Agenda

August 19, 2015

Continuous Casting Consortium Annual Meeting 2015

Brian G. Thomas, Director

Department of Mechanical Science & Engineering
University of Illinois at Urbana-Champaign

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

Attendees

ABB:	Martin Sedén
AK Steel:	H. Schade, Ken Morales
ArcelorMittal:	Tatha Bhattacharya, Rui Liu, Rich Gass, B. Forman, Pascal Gardin Joydeep Sengupta, Jackie Leung, Kinnor Chattopadhyay
Baosteel:	Xiaoming Ruan
JFE Steel:	Akitoshi Matsui
Magnesita Refractories:	Rodrigo Borges, Ramon Resende, A. Rubens Freire, Alexandre Resende
Nippon Steel & Sumitomo Met.:	Kenji Taguchi
Nucor Steel:	Neal Ross, Madeline Rembold, (Nucor Decatur); Daniel Green (Nucor Tuscaloosa)
Postech:	Seon-Hyo Kim
Posco:	Jong-Yeon Hwang
SSAB:	Sunday Abraham & Xiaoxu Zhou
Ansys / Fluent Inc.:	Ashwini Kumar?
University of Illinois:	Brian G. Thomas, Joseph Bentsman, Pratap Vanka, Seong-Mook Cho, Hyunjin Yang, Kai Jin, Kun Xu, Adnan Akhtar, Xiaolu Yan, Nathan Seymour, Shengji Yang, Zhelin Chen, Aravind Murali, Matt Zappulla, Hyoung-jun Lee.
Other CCC Researchers:	S-H Kim, Seid Koric, Pavan Penumakala, Manjunath Rajagopal, Carly Conley (CSM)

Day 1: Morning Session

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

8:05	B.G. Thomas	1 Overview of Projects
8:20	S.-M. Cho	Investigation of Flow Pattern, Surface Behavior, and Mold Slag Entrainment using Oil-Water Model and CFD Model
8:40	S.-M. Cho & H-J Lee	Physical Water Model Experiments
8:50	S.-M. Cho	Effect of Nozzle Port Angle on Mold Flow
9:10	H. Yang	Pressure-energy Model of Tundish, Slide-gate, and Nozzle Flow and Application to Avoiding Aspiration
9:40	H. Yang	5 Two-Phase Modeling of Turbulent Flow in a Nozzle with Gas Pockets and Bubbles
10:00	*Break*	
10:30	K. Jin	Argon Bubble Behavior in EMBr Field
10:40	K. Jin	Effect of EMBr on Flow in SEN and Mold
11:00		Effect of EMBr on Flow and Particle Capture including Hooks
11:10	A. Akhtar	Modeling of Nailboard Measurement Method
11:40		Discussion of Flow Projects
12:00pm	*Lunch*	2005 Mech. Eng. Lab

Day 1: Afternoon Session

1:00	X. Yan	Model of Meniscus Behavior and Oscillation Mark Formation
1:30	S. Yang	10 Effect of Non-Newtonian Slag Behavior on Gap Flow and Friction in CC
1:50	M. Zappulla	Modeling of Depression Formation during Solidification in the Mold
2:20	Z. Chen	Investigating Dynamic Thermal Behavior with CONOFFLINE
2:50	*Break*	
3:20	N. Seymour	Constitutive Equations for Steel at Elevated Temperatures
3:40		Thermal-Stress Analysis of Solidifying Shell Including Bending and Unbending
4:00	Z. Chen	15 Capturing and Suppressing Resonance in Mold Oscillation
4:30		Group Discussion of Projects and Future Directions
5:30	Adjourn	

6:00 Dinner Colonial Room, Illini Union Building

Day 2 (Aug. 20)

B.G. Thomas: 356 Mech. Eng. Bldg.
Informal discussions on future projects
(Prior appointments would be helpful – please confirm)

8:00 – 9:00	SSAB – S. Abraham
9:00 – 10:00	AK Steel – K. Morales
10:00 – 11:00	ABB – M. Seden
11:00 – 12:00	ArcelorMittal – T. Bhattacharya, J. Sengupta, &?
2:00 – 3:00pm	JFE – Matsui?
3:00 – 4:00pm	Baosteel – X. Ruan
4:00 – 5:00pm	?

8:00 am-? *Research group: 345 Mech. Eng. Bldg.*
Informal discussions with students
Further details on current projects and software
CON1D operation etc.
Questions

Day 3 (Aug. 21) Magnesita – R. Borges, R. RESENDE and R. FREIRE

2015 CCC Reports – Flow with Bubbles

Dynamics of argon bubbles in steel continuous casting with a magnetic field

Kai Jin, Pratap Vanka, Hyunjin Yang, Matthew Zappulla, Seid Koric, Ahmed Taha, and Brian G. Thomas

Blue Waters Symposium, 2015, CCC Report 201501

Rise of an argon bubble in liquid steel in the presence of a transverse magnetic field

K. Jin, P. Kumar, S. P. Vanka,,and B. G. Thomas

CCC Report 201502

Modeling and Measurements of Multiphase Flow and Bubble Entrapment in Steel Continuous Casting

Kai Jin, Brian G. Thomas, and Xiaoming Ruan

CCC Report 201503

2015 CCC Reports – Flow with EMBr

Effect of EMBr on Multiphase Flow and Bubble Entrapment in Steel Continuous Casting

JIN Kai, THOMAS Brian G., RUAN Xiao-ming

CCC Report 201504

Simulation and Validation of Fluid Flow and Particle Transport in Continuous Slab Casting with Electromagnetic Braking (EMBr)

Kai Jin, B.G. Thomas, R. Liu, S.P. Vanka and X. M. Ruan

Modeling of Casting, Welding, and Advanced Solidification Processes (MCWASP XIV), Hyogo, Japan, June. 21-26, 2015, IOP Conf: Materials Sci. & Eng. 84(1), 2015, pp. 012095:1-8.

Effect of Single-Ruler Electromagnetic Braking (EMBr) Location on Transient Flow in Continuous Casting

B.G. Thomas, R. Singh, S.P. Vanka, UIUC, Urbana, Illinois

Klaus Timmel, Sven Eckert, Gunter Gerbeth, HZDR, Dresden, Germany

J. Manufacturing Science and Production, 15 (1), pp. 93-104, 2015.

2015 CCC Reports – Thermal & Mechanical

New Method to Measure Metallurgical Length and Application to Improve Computational Models

Petrus, Bryan, Danny Hammon, Megan Miller, Bob Williams, Adam Zewe, Zhelin Chen, Joseph Bentsman, Brian G. Thomas

AISTech 2015, Cleveland, OH, May 4-6, 2015, Assoc. Iron Steel Technology, Warrendale, PA, pp. 3238-3248.

A Reduced-Order Model of Mold Heat Transfer in the Continuous Casting of Steel

Lance C. Hibbeler, Melody M. Chin See, Junya Iwasaki, Kenneth E. Swartz, Ronald J. O'Malley, Brian G. Thomas

CCC Report 201505

Elasto Visco-Plastic Model of Steel Solidification with Local Damage and Failure

Murali, Aravind, Seid Koric, and Brian G. Thomas

Plasticity 2015, Montego Bay, Jamaica, January 4-9, 2015.

Thermomechanical Behavior of a Wide Slab-Casting Mold

Hamilton, Gavin J., Lance C. Hibbeler, and Brian G. Thomas

AISTech 2015, Cleveland, OH, May 4-6, 2015, Assoc. Iron Steel Technology, Warrendale, PA, pp. 2593-2605.

2015 CCC Reports – Reprints: Flow

Model of Gas Flow through Porous Refractory Applied to an Upper Tundish Nozzle

Rui Liu and Brian G. Thomas

Metallurgical and Materials Transactions B, 46 (1), pp. 388-405, 2015

Numerical Investigation of Slag Entrainment

Swartz, Kenneth E, Lance C. Hibbeler, Brendan P. Joyce, and Brian G. Thomas, Iron and Steel Technology, 12 (7), July, in press, 2015. (reprinted from AISTech 2014 Proceedings, Indianapolis, IN, May 5-8, 2014, Assoc. Iron Steel Technology, Warrendale, PA, pp. 1865-1879).

Measurements of Molten Steel Surface Velocity and Effect of Stopper-rod Movement on Transient Multiphase Fluid Flow in Continuous Casting

Rui Liu, Brian G. Thomas, Joydeep Sengupta, Stephen D. Chung and ManhKha Trinh,

ISIJ International, 54 (10), pp. 2314-2323, 2014.

2015 CCC Reports – Reprints: Mensicus Behavior

Estimation of Time-Temperature-Transformation Diagrams of Mold Powder Slags from Thermo-analysis of Non-Isothermal Crystallization

Maldonado, Yadira G., Claudia Barraza de la P., Sergio Rodríguez A., A. Humberto Castillejos E. and Brian G. Thomas

Metallurgical and Materials Transactions B, 46B (1), pp. 286-303, 2015

Transient Thermo-Fluid Model of Meniscus Behavior and Slag Consumption in Steel Continuous Casting

ASM Jonayat and Brian G. Thomas

Metallurgical and Materials Transactions B, 45: 5, (Oct.), pp. 1842-1864, 2014.

Looking into continuous casting mould

Kenneth C. Mills, Pavel E Ramirez Lopez, Peter D Lee, Begoña Santillana, Brian G. Thomas, Rodolfo Morales

Ironmaking & Steelmaking 05/2014; 41(4), 242-249, 2014.

2015 CCC Reports – Reprints: Modeling FUndamentals

Three-Dimensional Flow in a Driven Cavity Subjected to an External Magnetic Field

Jin, K., S.P. Vanka, and B.G. Thomas

J. Fluids Eng., 137 (July), pp. 071104-1 – 071104-14, 2015.

Preliminary Evaluation of Abaqus, FLUENT, and in-house GPU code Performance on Blue Waters,

Thomas, B.G., L.C. Hibbeler, K. Jin, S. Koric, R. Liu, and A. Taha

Blue Waters Symposium, University of Illinois, Urbana, IL, May 12-15, 2014, pp. 68-69.

2015 CCC Reports – Controls

Capturing and Suppressing Resonance in Steel Casting Mold Oscillation Systems Using Timoshenko Beam Model

Oyuna Angatkina, Vivek Natarajan, Zhelin Chen, and Joseph Bentsman

2015 American Control Conference, Palmer House Hilton, July 1-3, 2015. Chicago, IL, USA

Online Recalibration of the State Estimators for a System with Moving Boundaries Using Sparse Discrete-in-Time Temperature Measurements

Bryan Petrus, Joseph Bentsman, Member, IEEE, and Brian G. Thomas

CCC Report 201506