Hot tearing Studies in Electromagnetic Casting of Aluminum Alloys

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Introduction

- Electro magnetic casting (EMC), where the solidifying metal is supported by electromagnetic forces offers smooth surface with homogenous microstructure.
- Hot tearing, which corresponds to the opening of cracks in the mushy zone at high solid fractions is a major constraint for EMC.

Problem Definition

The interaction between the crack origin at micro level and cooling at macro level must be studied.

For the same cooling conditions, 5xxx alloys are not prone to hot cracking but 6xxx are.

Objectives

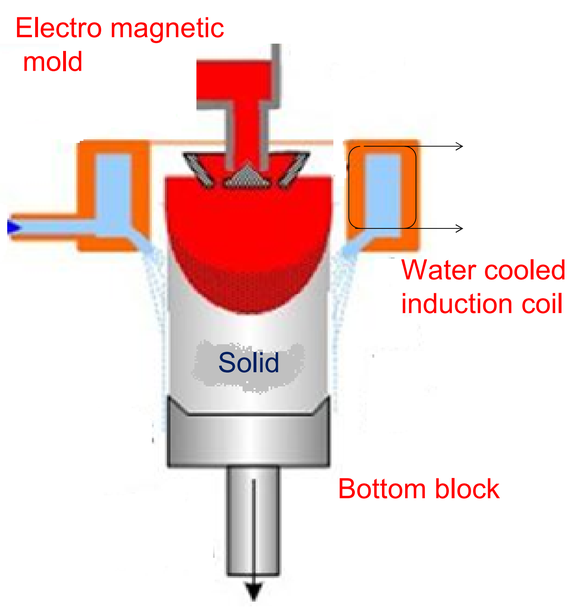
To simulate the temperature profiles in EMC

To apply the non mechanical hot tearing criteria to AA5754 and AA6061

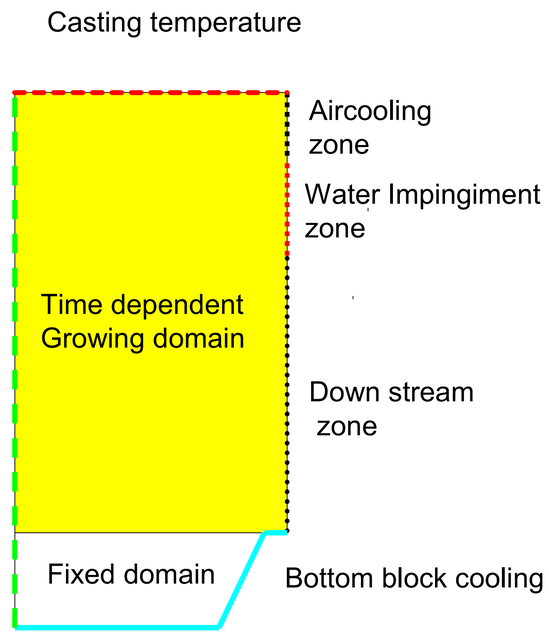
Cooperation

Prof. A.Bertram, GRK1554 Member,
Institute of Mechanics

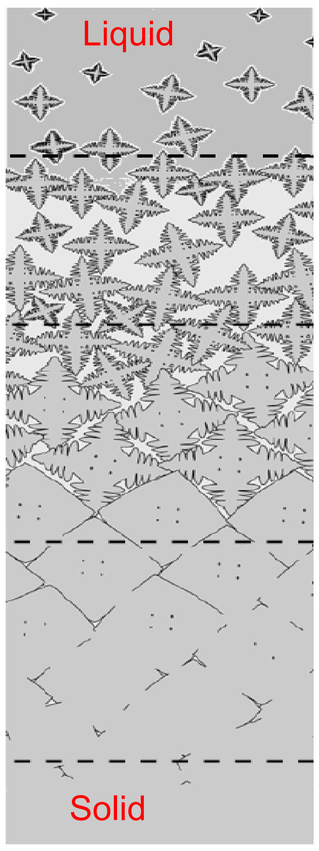
Casting Process



Schematic of the Electro Magnetic Casting



Macroscopic computational domain and boundary conditions



Equiaxed dendrite growth at micro level

What is the relation between micro level hot tears and macro level cooling rate …

liquid feeding < solidficaton shrinkage = porosity

porosity + stress = hot tearing

Analytical Description

Hot tearing Criteria

Feurer criteria:

If Volumetric liquid flow <solidficaton shrinkage(SRG) Hot tear

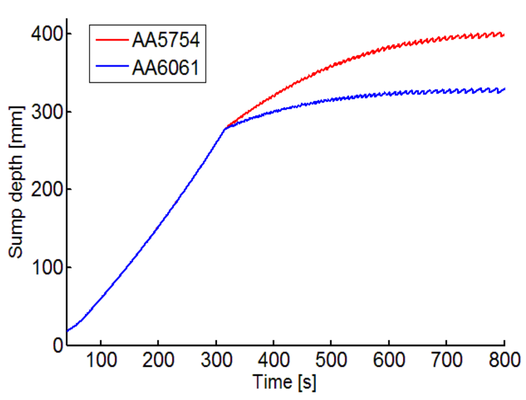
Clyne and Davies citeria:

$$HCS = \frac{Time\ Spent\ in\ Mushy}{Liquid\ feeding\ Time}$$

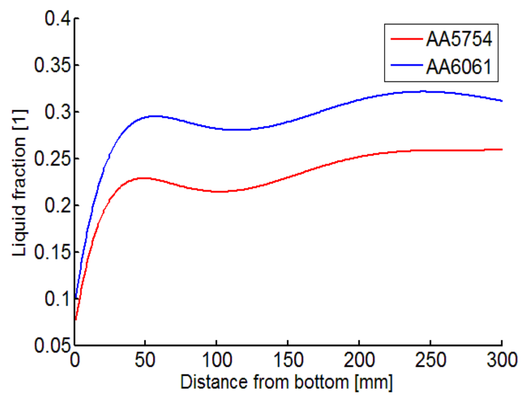
Katgerman citeria:

$$HCS = \frac{Time\ after\ crtical\ mushy}{Time\ to\ reach\ crtical\ mushy}$$

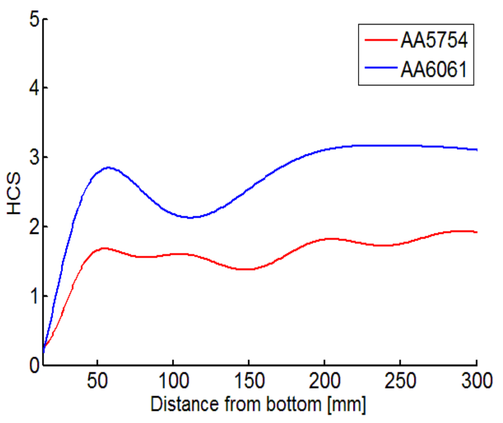
Comparison of AA5754 and AA6061



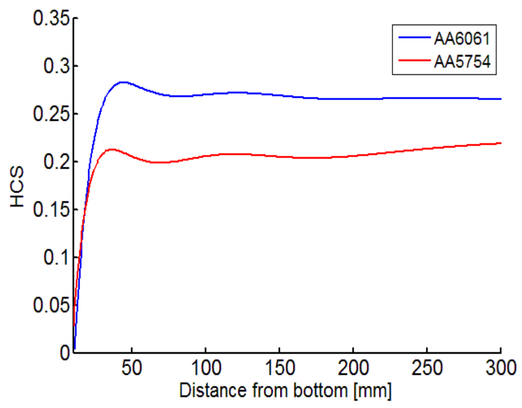
Sump Depth



Feurer criteria



Clyne and Davies criteria



Kategerman criteria

Results and Discussion

- P.Pavan Kumar, A.K.Nallathambi, E.Specht, A.Bertram, *Technische Mechanik*, 32, 2012, pp. 342 – 357.
- P.K.Penumakala, A.K.Nallathambi, E.Specht, *AIST Steel Properties and Applications Conference,* 2012,575 583.
- P.K.Penumakala, A.K.Nallathambi, E.Specht, Numerical Heat Transfer *Conference,* 2012, pp. 311-319.
- A.K.Nallathambi, P.K.Penumakala, E.Specht, Liquid metal Processing Conference, USA, Sep 22–25,2013.
- P.K.Penumakala, A.K.Nallathambi, E.Specht, Liquid metal Processing Conference, USA, Sep 22–25,2013.

Conclusions

The simulation results are applied to reduce the cracks during casting at **AMAG Casting GMBH**, **Austria.**

DFG-Graduate School 1554 “Micro-Macro-Interactions in Structured Media and Particle Systems”