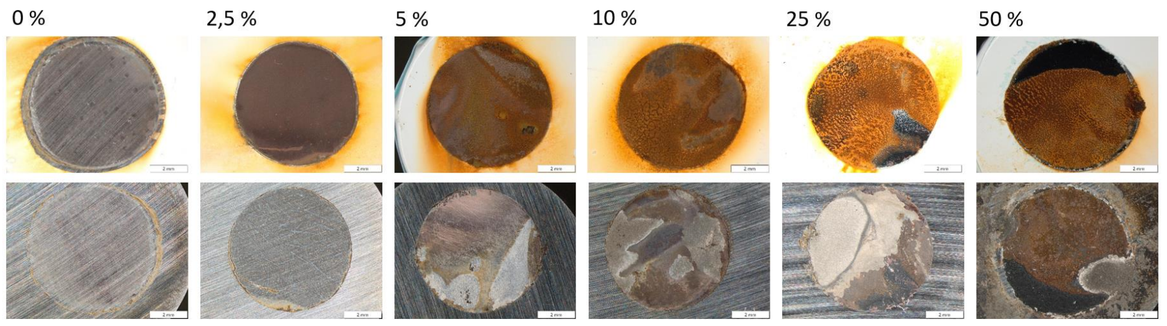
- Oxygen free conditions reduce the corrosion of steels with low chromium content:
  → OCP increase, Corrosion current decrease
- With higher chromium contents in oxygen free conditions:
  → OCP decrease, Corrosion current increase slightly




- Development of mould tempering device and test rig for corrosion experiments under different conditions.



- Control of oxygen saturation with injection of nitrogen.
- Testrow (1.2312) with different kind of oxygen contents in test rig with controlled oxygen concetration for 10 days:




- Corrosion attack decrease with increasing oxygen content

## Conclusions

- Oxygen content of cooling water has an influence to the corrosion resistance of different kinds of plastic mould steels.
- For low chromium contents in the steel, an oxygen free environment could be positive for corrosion rate, at higher chromium contents it could also be negative.
- The developed mould tempering device could help to decrease the corrosion rate in plastic mould forms made of low alloyed steels with lowering the oxygen content of the cooling water.


## Acknowledgements

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