62nd Conference on Glass Problems

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62nd Conference on Glass Problems

A Collection of Papers Presented at the 62nd Conference on Glass Problems

John Kieffer
Editor

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at Urbana-Champaign

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Preface

The 62nd Conference on Glass Problems continues a long tradition of meetings that bring together representatives from the glass manufacturing industries, supplier companies, academia, and government agencies. Attendees from around the world gather for two days and discuss the latest developments in glass manufacturing technology, market trends, and legislative policies. This conference provides a meeting place for professionals and students, as well as an environment for learning, information exchange, and the inception of new initiatives.

The Conference on Glass Problems is an annual event, which is hosted in alternate years by the University of Illinois and the Ohio State University. The first conference was held in 1934 at the Department of Ceramic Engineering of the University of Illinois, and was organized by Prof. C.W. Pamerlee, who perceived the need for a forum at which the glass manufacturing industries could discuss practical issues associated with plant operation and product quality.

The tragic events of September 11, 2001, which occurred a short five weeks before this meeting, cast a perceptible shadow on the conference. The impact that the terrorist attacks had on the way we go about our daily lives, the concern it caused for safety, and the ensuing reluctance to travel created a serious digression from the objective of this conference, especially during the intense final weeks of planning.

It was therefore gratifying to see that the participation at the conference, although down from previous years, was much larger than some skeptical predictions would have suggested. In this light, the 62nd Conference on Glass Problems was a success in two respects. First, the technical program was of consistent high quality, and second, through their attendance, the technical community demonstrated a resolve to overcome adversity and a commitment toward the preservation of the standards and values that have facilitated technological progress to the echelon we enjoy today.

The 62nd Conference on Glass Problems included the following four topical sessions:

1. Process Modeling and Control, chaired by Ruud Beerkens, Richard E. Galusha, and Larry McCloskey
2. Energy and Melter Technology, chaired by R. Eugene Davis, Robert Lawhon, and Phillip Ross
3. Refractories, chaired by Gary M. Crabb, Tom Dankert, and Marilyn DeLong
4. Market and Technology Trends, chaired by Gary M. Crabb, Tom Dankert, and Marilyn DeLong

Following tradition, papers presented at the 62nd Conference on Glass Problems are published in the 2001 edition of The Collected Papers. The manuscripts in these proceedings are reproduced after they have undergone a rigorous review by the respective session chair. The assistance of the session chairs in this process is greatly appreciated. Minor editing upon compilation of The Collected Papers was done by John Kieffer. The University of Illinois is not responsible for statements and opinions expressed in this publication.

Acknowledgments

A special note of appreciation is extended to the members of the Program Advisory Committee:

Prof. Ruud Beerkens, TNO-TPD Glass Technology

Mr. Gary Crabb, Corhart Refractories

Mr. Tom Dankert, Owens Illinois

Mr. Eugene Davis, Thomson Consumer Electronics

Ms. Marilyn DeLong, Certainteed

Mr. Richard Galusha, Corning Incorporated

Mr. Robert Lawhon, PPG Industries

Mr. Larry McCloskey, Toledo Engineering Co.

Mr. Phillip Ross, Glass Industry Consulting

Members of this committee have been instrumental in identifying and soliciting outstanding speakers on timely topics. The work of this committee ensures the high quality of papers presented at this conference, which is key to its continuing success.

The official welcome to the conference was given by David Daniels, Dean of the College of Engineering of the University of Illinois. Prof. John Weaver, Head of the Department of Materials Science and Engineering made the opening remarks.

Prof. John Kieffer of the University of Illinois at Urbana-Champaign was Director of the 62nd Conference on Glass Problems, and Prof. Charles H. Drummond, III, The Ohio State University, presided at the banquet.

The conference was held at the Krannert Center for Performing Arts. Logistics, facilities, and services have been superbly arranged, thanks to Jay Menacher, Assistant to the Head of the Department of Materials Science and Engineering, and Scott Miller and his associates from the Office for Conferences and Institutes at the University of Illinois.

Ceramic Engineering and Science Proceedings
John Kieffer

Process Modeling and Control

Practical Examples and Advantages of Advanced Control Applications by Expert System ESII

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Advanced furnace control is one of the latest improvements in furnace and forehearth operation. This new concept allows us to build knowledge about the process into an interactive control strategy. Most of the forming processes, such as those for float glass, flat glass, container glass, LCD glass, TV glass, pressed glassware, fiberglass, tableware, tubing, and lighting glass, highly depend on precise forming conditions, such as temperature and proper thermal gradient of the glass entering the process. Advanced control of conditioning can significantly improve these parameters and influence directly production efficiency. Additionally, advanced control helps to improve the melting performance and reduce energy usage, by reducing variations and consistent operation. This article describes practical results from several industrial applications.

Introduction

The relatively recent introduction of cheaper and faster computers influenced wide use of conventional control for melter, forehearth, and lehr operation and became a platform for advanced software technologies,[1] such as advanced furnace or forehearth control. This new concept allows us to build knowledge about the process into an interactive control strategy, enhance design capability of the forehearth, support the furnace operator, and solve difficult situations such as job changes and interactions between several forehearths. The following text will review the control tasks of melting and conditioning, discuss main control technologies, explain an advanced control concept, and present practical examples of its application.

Control Tasks for Melting and Conditioning

The effort to build a concept for advanced control leads us first to analyze the melting and conditioning process and its critical parts. Such bottleneck

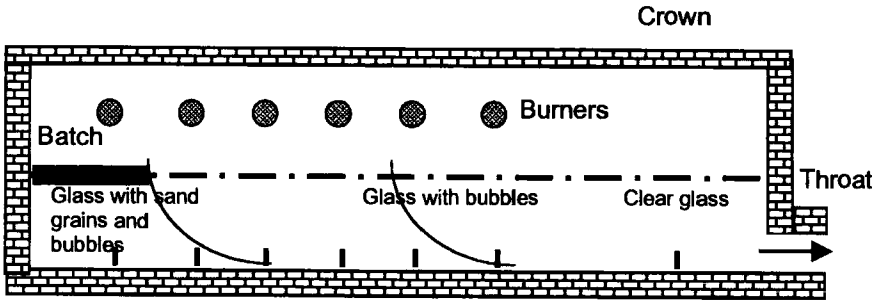

Fig. 1. Melting zones inside the glass furnace

analysis contributes to the understanding of what can be essential for control and how a control concept for conditioning interacts with furnace design and the melting process.

It should be noted that word "conditioning" has different meanings in various glass forming processes. Therefore conditioning is more linked to a particular forming process. Each conditioning system depends highly on glass type as well as on particular forming method.

Glass Quality Control: Primary Glass Defects

The target for good glass quality is to balance mass flow of the batch with an appropriate amount of heat to cover the chemical reaction and glass and batch heatup. This demand resulted in today's concept of tank design, which was developed over the last 100 years. This tank concept has several zones with gradual melting and refining phases (see Fig. 1). First, heat is supplied into the cold batch, which is converted into a liquid phase filled with heterogeneous mixture of solid particles (mostly silica sand grains) and with still reacting batch material releasing of lots of gaseous phase (bubbles and seeds). A second zone, which is mainly below the batch blanket, contains molten glass, dissolving silica grains, and bubbles with no vigorous chemical reactions. As silica sand is usually dissolved faster than bubbles are refined, there is a zone containing only glass and bubbles. This zone is closer to the throat and poses a high risk of reduced glass quality. The last zone can be defined as preconditioning and buffer zone. Glass temperature is reduced in this part and additional residence of the melt here can contribute to additional refining. In most furnaces, the following zones can be found: