UDDEHOLM


# Mselly Nzotta

## Uddeholms AB

## HAGFORS

**Senior Researcher, Process Development, Process Metallurgy**

# WELCOME TO UDDEHOLMS AB

# RESEARCH FUND FOR COAL AND STEEL

# #1 IN HIGH PERFORMANCE TOOL STEEL

# WELCOME TO UDDEHOLMS AB

**Development of steel grade related systems with low re-oxidation potential in ladle and optimized ladle glaze technique for improving steel cleanliness**

**UDDEHOLMS AB Contribution**
**KTH Contribution**

## General objective of the project

The **overall objective of the project** was to investigate the impact of reoxidation and ladle glaze on steel cleanliness during ladle metallurgy. The goal was to develop optimized steel grade related slag compositions with low potential for reoxidation and inclusion formation. Additionally the ladle glaze technique was improved to prevent the formation of non metallic inclusions in steel melts.

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1. INTRODUCTION: Uddeholmas AB
2. Process Overview
3. Project Team
    - Work Program
4. Plant reference sampling
    - Work Undertaken
    - Main Findings
5. Work done based on main findings
6. Conclusions

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# Total number of employees  around 780


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# Process overview

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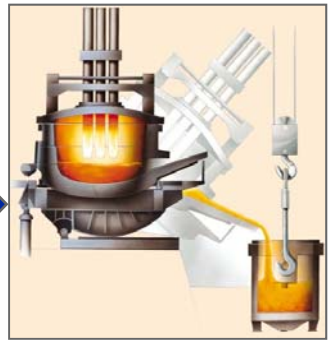
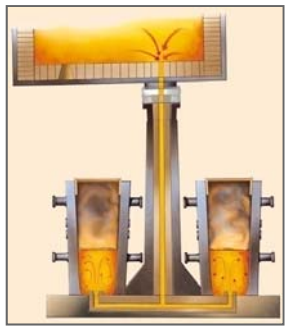
Raw material



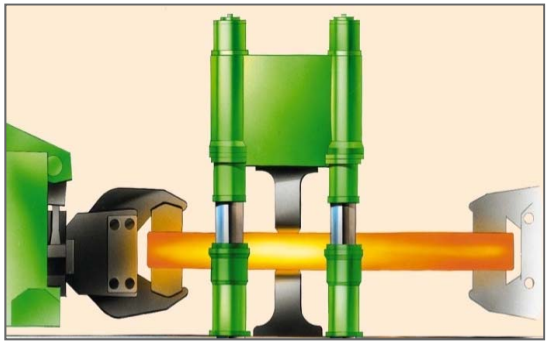
*Electric arc furnace*

*Ladle furnace*



*Vacuum-degassing*

Hot working



Heat treatment

Machining

Inspection & Testing

Stock

Customer

Customer

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# PROJECT TEAM

- TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG (TUFRG)
- KUNGLIGA TEKNISKA HÖGSKOLAN (KTH)
- UDDEHOLMS AB (UDDETOOL)
- SSAB OXELÖSUND AB (SSABO)
- THYSSENKRUPP NIROSTA GmbH (TKN)

KUNGLIGA TEKNISKA HÖGSKOLAN (KTH)
UDDEHOLMS AB (UDDETOOL)

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**UDDETOOL and KTH jointly work to:**

Define target values of amount, size distribution and composition of inclusions to meet the requirement of steel cleanness and product quality

Define investigate the interaction between deoxidized steel (low – high alloyed steel grades) melts and oxidic materials during the process of ladle metallurgy.

UDDEHOLMS AB (UDDETOOL)

## Scope of the work

**The focus of UDDETOOL activity was on**

- Al killed tool steels (AISI H13 tool steel (A), AISI H13 tool steel (B) AISI H13 tool steel (C))with high level of cleanness and low sulphur steel levels
- The work is devoted to define operating practice (slag composition) to be applied in re-heating and under vacuum operations

## UDDEHOLMS AB (UDDETOOL)

- **REFERENCE SAMPLING (STEEL AND SLAG SAMPLES)**
  - ❑ Selected steel grades: Steel A, Steel B and Steel C
  - Lower Cr contents to higher
  - Lower Si contents to higher

Aim:☞ to study effect of process slag on NMI composition

- **TRACER EXPERIMENTS**

Aim:☞ to study the formation of NMI by ladle glaze

KUNGLIGA TEKNISKA HÖGSKOLAN (KTH)

## Scope of the work

## KTH activity is based on:

- Thermodynamic calculations using Thermocalc to find the products of the reaction between ladle slag (glaze) and refractory
- The effect of the ladle glaze in generating inclusions
- Sampling of ladle glaze and ladle lining from UDDETOOL and SSABO

**Description of the activity**

Main activities were:

1. Development of thermodynamic model to describe the interactions between steel, slag and inclusions
2. Tuning and refining of the model on the basis of industrial experimental results
3. Development and validation of operating conditions

## SSAB OXELÖSUND AB (SSABO)

1. REFERENCE SAMPLING (STEEL AND SLAG SAMPLES)
   - Carbon steels

## THYSSENKRUPP NIROSTA GmbH (TKN)

1. REFERENCE SAMPLING (STEEL AND SLAG SAMPLES)
   - Stainless steels

## RESULTS

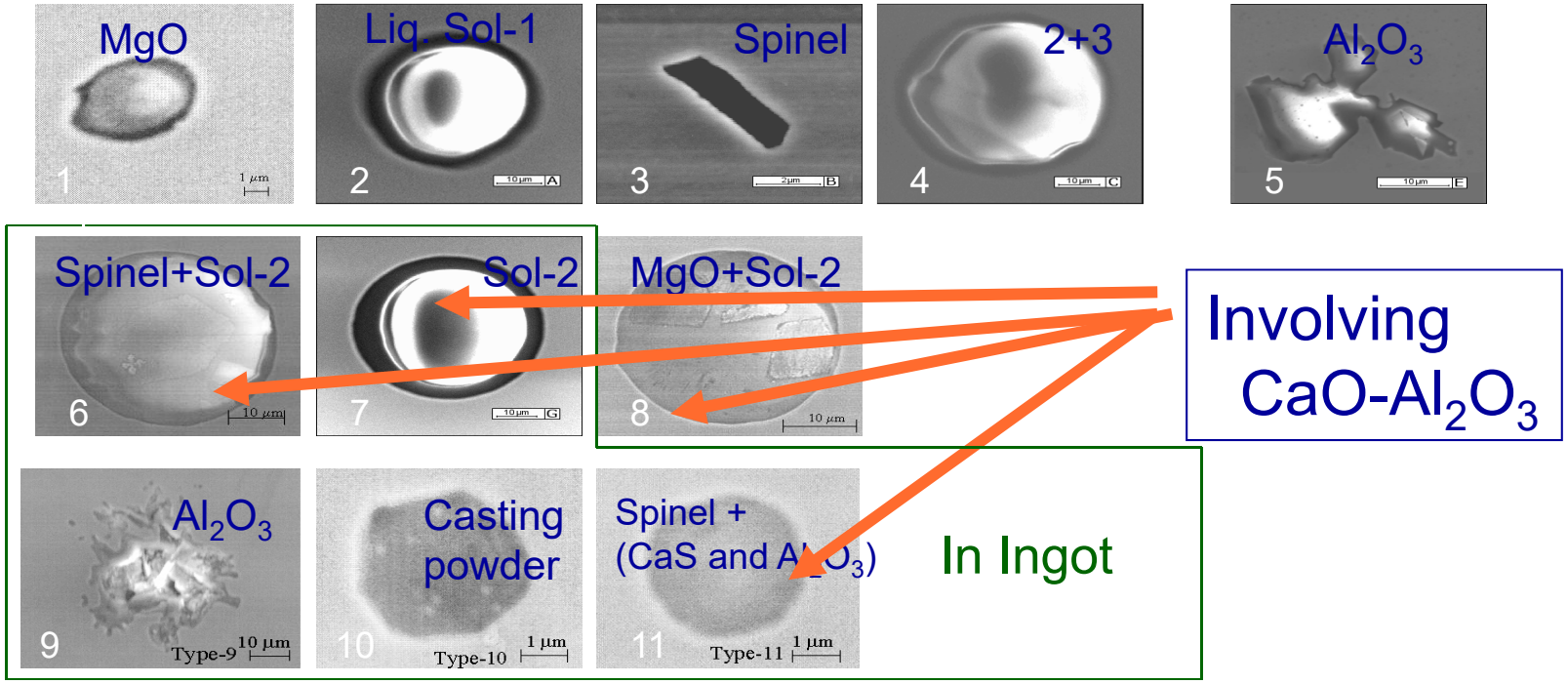
1) Reference sampling in the case of NIMAX, MIRRAX and ORVR 2M has shown:
   - ❑ Target slag not reached
   - ❑ Slag carry-over is a probable course..
   - ❑ Re-oxidation during ladle treatment
   - ❑ There is are chemical development of NMI from EAF and new NMI as a result of de-oxidation + ladle glaze
2) What to do?
   - ❑ The issue of slag carry-over is to be addressed
   - ❑ %-SiO2 to be reduced to avoid formation of ladle glaze

# UDDEHOLMS AB (UDDETOOL)

Demo_Avslaggning_Mitt.avi

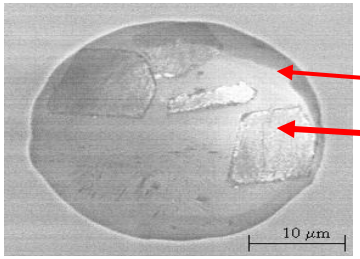
# Generation of Ladle Glaze

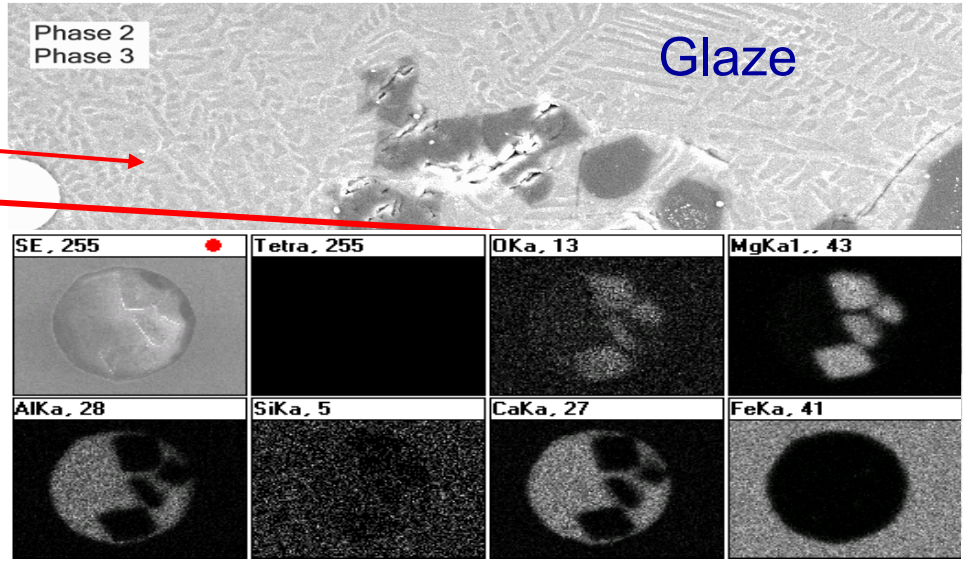
## Types (Based on the study at Uddeholm)



# FROM LADLE GLAZE

Type 8




## Composition:

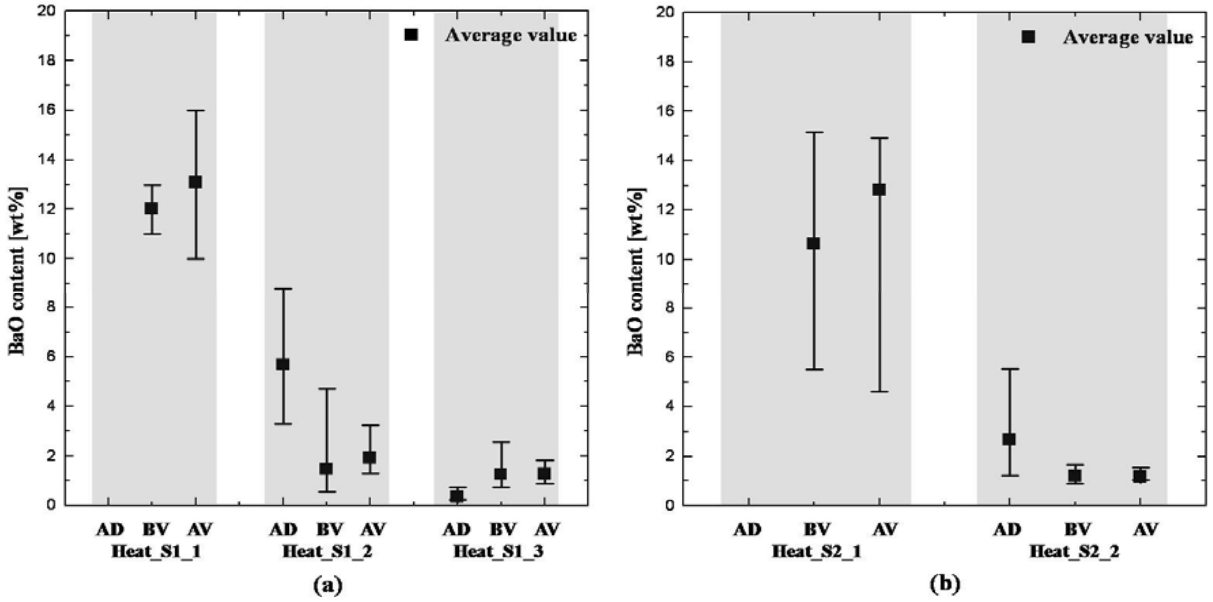
Phase 1: MgO

Phase 2: $3CaO \cdot Al_2O_3$

Phase 3: $CaO\text{-}Al_2O_3\text{-}MgO\text{-}SiO_2$

# Industrial Trials with Tracer

- The formation of non-metallic inclusions by ladle glaze
- The effect of slag on the non-metallic inclusions



## Conclusions

The following objectives were met:

- Significant reduction of the detrimental non-metallic inclusion content in steel or conversion to less harmful non-metallic products (chemistry or size). - More precise process control. - Increased productivity (throughput and yield) due to reduction of process disturbances caused by inclusion-related phenomena.

THANK YOU!