Valorisation and Dissemination of Secondary Metallurgy Technology

DissTec

Industrial feedback: Tundish metallurgy and inclusion engineering

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Innovative tundish management for final steel thermal and chemical adjustment

(TUNDJUST, RFSR-CT-2005-00013)

- *Centro Sviluppo Materiali (CSM)*
- *Cogne Acciai Speciali (CAS)*
- *VDEh-Betriebsforschungsinstitut (VDEh-BFI)*
- *Deutsche Edelstahlwerke (DEW)*

Work aimed at performing tundish metallurgy = inclusion design for improved workability steel

identification of inclusion composition

thermodynamics

'anorthite'

identification of suitable mixing conditions

Fluid-dynamics

Benefits: costs saving – efficient routes

Identification of operating practice for successful castingmetallurgy)

Application

Technical scenario

Requests to favour efficient material addition

a) The material should have residence time in steel long enough to <u>melt</u> completely

b) The material should have residence time in steel long enough to <u>mix</u> completely

c) Strategy for inclusion should be chosen (for inclusion engineering, they should be formed, not removed)

d) The control of the composition should be considered ('melt composition stability')

e) Techniques for regular addition

Operational scenario

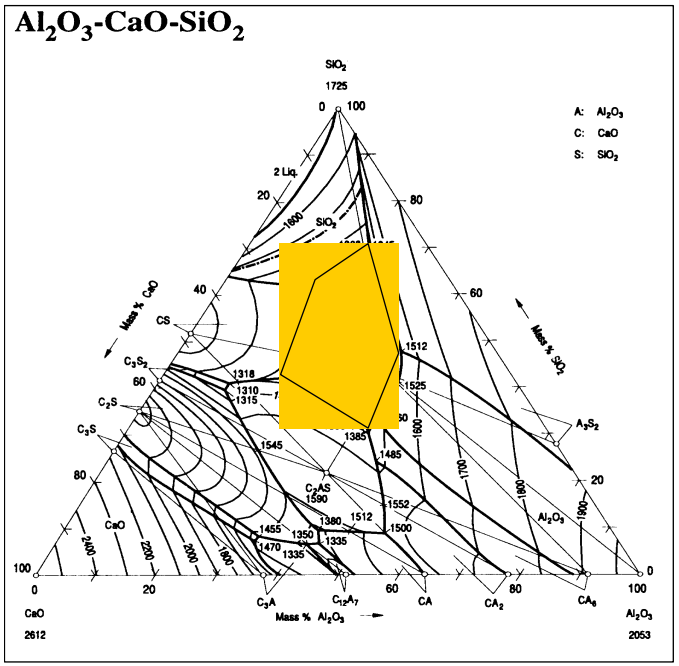
Cogne Acciai Speciali reference configuration : 4-strand billet tundish
Presence of pads and multiple hole baffles

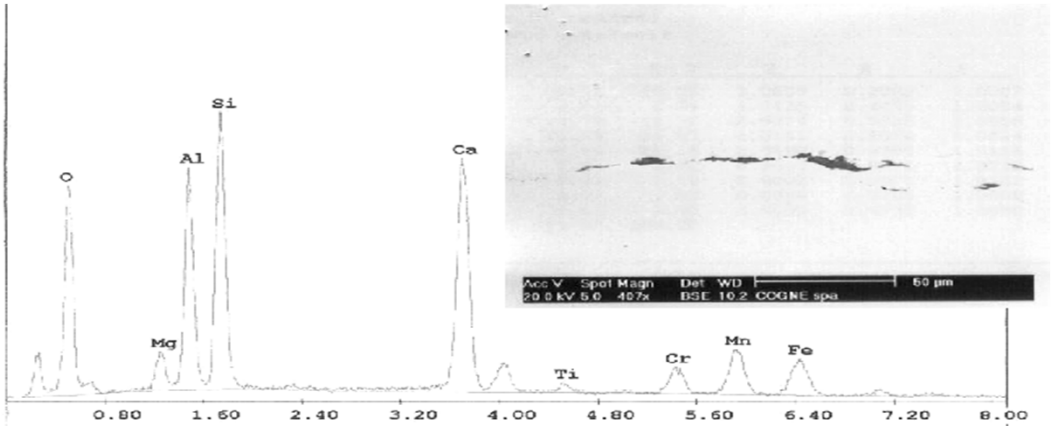
Addition of alloying elements :

- in the pad
- in the zone within the holed dams

Metallurgical scenario

Inclusion engineering strategy:
'High drawability steels': needed **high deformable inclusions (e.g., anorthites)**



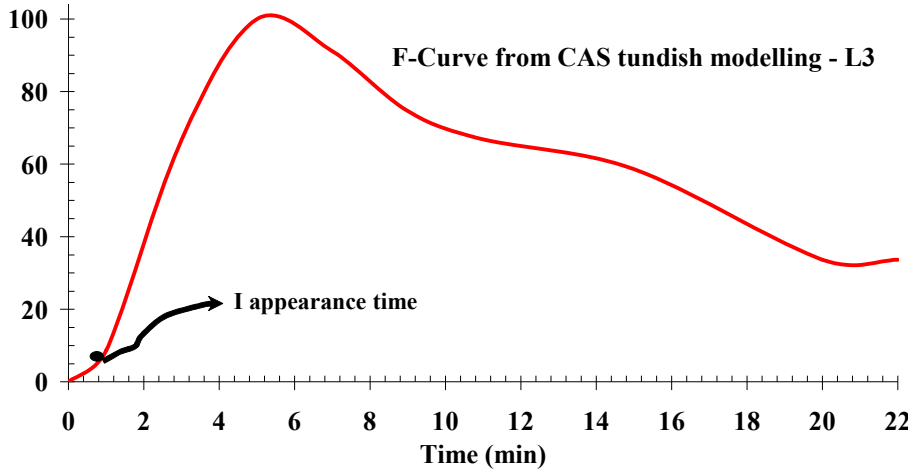


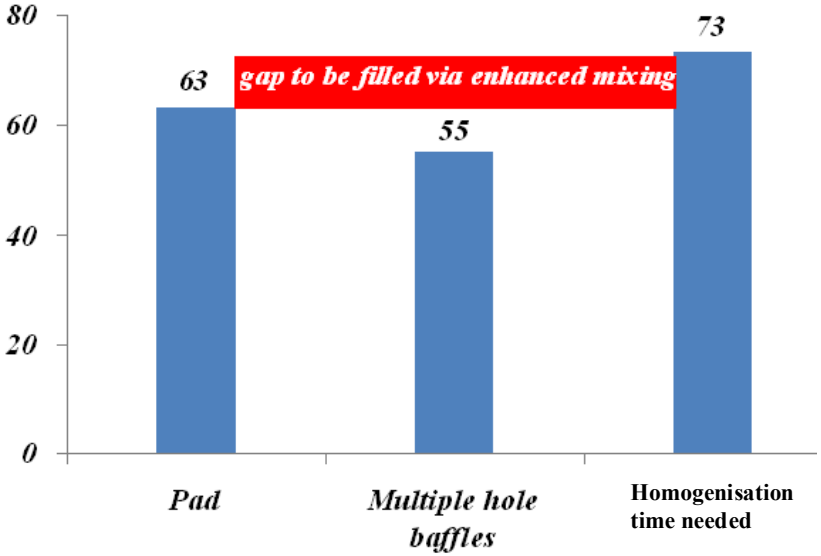
✓ ***Adequate material for addition previously identified after thermo-dynamic modelling***

BFI MPI Materials Processing Institute Excellence in Materials & Process Innovation CRM GROUP swerea MEFOS CSM Centro Sviluppo Materiali

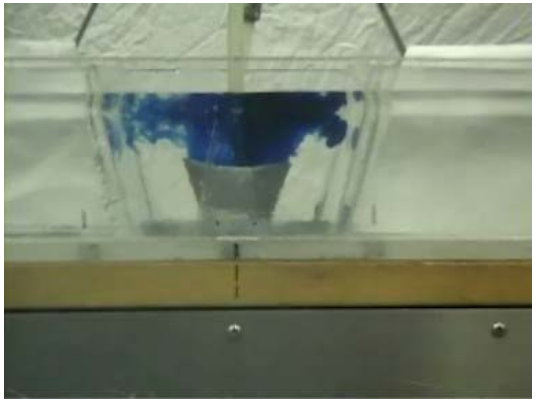
Need of enhancing mixing/dissolution of material injected in tundish

Evaluation criterion: to assess the target inclusion population, melting-dissolution time needed should be less than minimum time to reach strands.

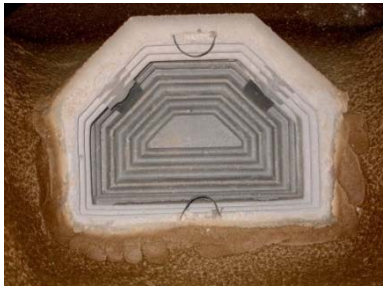




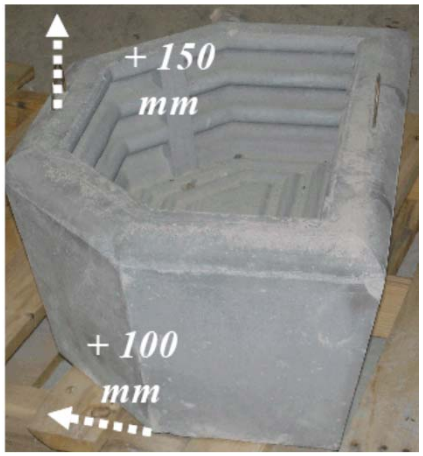
This minimum time is the 'first appearance time' (of steel at exit) The comparison of results is an information on the expected mixing behaviour (a sort of 'index of dissolution')

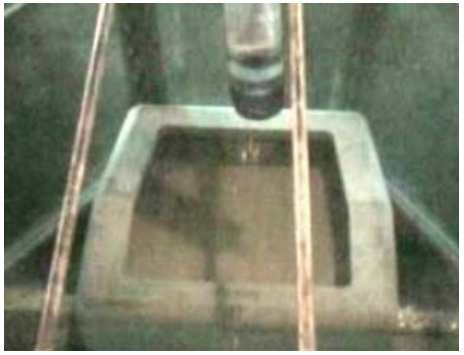


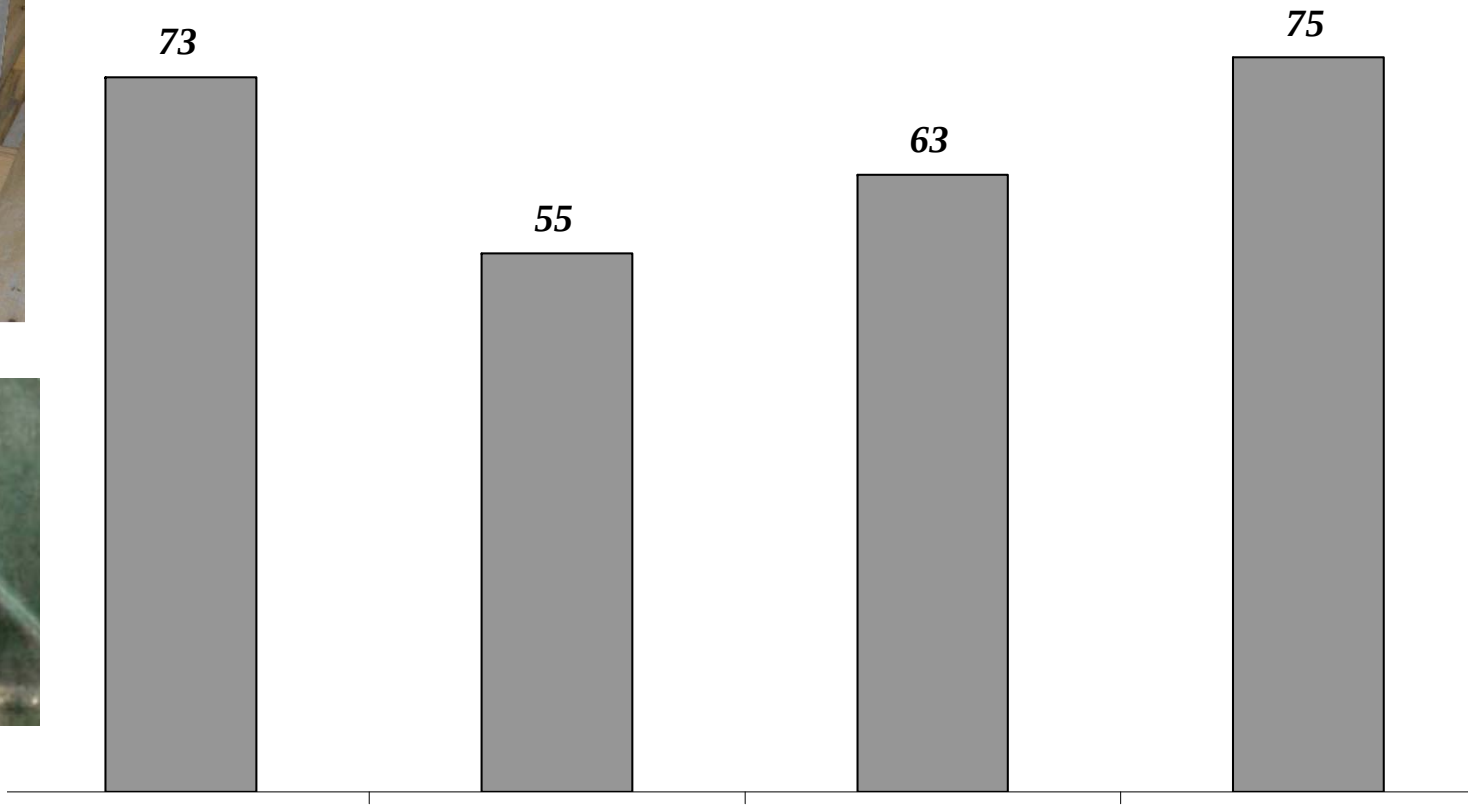
Flow water modelling features



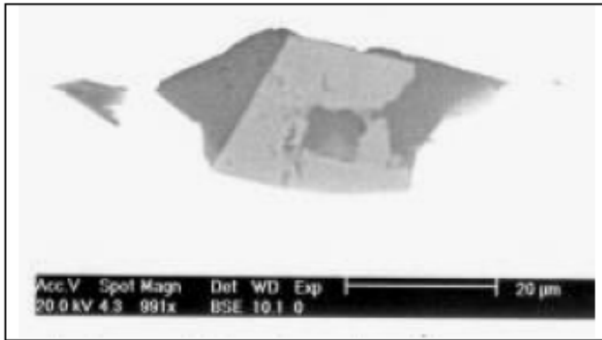
Enhanced pad allowed to reach the minimum steel residence time to attain complete added material dissolution/mixing



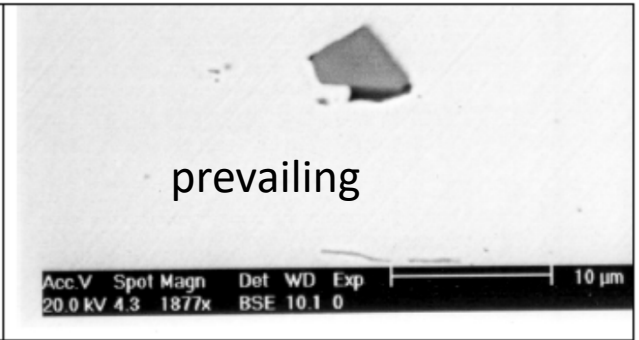




Trials for inclusion engineering : history			
	Trial I	Trial II	Trial III
Steel	F304 L	F304L/1	304R
Oxygen content (ppm)	100	130	60
Ca-Si : kg/ton	0,6	0,75	1,2
Flow modifier	BAFFLES	BAFFLES	IMPACT BOX
Result	Very few anorthites	Very few anorthites	50% anorthites content with respect to target



'Globular' – anorthite



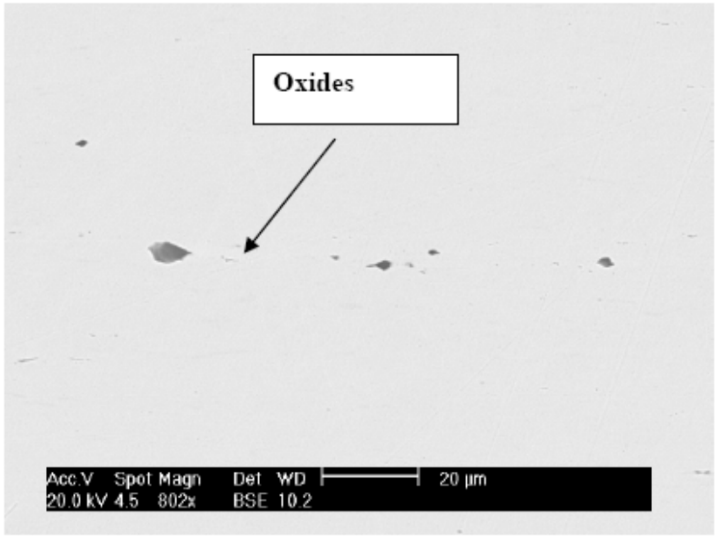
'Spherical' – Cromite

Successful testing: with enhanced pad

operating conditions

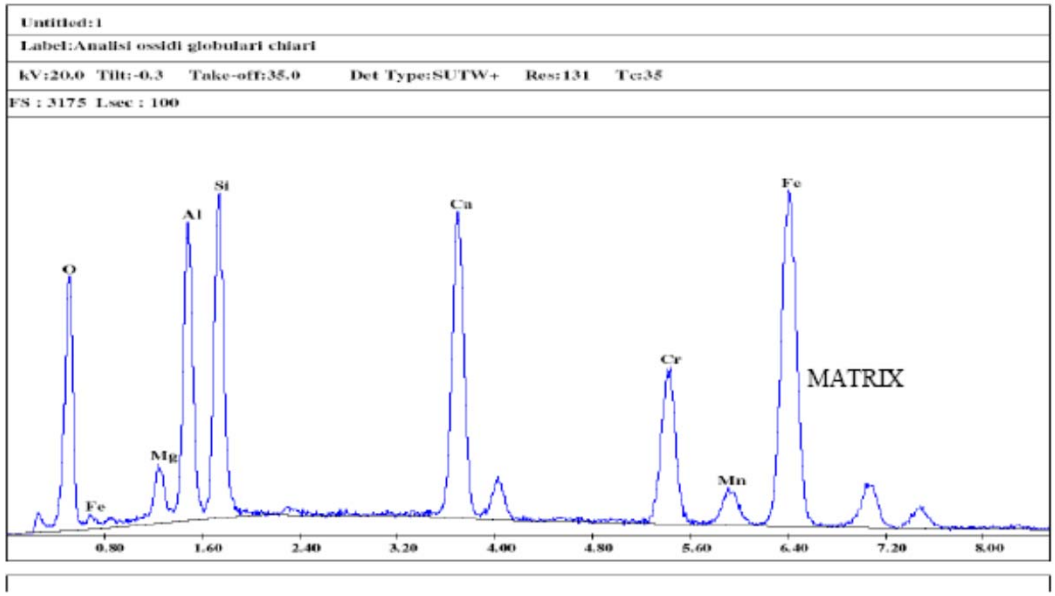
Steel grade	304R	
Flow modifiers	***pad***	
Weight/temperature	12 tons, 1503°C	
Billet size	Square 160 mm	
Casting speed	1.5 mt/min	
Added material	CaSi ferroalloy (30/60) ϕ 2-4 mm	
Addition point	(Bags) into the pad	
Addition rate: filling: 3 Kg at 2 t – 5 Kg at 7t – 5 Kg at 8 t - 5 Kg at 11 t •steady-state casting: 1.2 ton/min		

Standard pre-treatment before inclusion engineering operations



SEM image

Desired composition achieved

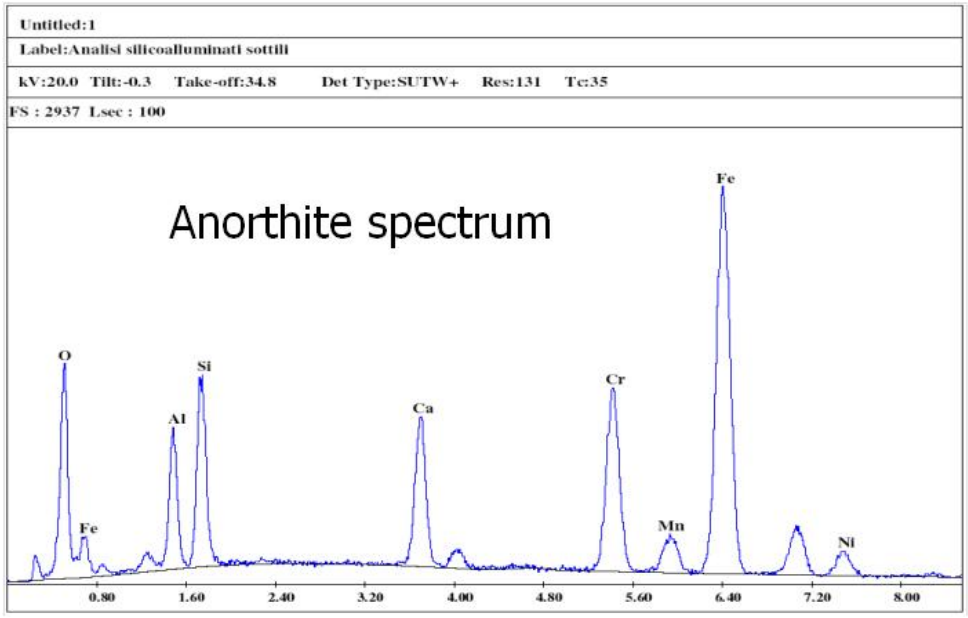


spectrum

Work aimed at performing tundish metallurgy = inclusion design for improved workability steel

'anorthite'

Successful tests: target composition achieved and operating practice defined and added in route



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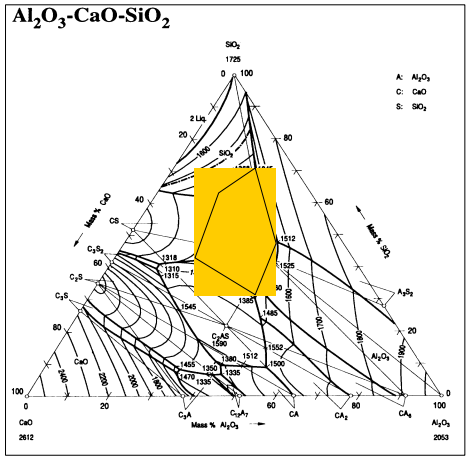

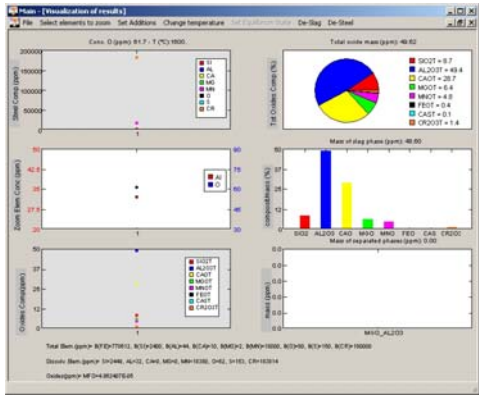

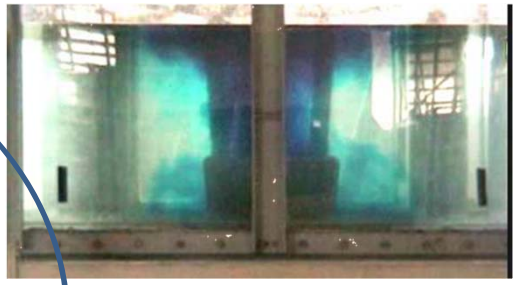

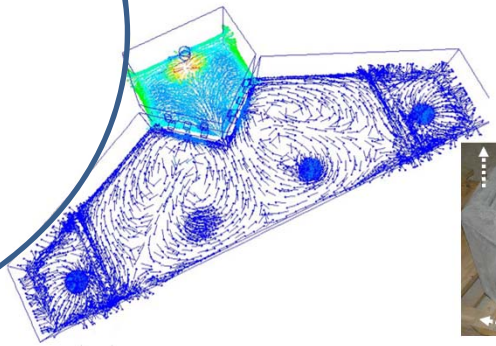

Tools synergy