WCCM XI - ECCM V - ECFD VI
BARCELONA 2014

11th World Congress on Computational Mechanics (WCCM XI)

and

5th European Conference on Computational Mechanics (ECCM V)

6th European Conference on Computational Fluid Dynamics (ECFD VI)

July 20 - 25, 2014, Barcelona, Spain

PROGRAM

11th. World Congress on Computational Mechanics

WCCM XI

5th. European Congress on Computational Mechanics

ECCM V

6th. European Congress on Computational Fluid Dynamics

ECFD VI

Barcelona, Spain
July 20 – 25, 2014

Eugenio Oñate, Xavier Oliver and Antonio Huerta (Eds.)

Organized by

Spanish Association for Numerical Methods in Engineering (SEMNI)
in its 25th Anniversary

with the support of
International Center for Numerical Methods in Engineering (CIMNE)

Proceedings of the jointly organized

11th. World Congress on Computational Mechanics - WCCM XI
5th. European Congress on Computational Mechanics - ECCM V
6th. European Congress on Computational Fluid Dynamics - ECFD VI
Barcelona, Spain
July 20 – 25, 2014

Edited by

Eugenio Oñate
Universitat Politècnica de Catalunya, Spain

Xavier Oliver
Universitat Politècnica de Catalunya, Spain

Antonio Huerta
Universitat Politècnica de Catalunya, Spain

A publication of:

International Center for Numerical Methods in Engineeering (CIMNE)

Barcelona, Spain

11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Congress on Computational Mechanics (ECCM V)
6th. European Congress on Computational Fluid Dynamics (ECFD VI)
Eugenio Oñate, Xavier Oliver and Antonio Huerta (Eds.)

First Edition: July 2014
Printed by: Artes Gráficas Torres S.A., Huelva 9, 08940 Cornellà de Llobregat, Spain
Depósito Legal: B-17935-2014
ISBN: 978-84-942844-7-2

PREFACE

This book contains the full papers presented at the jointly organized 11th Workd Congress on Computational Mechanics, the 5th European Conference on Computational Mechanics and the 6th European Conference on Computational Fluid Dynamics (WCCM XI – ECCM V – ECCM VI 2014)

The congress topics cover most disciplines on the theory and applications of computational methods in a broad number of areas in engineering and applied sciences.

Out of the over 4000 abstracts received, some 3200 papers were accepted for presentation in the congress.

Papers were distributed over 216 minisymposia, 8 special technological sessions in aeronautics and 26 thematic sessions including contributed papers.

The technical program includes 6 Plenary Lectures, 30 Semi Plenary Lectures (including an Industrial Lecture and several Young Investigator Lectures), as well as an Opening and a Closing Lecture.

All these activities together will make of the WCCM XI - ECCM V - ECFD VI meeting the largest event held under the auspices of the IACM and ECCOMAS so far. Some 4000 scientists, academics, researchers and engineers from over 60 countries will gather in Barcelona for presenting their work, listening to the latest developments in the many different congress topics and, over all, meeting old and new colleagues.

This volume includes contributions sent directly from the authors. The editors can not accept responsibility for any inaccuracies, comments and opinions contained in the papers.

The organizers would like to thank all authors for submitting their contributions, as well as the supporting organizations for their help in making the congress possible.

Eugenio Oñate Xavier Oliver Antonio Huerta

Co-Chairmen of the WCCM XI – ECCM V – ECFD VI Congress

ACKNOWLEDGEMENTS

Stand 13

Social Program
Sponsorship

Stands 15, 16, 21 and 22

Stands 7 and 8

CRC Press
Stand 10

Welcome Reception
Sponsorship

Stand 1

Stand 9

Stand 2

John Wiley & Sons Ltd
Stands 3 and 4

WCCM XII Announcement
Stand 12

Portable Multimedia Solutions
(PMS)
Inflatable Structure

Stands 25, 26, 27 and 28

SUMMARY

CONTENTS

MINISYMPOSIA IN THE FRAME OF ECCM V (TOMO II)

MINISYMPOSIA IN THE FRAME OF ECCM V (continues) (TOMO III)

MINISYMPOSIA IN THE FRAME OF ECCM V (continues) (TOMO IV)

Minisymposia in the frame of ECFD VI (TOMO V)

Contributed Papers in the frame of ECCM V (TOMO VI)

Contributed papers in the frame of ECFD VI (TOMO VI)

Special Technological Sessions (TOMO VI)

LIST OF PAPERS

AUTHORS INDEX

11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
E. Oñate, J. Oliver and A. Huerta (Eds)

IDENTIFICATION OF DEFECTS ORIGINATED DURING THE FILLING OF CAST PIECES THROUGH PARTICLES MODELLING

JESÚS M. BLANCO[†*], **PRIMITIVO CARRANZA**[†], **RAFAEL PINTOS**[†], **PEDRO ARRIAGA**[†] **AND LAKHDAR REMAKI**[††]

[†] UPV/EHU University of the Basque Country; School of Engineering
Alameda Urquijo, s/n. 48013 Bilbao
jesusmaria.blanco@ehu.es; http://www.ingeniaritza-bilbao.ehu.es/p224-home/es

[††] BCAM (Basque Center for Applied Mathematics)
Alameda Mazarredo, 14. 48009 Bilbao
lremaki@bcamath.org; http://www.bcamath.org

Key Words: *Cast pieces, Defects, Particles, Numerical analysis, Fluid dynamics.*

Abstract. In casting processes, strong recirculation zones may trap air, gases and strip particles of sand off the mold affecting seriously the quality of the cast pieces. Especially during the filling of molten pieces with large surfaces, several faults were detected which are responsible of considerable economic losses in such casting processes. The aim of this work is focused on the correct identification of these physical phenomena, through Computational Fluid Dynamics (CFD). A fully experimental work correlating a saline solution with similar properties than the liquid alloy was carried out in order to guess the flow behavior inside the mold. Different parameters such as filling time, temperature and velocity of the liquid alloy together with the geometrical design of the mold were taken into account. The simulated evolution profiles and propagation speeds were compared with the laboratory experiments showing good agreement, validating thus the numerical model. Through an advanced particles modeling feature from a commercial package, the potential to predict and later correct some casting defects was demonstrated. As a conclusion, the mold together with supply channels need to be carefully optimized in order to control the correct direction of solidification avoiding the appearance of oxides but also to prevent stripping the sand off the walls.

1 INTRODUCTION

Physical phenomena directly associated to the filling of heavy cast pieces with great surfaces; responsible of multiple defects, is a key factor that is crucial to understand in deep. The fluid dynamics of the casting for these types of pieces has been carefully studied in order to know the causes of the defects encountered which will be described later. For this reason, preliminary tests on pilot-scale models were performed, which is indeed a time-consuming and thus expensive activity. A full experimental campaign, including multiple changes in the

[*] Corresponding author (Jesús M. Blanco).

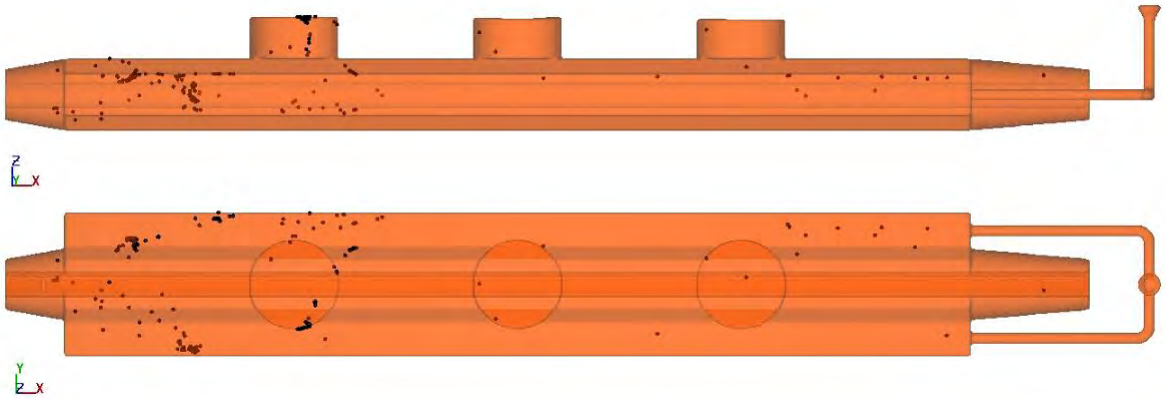

Figure 9: Mass weighted particles concentration observed at the end of the casting process.

The final distribution of particles in the system shows a strong dependency on the alloy temperature and the cooling rate. After filling, temperature in the side of cast located opposite to the inlet is lower, which means that crystallization process begins earlier in that area.

6 CONCLUSIONS

After this study, the next conclusions have been addressed:

- A CFD approach presented in this paper shows a good potential to predict defects in metal casting processes through particle modeling.
- The most important factor influencing the behavior of the solid particles in the mould cavity is their density in relation to the averaged density of the liquid alloy.
- The two defects shown on figure 2 are confirmed with the numerical analysis carried out here. For the so called "Steel Island" defect, the oxides are placed on particular areas, on the upper surface of the piece, forming a characteristic shape of island. Finally, due to a water hammer effect inside the mold, particles of sands are strip off and later trapped, particularly at the opposite side of the feeding ducts. This defect has been carefully reproduced through this particle model. It has been appreciated that final particles location depends on the cooling rate and temperature distribution in the system after filling.
- Regarding the future work, more precise definition of the thermal calculation should be included in the CFD approach with the aim of obtaining the unintended porosities at the end of the casting process. Moreover, further experiments should be conducted and compare the experimental with numerical outcomes.

NOMENCLATURE

BBGC	Bottom Boundary Gravity Current
CCD	Charge-Coupled Device
CFD	Computational Fluid Dynamics
DPM	Discrete Particle Model
FAVOR	Fractional Area-Volume Obstacle Representation
FVM	Finite Volume Method
GMRES	Generalized Minimum Residual Solver