



Continuous Casting Consortium Annual Meeting 2013

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Casting

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Objectives

- To develop computational models of continuous casting of steel and related processes
- To apply these models to problems of practical interest to the steel industry



Tentative Attendees

ABB:	Martin Sedén	
ArcelorMittal:	Tatha Bhattacharya, Hongbin Yin (Global R&D, E.Chicago),	
	Rudolf Moravec?, Joydeep Sengupta (Dofasco) ?	
Baosteel:	Ruan Xiaoming, Hongzhi Shi	
Magnesita Refractories:	Alessandro Prenazzi, Bruno Ribeiro, Bruno Stoco, R. Freire, (Br	razil)
	R.Nunnington (York, PA)	
Nucor Steel:	Ron O'Malley (Decatur, AL), Bob Williams, Neal Ross	
Nippon Steel & Sumitomo Met.	: Yuichi Tsukaguchi, Norimasa Yamasaki	
Postech:	Seon-Hyo Kim	
Severstal:	Jon Powers and Ron Radzilowski	
SSAB:	Xiaoxu Zhao	
Tata Steel:	Dirk Van der Plas and Richard Longbottom	
Ansys / Fluent Inc.:	Ashwini Kumar	
University of Illinois:	Brian G. Thomas, Joseph Bentsman, Pratap Vanka,	
	Bryan Petrus, Rui Liu, Kun Xu, Kai Jin,	
	Lance Hibbeler, Yonghui Li, Prathiba Duvvuri,	
	Aravind Murali, A.S.M. Jonayat, Matt Zappulla, Ken Swartz.	
Other CCC researchers:	Seong-Mook Cho*, Hyung-jun Lee*, Hyunjin Yang,	
	James Buckland, Mihir Chavan, Kelli Martin,	
	Seid Koric, Ramnik Singh.	
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Day 1: Morning Session

8:00am Breakfast & Introductions 2005 Mech. Eng. Lab. (Deere Pavilion)

8:05	B.G. Thomas	Overview of Projects	
8:20	R. Liu & SM. Cho	Gas Flow Through Porous SEN Refractory, Formation into Bubbles, and Size Distribution Evolution in Nozzle	
8:40	Mihir Chivan	Nailboard Measurements of Surface Flow at Severstal	
8:50	Rui Liu	Multiphase Mold Flow Model at Severstal	
9:10	Ramnik Singh	Effect of Double-Ruler EMBr on Transient Mold Flow with LES Modeling and Scaling Laws	
9:30	SM. Cho	EMBr Effect on Mold Level Fluctuations at Posco	
10:00	Break		
10:30	Kai Jin	Bubble entrapment with Multiphase Flow and EMBr: Model Validation with Measurements at Baosteel	
11:00	ASM Jonayat	Thermal-fluid model of Oscillation, Meniscus Heat Transfer and Slag Consumption	
11:30		Discussion of Flow Projects	
12:00pn	n Lunch	2005 Mech. Eng. Lab	
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Day 1: Afternoon Session

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1:00	K. Swartz	Modeling Mold Flux Entrainment
1:15	P. Duvvuri	Mold Heat Transfer Spray Cooling Optimization
1:50	B. Petrus	Investigating Dynamic Thermal Behavior with CONOFFLINE
2:20	L. Hibbeler	Modeling and On-Line Measurement of NF Mold Taper Stress Analysis of Dendritic Microstructure During Solidification
2:40	A. Murali	Improvements to Equilibrium Model of Precipitate Formation
3:00	M. Zappulla	Equilibrium Precipitation Model Graphical User Interface
3:10	Break	
3:40	K. Xu	Heat Transfer, Bulging, and Machine Taper Modeling
4:00	Y. Li	Modeling SEN Preheating with Fluent and GASEQ
4:30		Group Discussion of Future Projects and Directions
5:30	Adjourn	
6:00 University o	Dinner f Illinois at Urbana-Champaign	Colonial Room, Illini Union Building Metals Processing Simulation Lab BG Thomas





EQPrecip 1.1

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CCC Precipitation Model – Equilibrium

- Standalone program to compute stable precipitates in steels,
- developed by Kun Xu
- revisions by A. Murali
- with user interface by Matt Zappulla
- with user-customizable database

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• graphical output and excel-file output



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2013 CCC Reports – Mold Flow with EMBr

(New)

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High Fidelity Numerical Investigations of Tailored Magnetic Fields for Defect Reduction in Continuous Casting of Steel Ramnik Singh

MS Thesis, University of Illinois, MechSE, 108p, 2013, CCC Report 201301

Large Eddy Simulations of Effect of Double-Ruler Electro-magnetic Field on Transient Flow during Continuous Casting R. Singh, B.G. Thomas and S.P. Vanka CCC Report 201302

Transient Fluid Flow During Steady Continuous Casting of Steel Slabs Part I: Measurements and Modeling of Two-phase Flow Seong-Mook Cho, Seon-Hyo Kim, Brian G. Thomas, and Yong-Jin Kim CCC Report 201303

Transient Fluid Flow During Steady Continuous Casting of Steel Slabs Part II: Effect of Double-Ruler Electromagnetic Braking (EMBr) Seong-Mook Cho, Seon-Hyo Kim, Brian G. Thomas, and Yong-Jin Kim CCC Report 201304



Effects of a Magnetic Field on Turbulent Flow in the Mold Region of a Steel Caster

Singh, R., B.G. Thomas, and P. Vanka *Metallurgical and Materials Transactions B,* submitted May, 2013

Effect of Electromagnetic Braking (EMBr) on Turbulent Flow in Continuous Casting (reprint)

Singh, R., B.G. Thomas, and S.P. Vanka

AISTech 2013 Proceedings, Pittsburgh, PA, May 6-8, 2013, Assoc. Iron Steel Technology, Warrendale, PA, pp. 1323-1336.

Flow Control with Ruler Electromagnetic Braking (EMBr) in Continuous Casting of Steel Slabs

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Thomas, Brian G., Ramnik Singh, Rajneesh Chaudhary, and Pratap Vanka Fifth Baosteel Biennial Academic Conference (BAC2013), Shanghai, PRC, June 4-6, 2013.



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2013 CCC Reports – Mold Flow (other)

Mold Slag Entrainment Mechanisms in Continuous Casting Molds (reprint)

Hibbeler, L.C., and Brian G. Thomas AISTech 2013 Proceedings, Pittsburgh, PA, May 6-8, 2013, Assoc. Iron Steel Technology, Warrendale, PA, pp. 1215-1230.

Slidegate Dithering Effects on Transient Flow and Mold Level Fluctuations (reprint) Liu, Rui, Brian G. Thomas, Love Kalra, Tathagata Bhattacharya, and Aloka Dasgupta, AISTech 2013 Proceedings, Pittsburgh, PA, May 6-8, 2013, Assoc. Iron Steel Technology, Warrendale, PA, pp. 1351-1364.

Transport and Entrapment of Particles in Steel Continuous Casting (reprint) Thomas, B.G., Q. Yuan, S. Mahmood, R. Liu, and R. Chaudhary *Metallurgical and Materials Transactions B,* in press. 9

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Computational Modeling of Temperature, Flow and Crystallization of Mold Slag during Double-Hot-Thermocouple-Technique Experiments

Zhou, L., W. Wang, R. Liu, and B. G. Thomas *Metallurgical and Materials Transactions B,* submitted May, 2013

Kinetic Study of the Devitrification of Mold Powder Slags (reprint)

Maldonado, Yadira G., F. Andrés Acosta, A. Humberto Castillejos and Brian G. Thomas *Iron and Steel Technology*, July, 2013 (reprinted from AISTech 2012, Atlanta, GA, May 7-9, 2012, Assoc. Iron Steel Technology, Warrendale, PA.)



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2013 CCC Reports – Fundamental Modeling

Calibration of Thermal Models of Steel Continuous Casting Molds (reprint) Hibbeler, L., M. Langeneckert, J. Iwasaki, I. Hwang, R. O'Malley, and B.G. Thomas Iron and Steel Technology Transactions, 10:5, Sept., 2013.

Measuring Heat Transfer During Spray Cooling Using Controlled Induction Heating Experiments and Computational Models (Reprint)

Zhou, Xiaoxu, B. G. Thomas, C. Alberto Hernández B., A. Humberto Castillejos E. and F. Andrés Acosta G.

Applied Mathematical Modeling, 37, 3181-3192, 2013. DOI: 10.1016/j.apm.2012.07.039

Particle Transport in a Turbulent Square Duct Flow with an Imposed Magnetic Field

Liu, R., Surya P. Vanka, and Brian G. Thomas Proceedings of the ASME 2013 Fluids Engineering Division Summer Meeting, FEDSM2013, 16503, Lake Tahoe, Nevada, USA, July 07-11, 2013.

Multiphysics Simulation of Metal Solidification Processes with Abaqus

Koric, Seid, Brian G. Thomas, and Lance Hibbeler

Simulia Community Conference, Vienna, Austria, May 21-24, 2013.