11-13 September / Eylül 2014
TÜYAP Fair, Convention & Congress Center, İstanbul
7th International Ankiros Foundry Congress
7. Uluslararası Ankiros Döküm Kongresi

«Effective Filtration of Steel Castings»

«Çelik Dökümde Verimli Filtrasyon»

David Hrabina
(Foseco)

3.Oturum: Döküm Teknolojileri Demir - Çelik

3rd Session: Casting Technologies Iron - Steel

Oturum Başkanı/Session Chairman: Seyfi Değirmenci (Componenta Döküm. Tic. San. A.Ş.)

Cost Effective Filtration of Steel Castings

ANKIROS Istanbul Turkey

12th September 2014, David Hrabina

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Targeted Achievement

- Why to filter?
  - To eliminate surface defects
  - To reduce welding re-work
  - To deliver castings faster
  - To improve casting's quality
  - To reduce production cost
  - ……and so on

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Problem to Overcome

- Why are some foundries still reluctunt to use filters broadly?
  - Because of fear from:
    - Filter's clogging by inclusions
    - Filter's breakage
    - Metal freezing on filters surface [Short pour]
    - Extended pouring time
    - Increased pouring temperature
    - …….and so on

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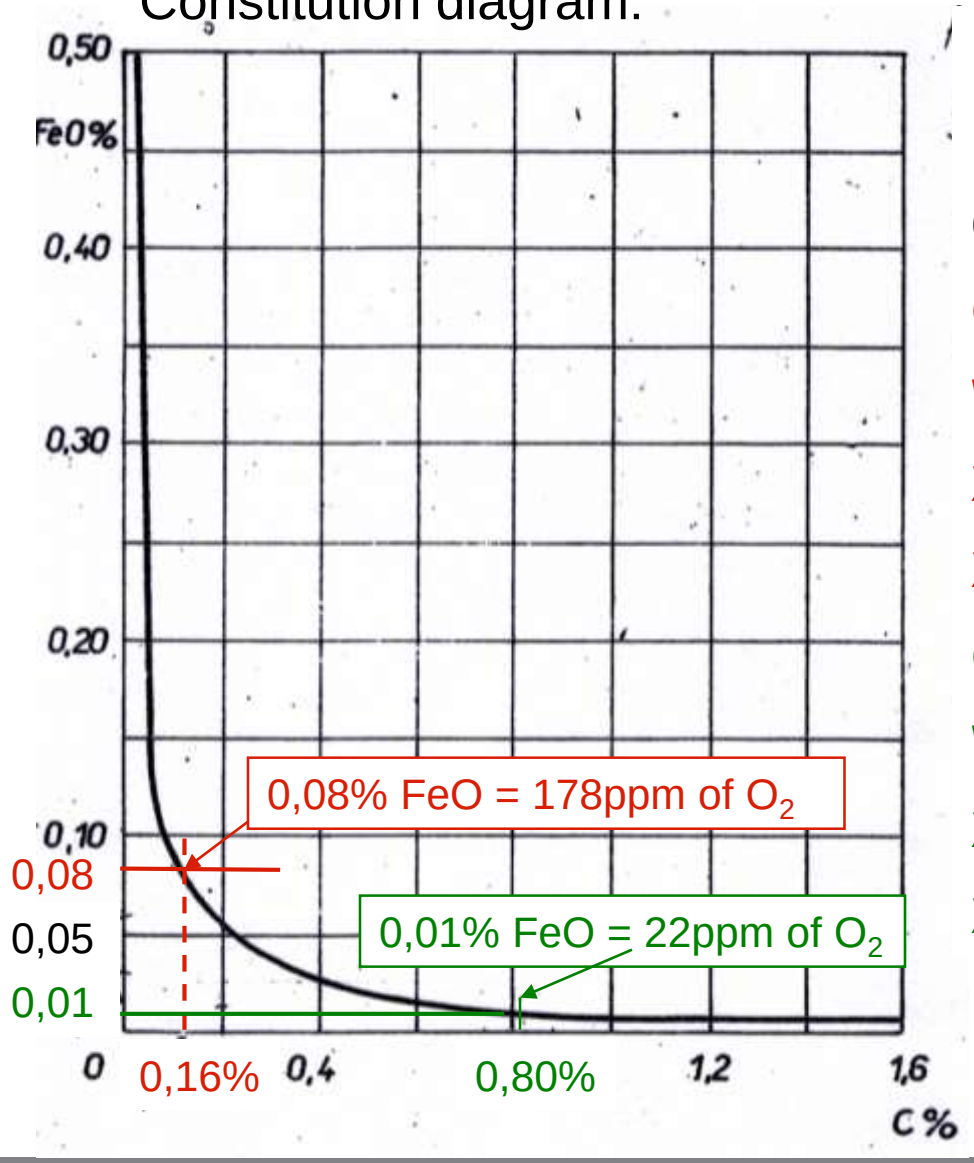
Oxygen solubility by carbon content during tapping temperature 1620°C

Constitution diagram:



Fe + ½ O_2	=	FeO
Fe density	=	56g/mol
Oxygen density	=	16g/mol

GS 16Mn5

What is oxygen content, if C is 0,16% ?

X = 0,08%

X =16/72 * 0,08 = 0,0178% = 178ppm

GS 80Mn5

What is oxygen content, if C is 0,80% ?

X = 0,01%

X =16/72 * 0,01 = 0,0022% = 22ppm

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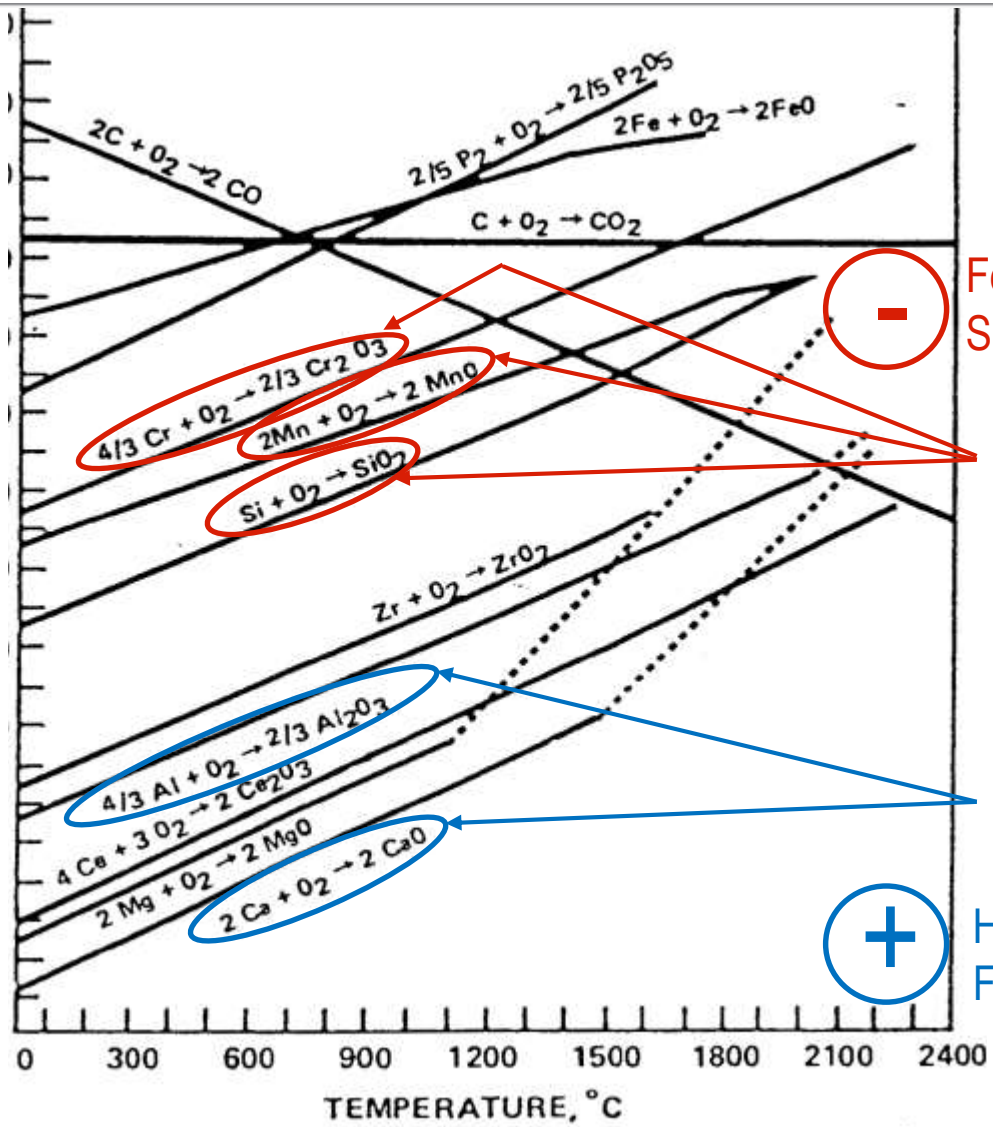
Metallurgical Influence to Metal Cleanliness - Flow Performance



1.—Standard free energies of formation of some oxides[1].

Fewer Gibbs free energy
Slower formation

Oxides reducing filtration capacity stronger

Oxides reducing filtration capacity fewer

Higher Gibbs free energy
Faster formation

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Oxygen Killing by Aluminium Prior final Alloying as FeSi, FeMn, FeCr etc.

- Aluminium bricks are forged to steel bar to be sunk under the slag level

Final alloying just after Aluminium is dissolved

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Never Do any “Final Steel Alloying” into the Pouring Ladle

Any alloying in the ladle creates oxides inhomogenous metal composition and temperature in the ladle. Even argon purging cannot guarantee alloys are properly desolve.

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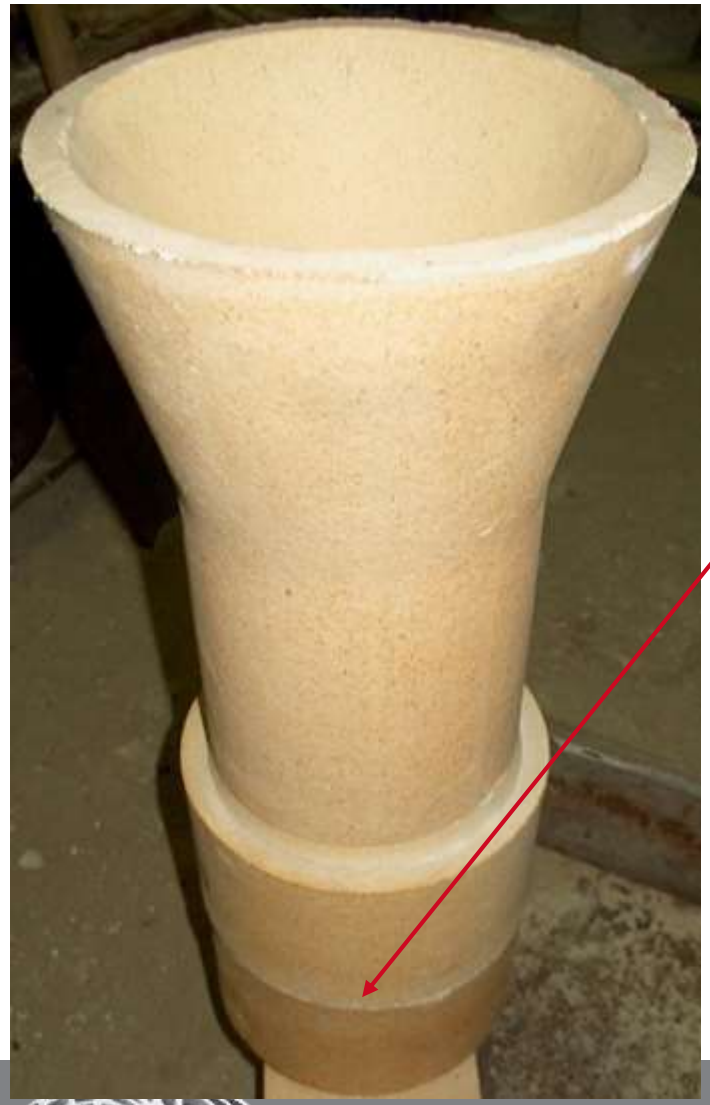
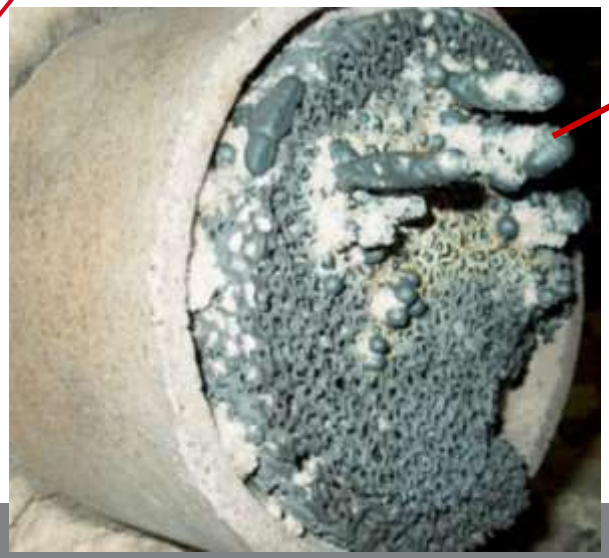
Material GS 20Mn5. STELEX PrO diameter100mm - Immediately Clogged

FeSi added as de-oxidatant into the ladle just during tapping from arc furnace





Just few grams of metal pass through filter

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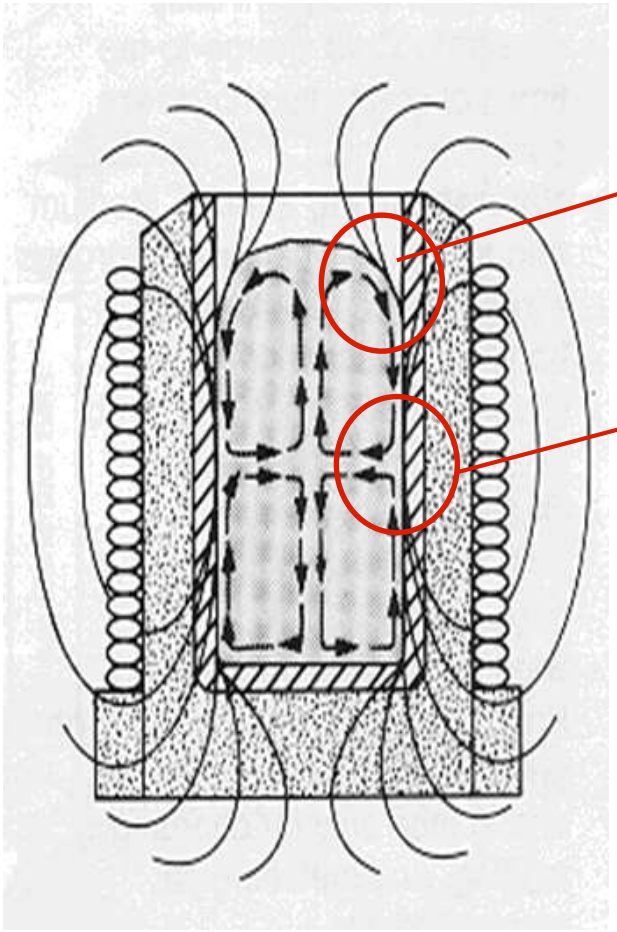
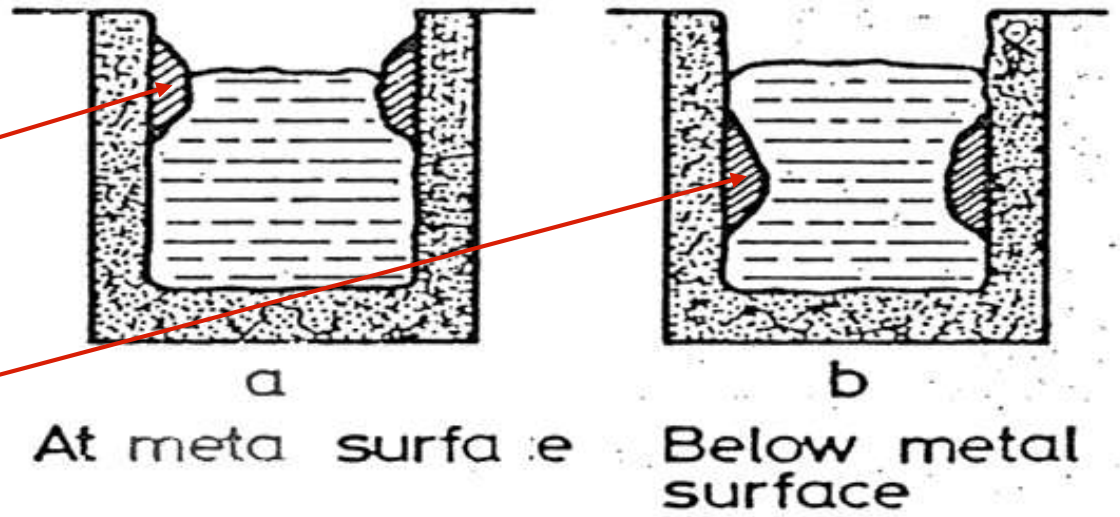
Increasing filtration capacity with Argon through a Purging Plug in the furnace





Positions in which slag build up may occui in coreless induction furnaces

Argon purging in the furnace by PP may improve the following:

- Reduce slag build up
- Reduce metal burn off
- Increase lining life time up to 20% compare to standard process
- Provides cleaner metal with much higher fluidity – opportunity to reduce pouring temperature

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Dirty Ladles

Slag flows down partially during heating

Dirty ladle ready for tapping from furnace

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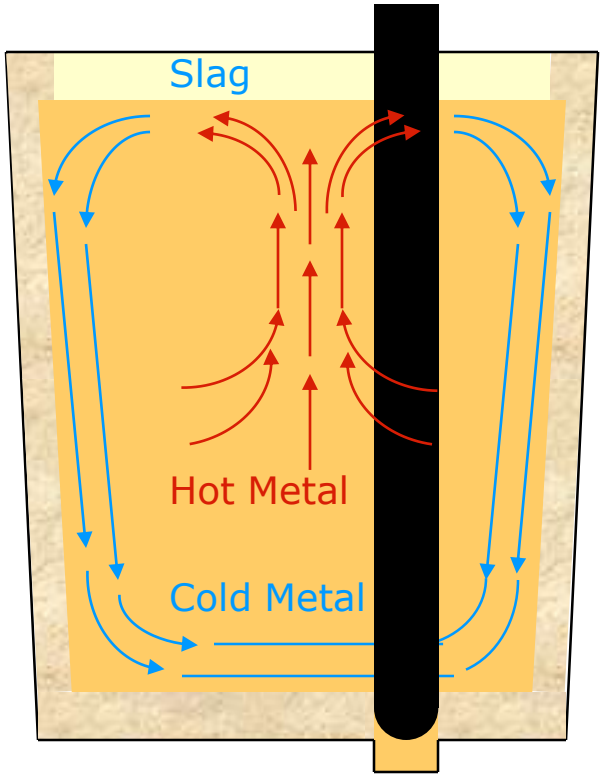
Thermal Gradients & Rotational Flow



- Thermal gradients cause rotation flow patterns within the ladle
- Tangential forces within the ladle during pouring cause rotational flow patterns (i.e. vortexing) within the ladle

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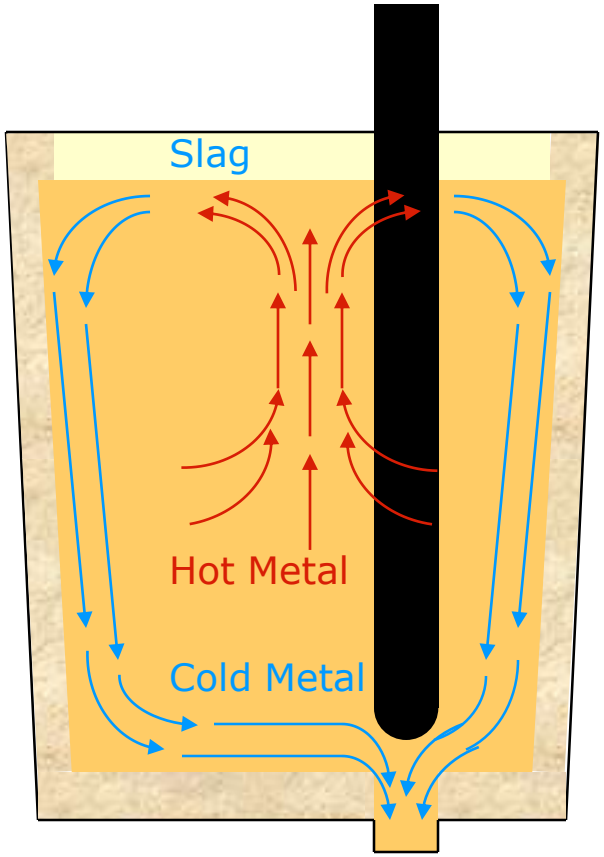
Bottom Pour Ladles



- The first metal leaking the ladle is the coldest and dirtiest poluted by inclusions
- Metal's temperature is reduced even more by passing through cold nozzle and entering cold running system
- Warmer metal from the ladle center comes later, when filter's surface might be already frozen

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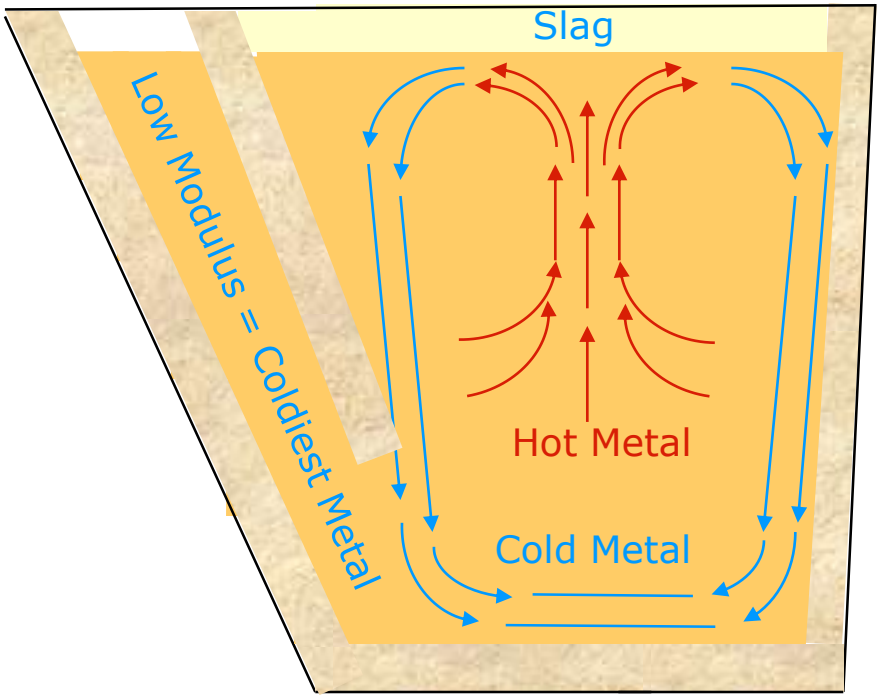
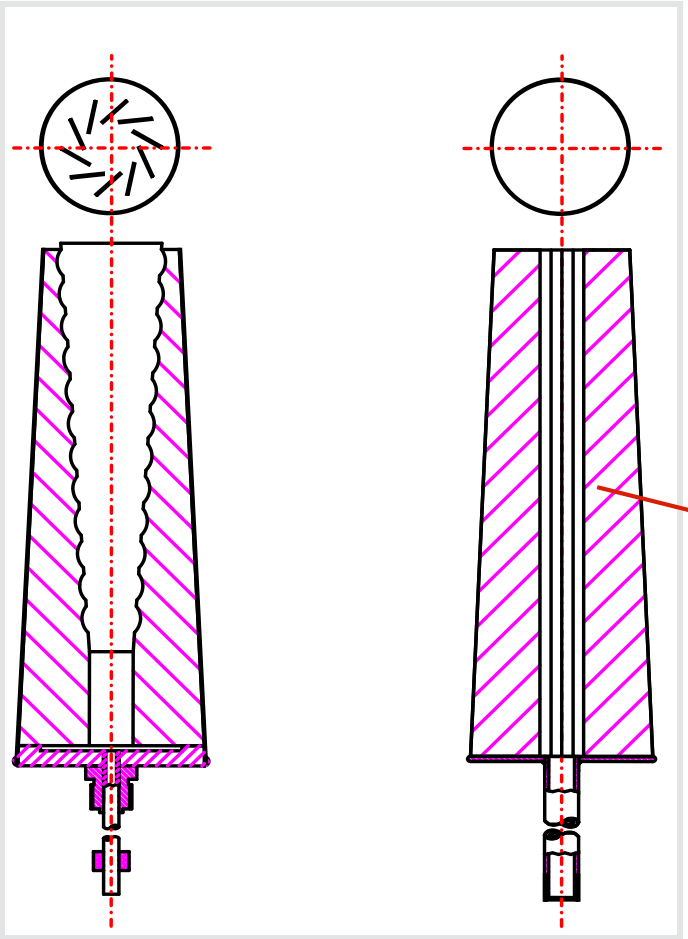
T – Pot Ladles



- Also romat T-pot ladle comes cold metal firstly to mould
- Solution might be wasting first few kg of cold metal from ladle prior to mould pouring

Purging Plug System



A 5 ton capacity KALTEK ladle with Purging Plug ready to use

In-line Filtration

- Filter's freezing – "Short pour" is especially dangerous for little castings with minimal metal volume surrounding filter's surface

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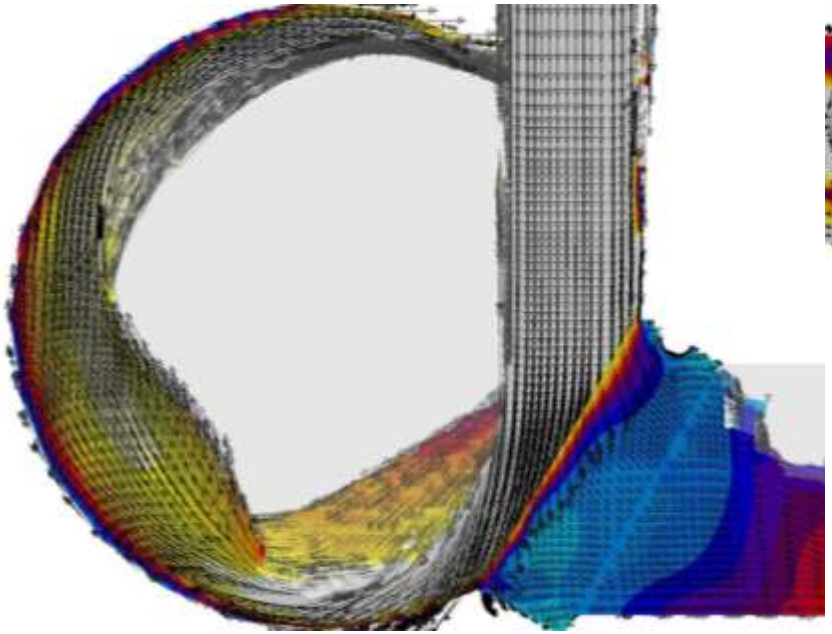
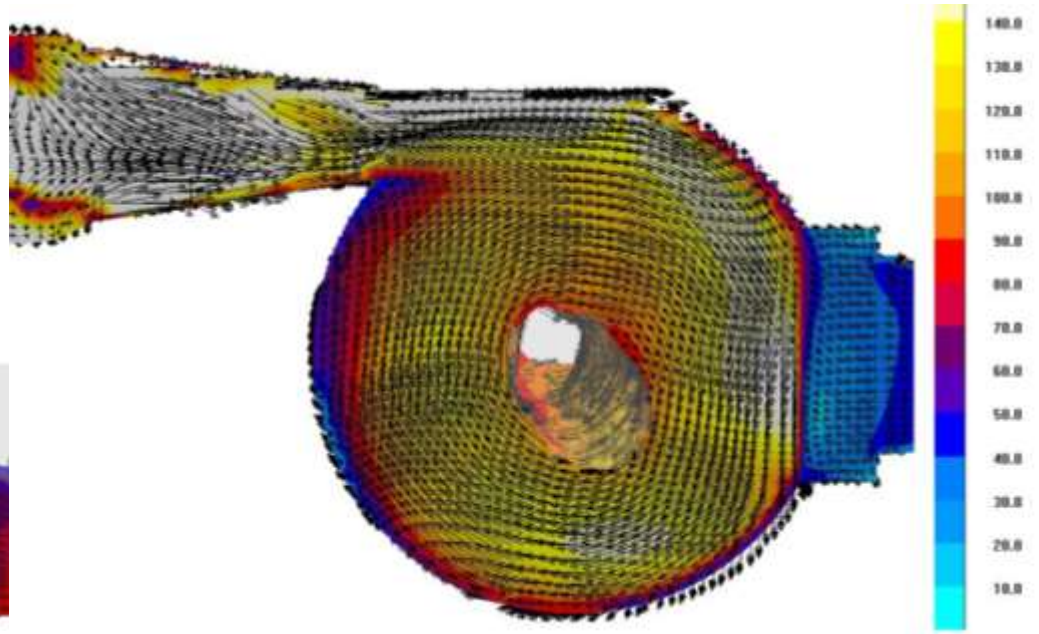
Swirling Filtration Chamber - TURBOPRINT





Vertically swirling Print

Horizontally swirling Print

- The first cold and dirty metal entering mould cavity might not always stay on filter's surface.
- It might just pre-heat filter's surface and be centrifuged off while freshly incoming warmer metal starts to pass filter through.

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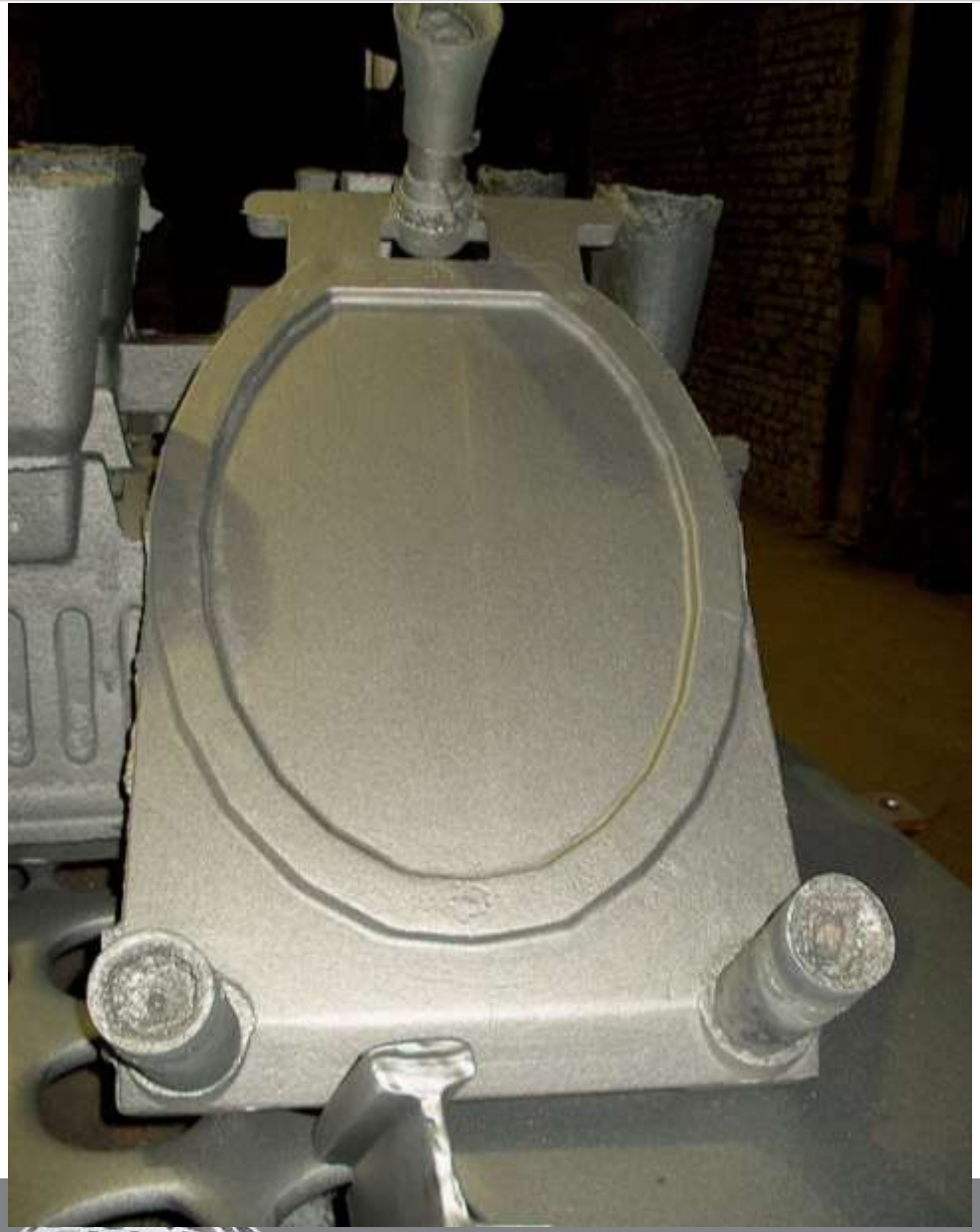
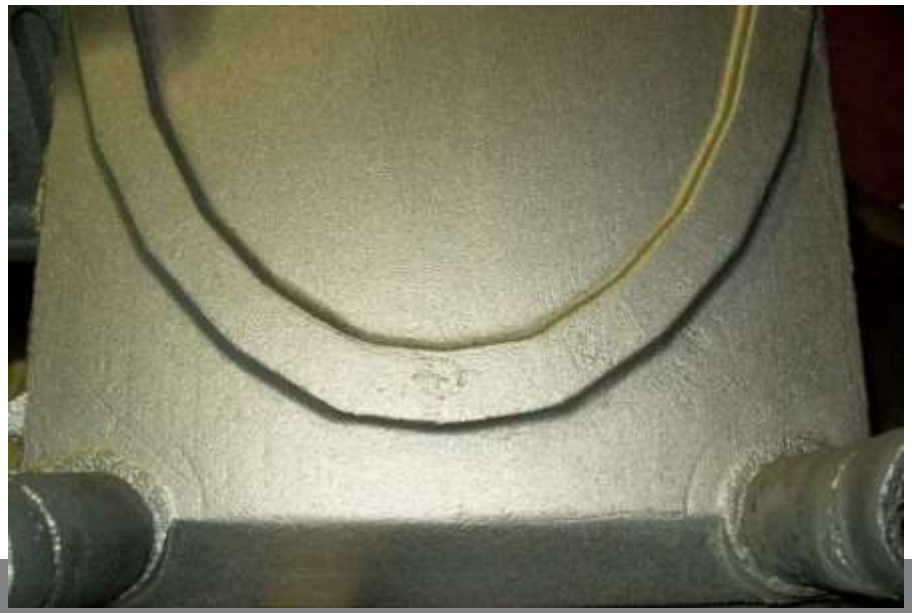
In-line Filtration – Horizontal Application Stainless Steel





Stainless Steel – Vertical Application

Smaller one moulding box

Molten metal saving

Surface improvement

Production 2 400 pcs/year

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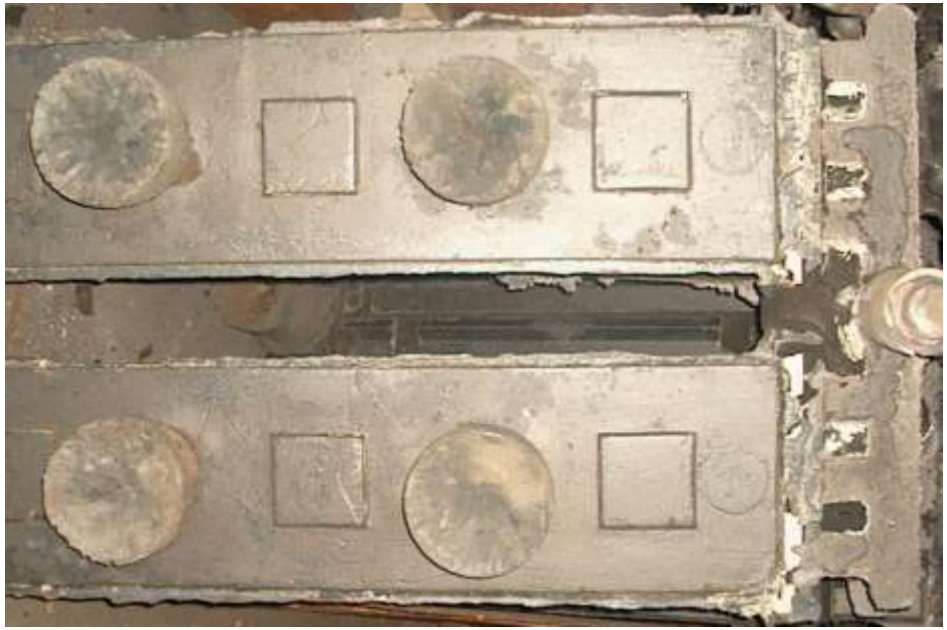
Direct Pour – KALPUR



- Running system elimination
- Metal Yield improvement
- Moulding box size reduction
- Fettling reduction
- Productivity increased

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Direct Pour – KALPUR

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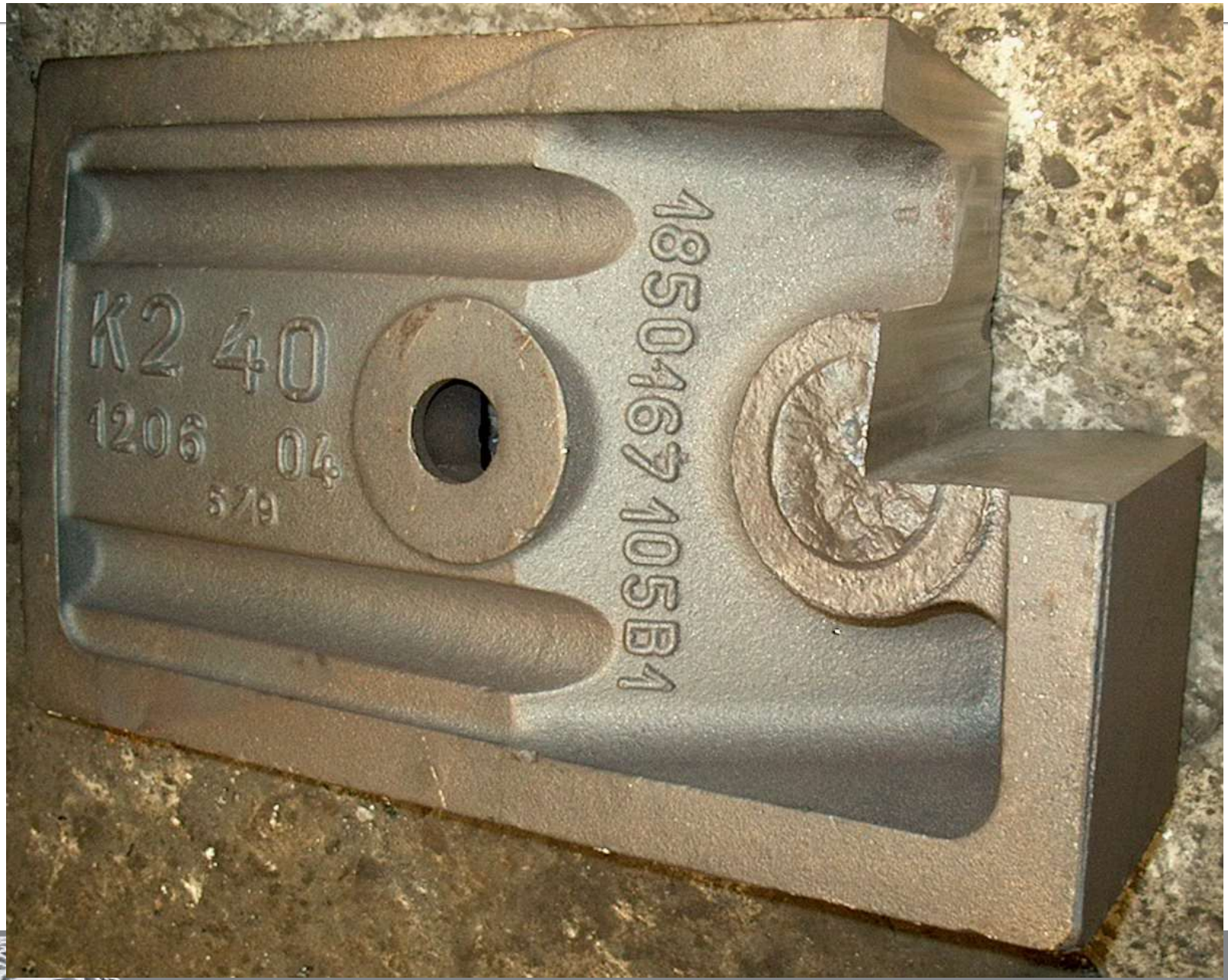
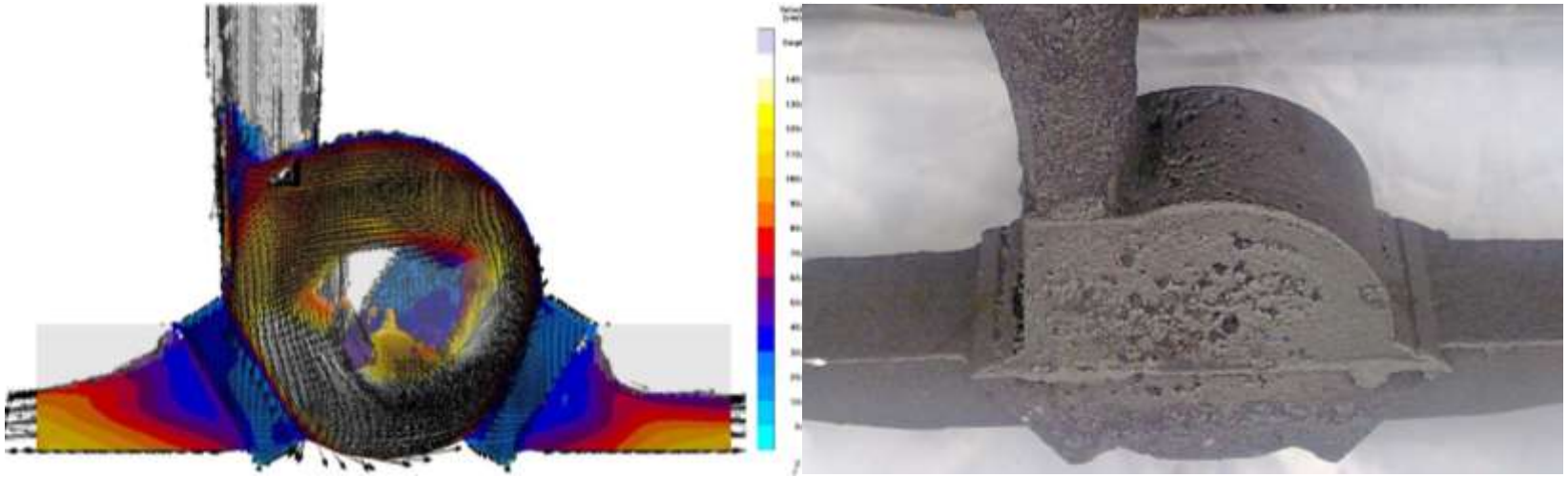
Direct Pour – KALPUR

Direct Pour – KALPUR

Direct Pour – KALPUR



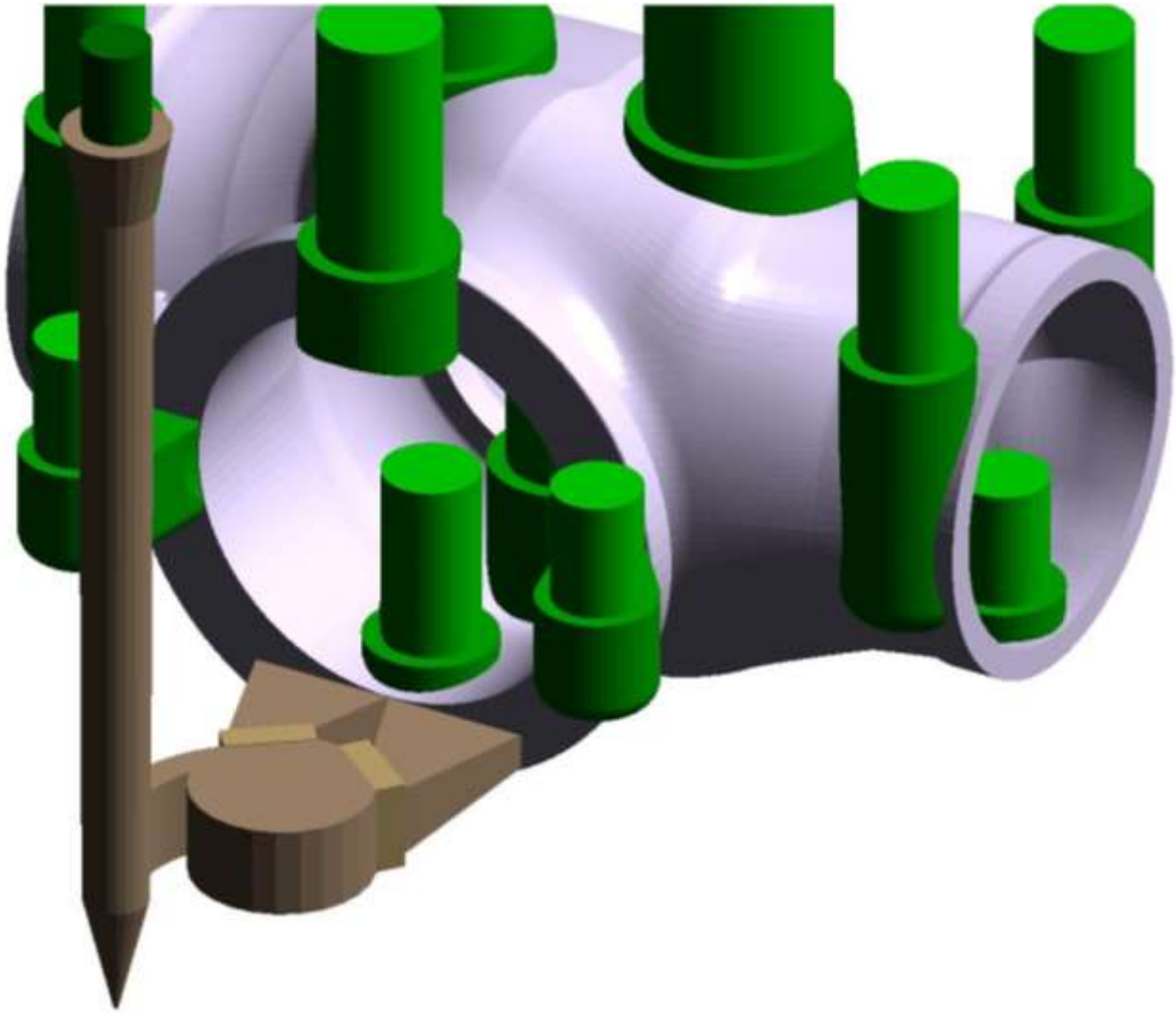
Swirling Filtration – TURBOPRINT



Metal swirling at inlet face of filters Swirling inclusions entrappment

Cast weight 580kg – Carbon steel [WCB / 1.0619]

- Proposed Running System



Cast weight 580kg Carbon steel [WCB / 1.0619]

- TURBOPRINT assembling by core mark

Cast weight 580kg – Carbon steel [WCB / 1.0619]

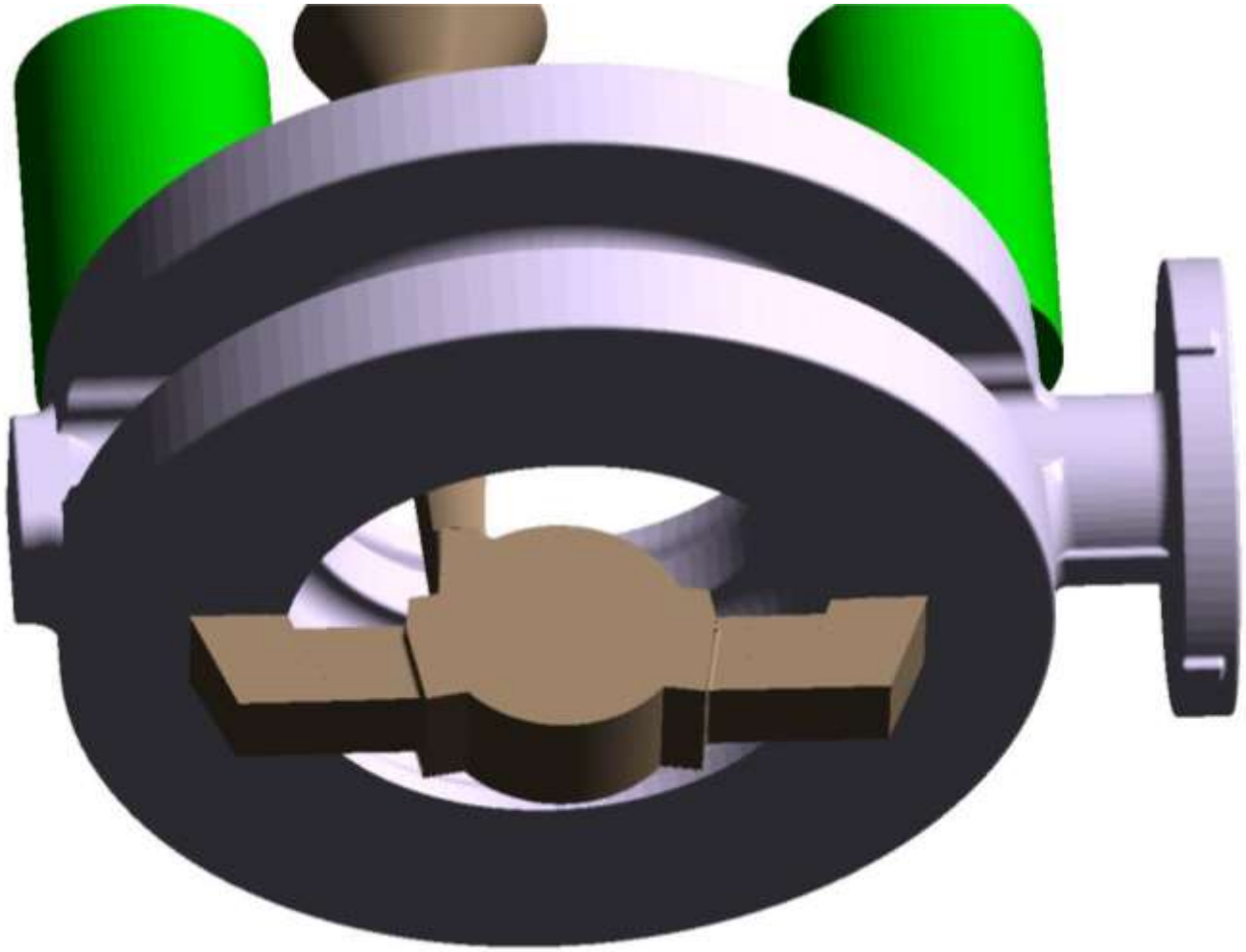
- Castings are completely defect free by Magnetic Penetration

Cast weight 580kg – Carbon steel [WCB / 1.0619]

- Unfiltered production – sand inclusions

Cast weight 330kg – High alloy [CF8M/C]

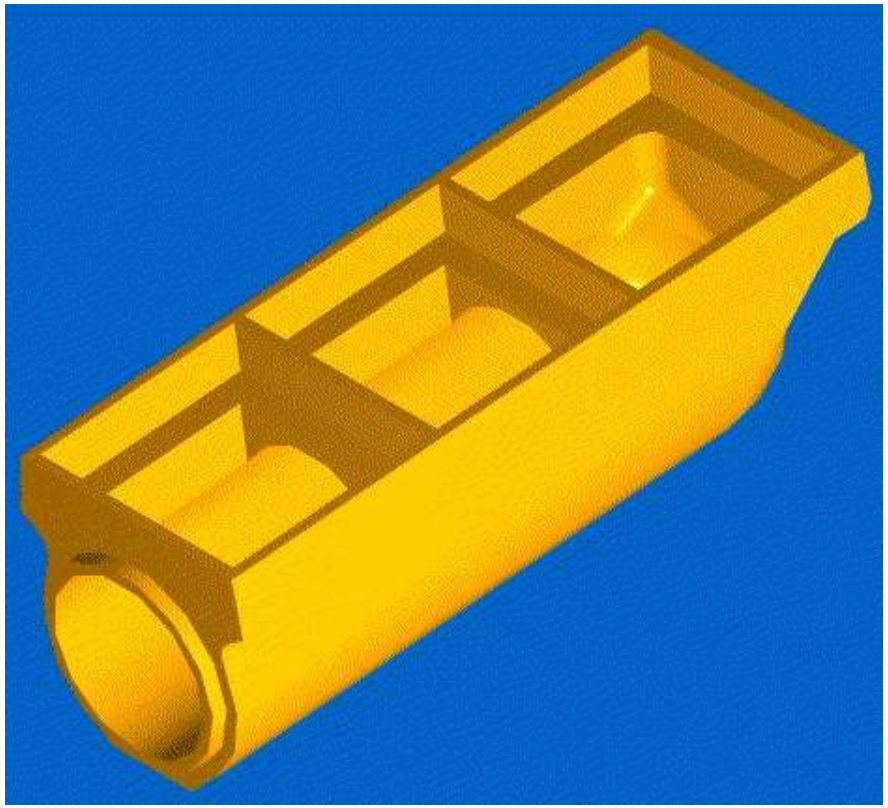
- Proposed Running System



Cast weight 330kg – High alloy [CF8M/C]

- Casting's surface after shot blasting

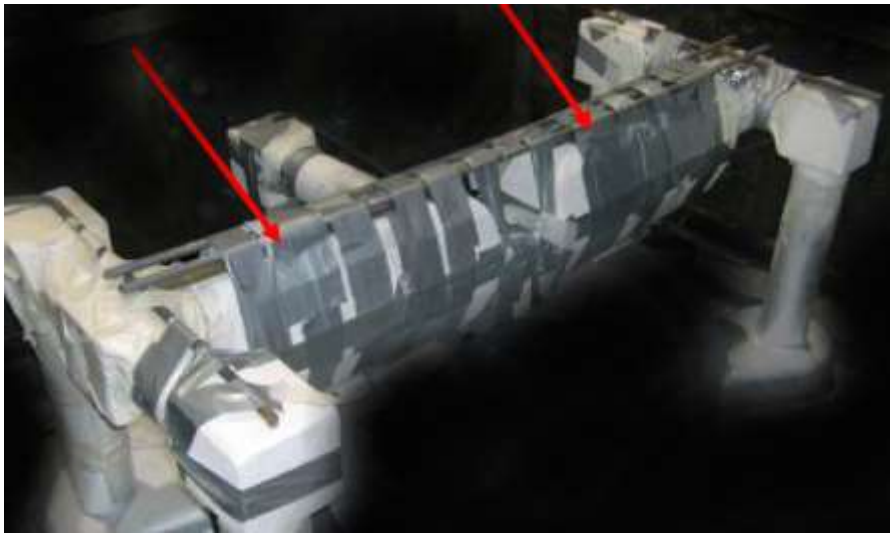
Hollotex FSt & FH

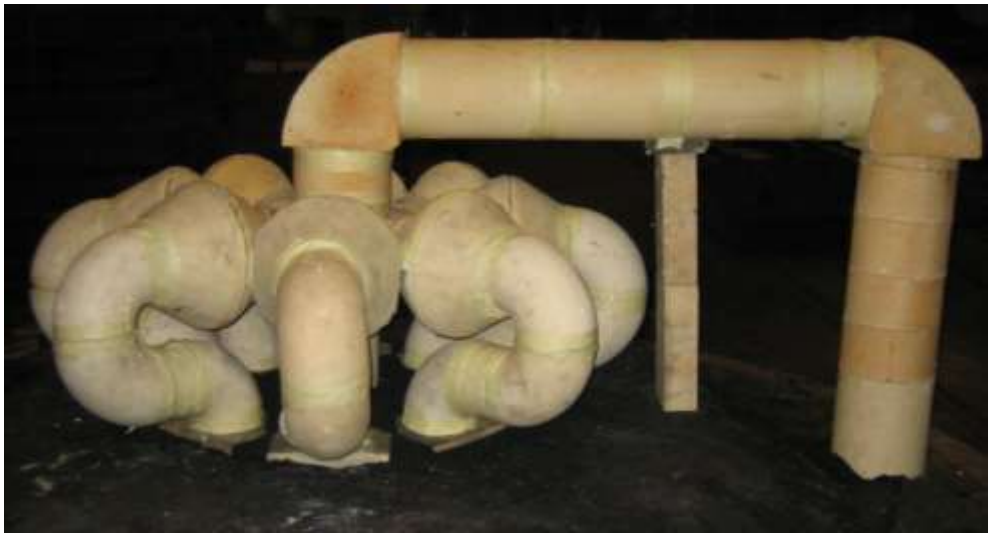


FSt Ceramic filtration tile

FH Ceramic system

Hollotex FSt & FH



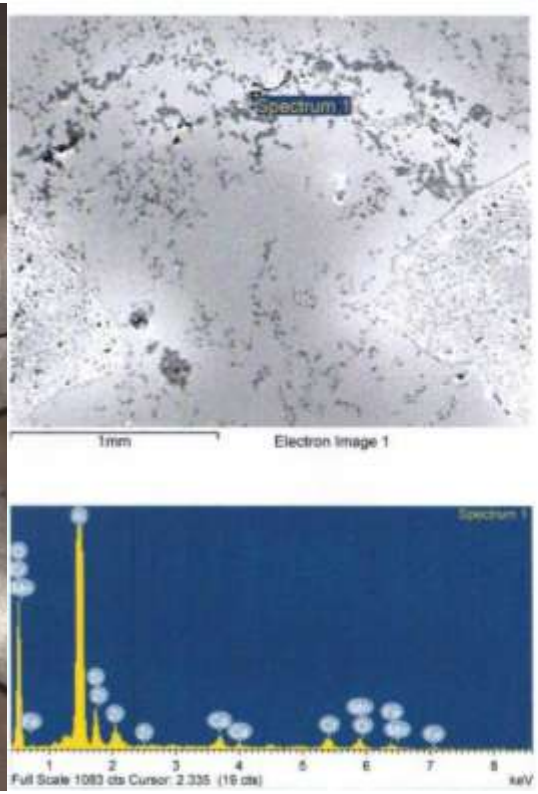


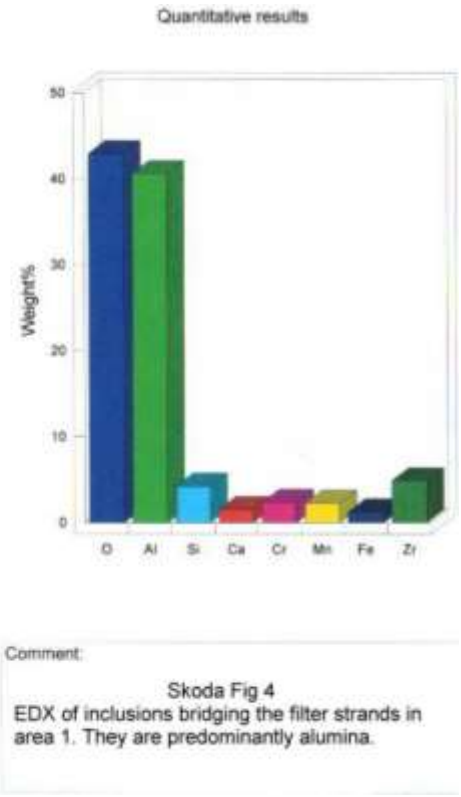
FSt Ceramic filtration tile

FH Ceramic system

Hollotex FH

Effective slag retention by filters





Detailed SEM inclusions analyses

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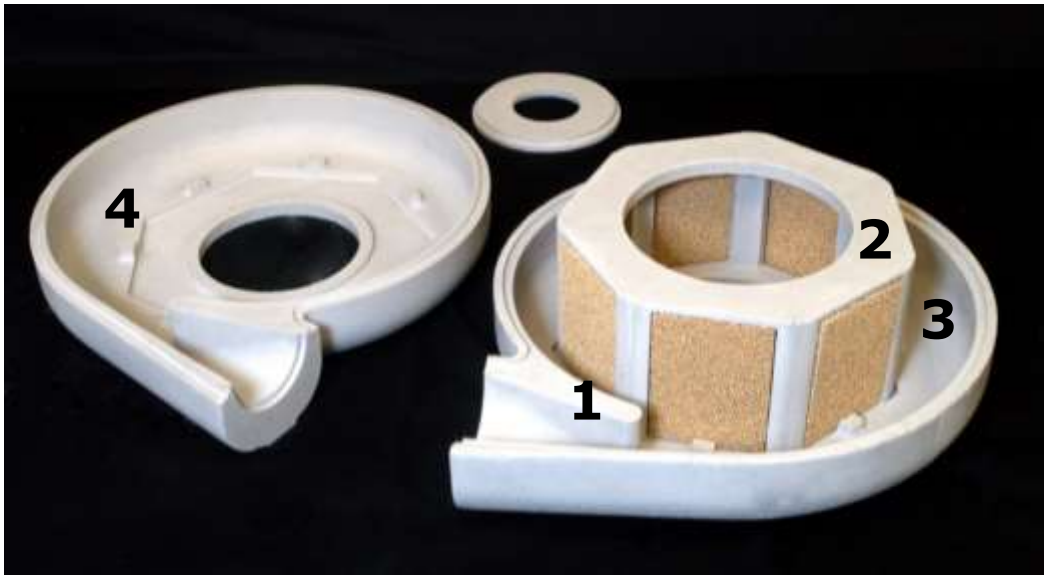
HOLLOTEX® CFU System



Features

1 Contoured entry baffle
2 Filter support cage
3 Offset flow channel
4 Symmetric design

Features assure consistent filtration performance
Filtration Capacity ~3-6 kg/cm^2 of filter area
Filtration Capacity of up to 12 000 kg per CFU unit

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Case Studies

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Case Studies

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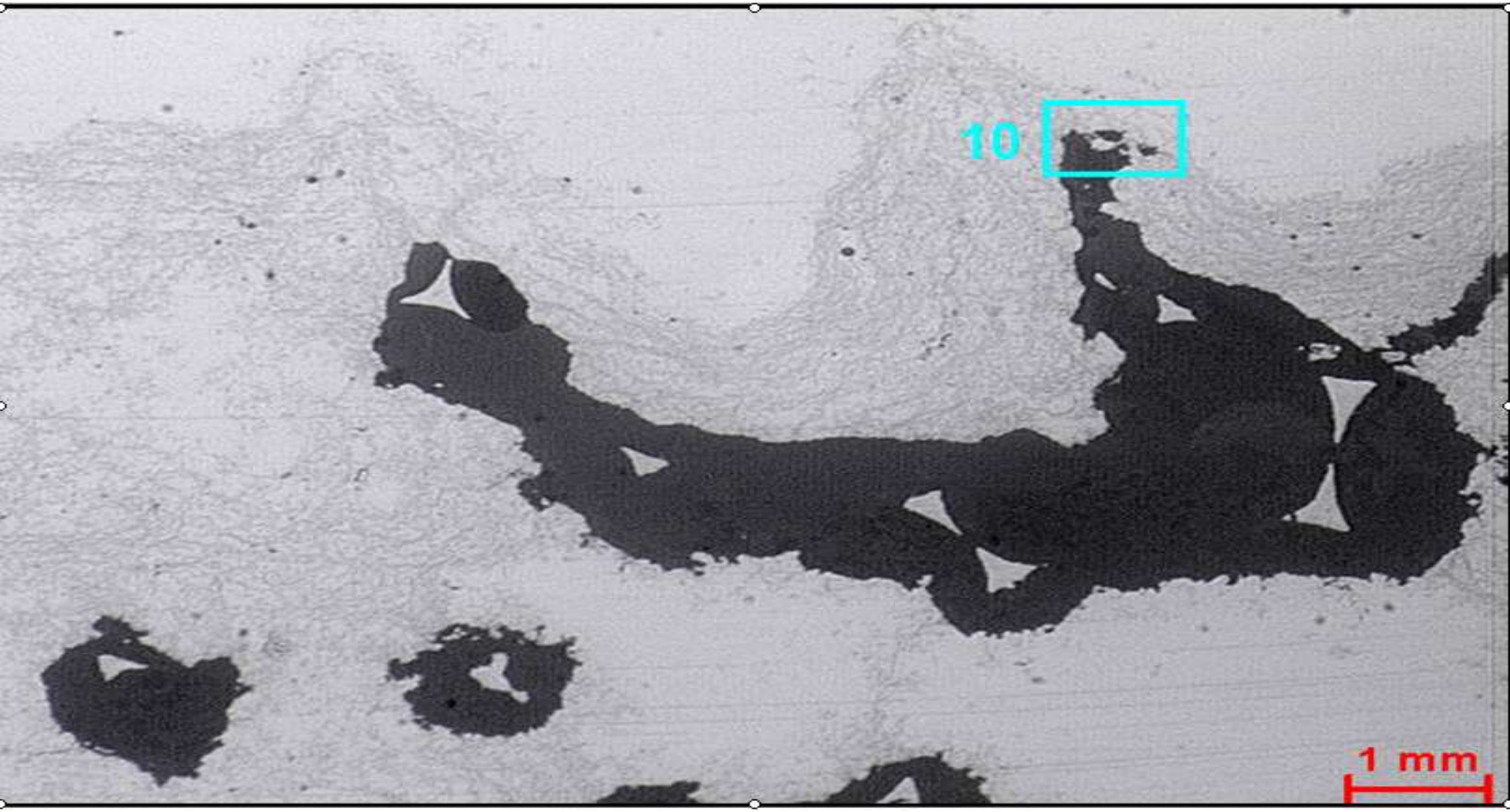
Filtration effectivity – deep bad filtration



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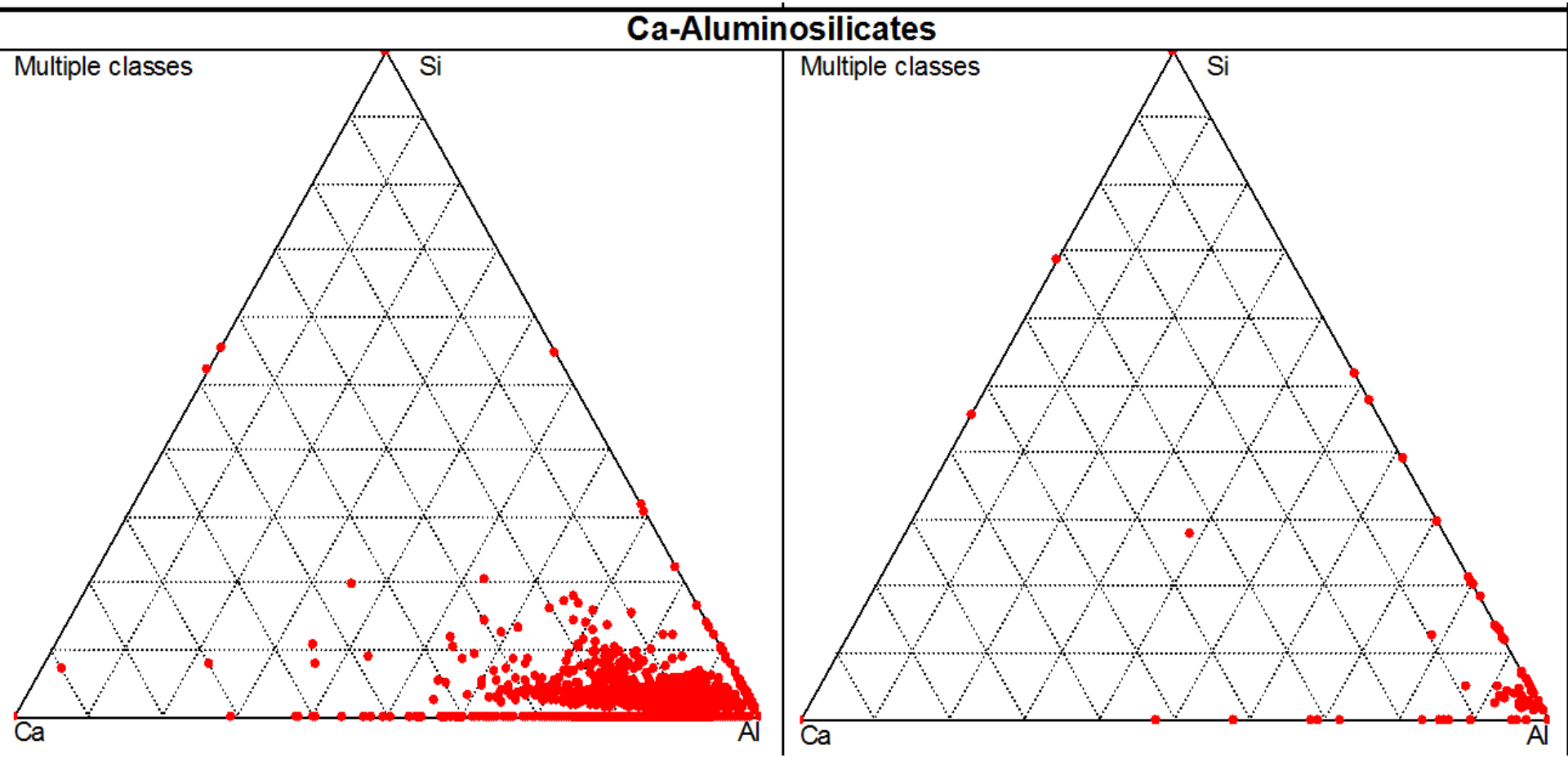
ASPEX analyses results – inclusions count



Sample C1 taken before filter

Sample C1 taken after filter

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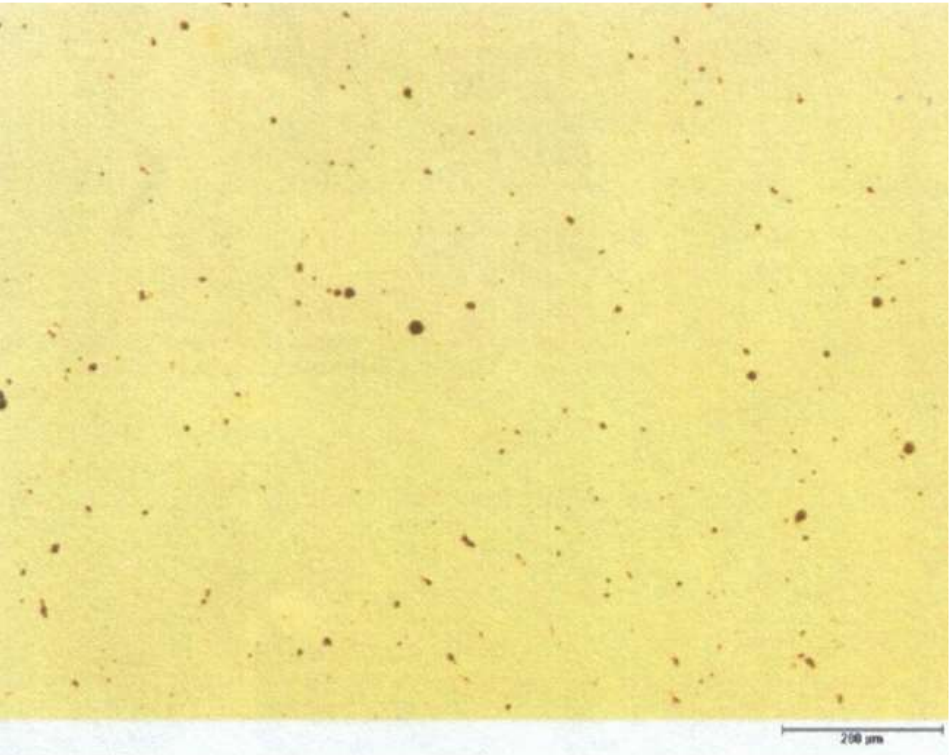
Metal Cleanliness Results



- *Metallographic before filter. The average inclusions content is 0,85%.*

- *Metallographic after filter. The average inclusions content is 0,19% only*

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