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DMG WORLD MEDIA

CZECH GLASS SOCIETY

TECHNICAL CONFERENCE PROCEEDINGS OF ABSTRACTS

GLASSMAN EUROPE 2007 CONFERENCE

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Content - lecture program

Added papers from universities

Introduction

The organiser of Glassman Europe 2007, DMG World Media (DMG), has joined forces with the Czech Glass Society (CGS) to prepare this technical conference. The book of abstracts and the proceedings with full papers on a CD includes 14 contributions from 7 countries and 5 added papers from two Czech universities.

This is the first conference prepared in coordination with CGS and DMG with a target to offer lectures closely connected with industry applications. The important goal is also show new products of exhibitors in Glassman Europe 2007 in the context of research.

The conference is divided into 2 sections: Energy Conservation in Glass and Manufacture and Technological Innovations in Glass Manufacture. The seminars include contributions from invited speakers, as well as selected exhibiting companies. The papers are prepared on a high technical level and the hope is that the lectures will lead to a wide-ranging discussion and open exchange of experiences.

Prague - “the heart of Europe” - is a suitable place for these formal and informal exchanges of knowledge, information, results and recommendations. The organisers also hope that visitors have the opportunity to visit many wonderful places in Prague.

PREPARATORY COMMITTEE

About the Czech Glass Society

The CZECH GLASS SOCIETY (CGS) is a voluntary, professional organisation which includes individual and collective members of glass branches, costume jewellery branches and allied branches, including their suppliers. The CGS was established in 1946 with the aim of uniting Czech glass specialists and maintaining a high standard of glass work. It has operated continually since then, regardless of the historical changes to the Czech countries.

The CGS helps to develop the creative activities, abilities and knowledge of its members. It is concerned with glass science, research, technology, living environment protection, glass works history, art, glass experts education, etc. These activities concentrate mainly upon, the organisation of professional conferences, seminars, lectures, professional courses, club activities, the editing of professional journals and books, the organisation of competitions and awarding prizes, consultation and preparation of standards, organisation of excursions and educational stays and visits of its members.

Activities of CGS are reflected in different professional sections:

- Raw materials, furnaces and glass melting
- Glass processing machines and glass forming
- Glass control – laboratory methods
- Ecology
- New glasses
- History of glass
- Control and modelling of technological processes
- Glass education system
- Art

The Czech Glass Society has 441 individual members and 31 collective members (companies employing around 2500 people); its Chairman is Petr Beránek.

The CGS is a member of national and international organisations: the Association of Glass and Ceramics Industry of the Czech Republic, the Czech Union of Science and Technology-Societies, the International Commission on Glass (ICG), the European Society of Glass Science and Technology (ESG).

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About Glassman Europe 2007

The International Glass Manufacturing Exhibition makes a welcome return to Prague in 2007, following the success of the 2005 event. Glassman Europe is staged on 9-10 May 2007 at the recently refurbished Industrial Palace exhibition centre.

Glassman exhibitions focus on the technology requirements of the primary glass manufacturing community. Industrial-scale producers of glass packaging, machine- and hand-made domestic glassware, flat glass, glassfibre materials and other specialist types of glass are among the event's core visitors.

Organised by dmg world media, Glassman exhibitions are held in emerging and traditional glassmaking regions throughout the world. Events are staged on a cyclical basis in Eastern and Western Europe, throughout South East Asia, as well as North and South America. In addition, in 2007, Glassman Middle East is launched in Egypt.

Future dates for your diary include:

- Glassman Middle East, Cairo, Egypt, 4-5 September 2007
- Glassman Asia, Hong Kong, 12-13 March 2008
- Glassman Europe , 13-14 May 2009

Associated publications *Glass International* and *Glass* are widely recognised as the international primary glassmaking community's leading English language magazines. Published 10 times per year, *Glass International* provides unrivalled coverage of the glass manufacturing industry worldwide. Two Chinese language editions are also produced annually. Sister bi-monthly publication *Glass* concentrates on news and developments in the influential European market, a region with which the title has been associated for more than 80 years.

For the latest news on these exhibitions and publications, visit the website www.glassmediaonline.com

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Energy Savings in Batch Melting

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The contribution is focused on the influence of chemical reactions between raw materials and intermediate products upon flow of technological process. On specific mechanism of chemical reactions depends if a melting suit proceeds by desirable way, i.e. by conversion of glass batch on glass melt or if the undesirable structures generate which are conducive to the operational problems and decrease in the efficiency of melting process. Some these undesirable structures which may generate in glass batch by unsuitable its course are described. The technological significance is also judged. Further the possibilities prevention its formation are discussed. Enclosures are supported with data from literature about energy saving by correct course of processes by conversion glass batch on glass melt.

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Analysis of Energetic Performance of Glass Melting Processes as a Basis for Advanced Glass Production

Lubomír Němec, Marcela Jebavá
Laboratory of Inorganic Materials, the Czech Republic

The experimental and theoretical knowledge of the industrial glass melting process, acquired during two last decades, opens a way to new melting concepts, characterized by smaller size, high performance and flexibility, low energy consumption and by producing high quality glasses. The modern features of such concepts offer the potential for production of new and advanced glassy materials produced in small intensified melting facilities and exhibiting extraordinary quality. The key to successful solution lies in melting process analysis, partially free from industrial experience. This work presents a method to evaluate the effect of temperature, process time, flow conditions and insulation in a model melting space (simulating melting tanks) on energy consumption, melting performance and flexibility of the process to convert rapidly from one glass type to another type of glass , in terms of dissolution and bubble removal (fining). The condition of complete accomplishment of both homogenization processes just prior to the glass leaving the space was kept in all calculations. The calculations applying the laboratory sand dissolution times and fining times aimed at finding theoretical optimum conditions of dissolution and bubble fining processes during glass melting. The results obtained under isothermal conditions provide a way to improve fundamentally both processes; particularly by process separation, application of controlled glass melt flows and special conditions for bubble removal.

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Possibilities of Energy Consumption Reduction in the Course of Glass Annealing

František Voldřich, the Czech Republic

The consumption of energy in the course of annealing of glass articles does not depend only on the level of technological method , it is also influenced by a number of other effects.

Mainly it is a quality of a conveyor belt lehr, a transfer of articles from forming machine, articles loading on conveyor belt of lehr, a design of a forehearth, pressure conditions in a conveyor belt lehr.

Lehr should embody surface losses by radiation as minimal as possible, heating proper for all fillings of a lehr, control of pressure conditions according to needs of a range of products.

Transfer from a forming machine should provide a cooling of articles as small as possible before proper annealing process. i.e. hood design of transport belt, its boosting, transfer onto cross belt, its covering and a solution of a minimum area of input and output of a lehr forehearth. Cross belt should be designed in such a way to sustain temperature variations from ambient temperature of a lehr up above annealing temperature.

A row of articles loading by means of a rod in such a way so they'll go beyond the boundary of the first heating zone, i.e. behind the end of a forehearth. Stability of articles position on conveyor belt for possibility of automatic articles unloading at the end of conveyor belt lehr.

By optimizing all influences it is possible to work out a setting schedule for each article annealing enabling to minimize a consumption of a conveyor belt lehr.

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Reduce Furnace Energy Consumption Using Calumite

Nicola J. Marriott, Calumite Ltd, UK

Calumite is an environmentally beneficial alumina source used in all types of soda-lime-silica glass making. Its unique melting and refining properties enable glass makers to reduce energy consumption, lower furnace temperatures, increase furnace pull, improve glass quality and reduce CO_2 and NO_x emissions.

The glassy nature of Calumite, combined with its chemical composition increase the melting rate of the batch. Depending on the specific furnace design and control parameters, this can be used to reduce the total energy consumption per tonne of glass, or specifically to reduce the use of electric boost.

Results are presented of energy savings that have been achieved through Calumite implementation in three different container glass furnaces. Addition of Calumite to a flint container furnace led to an overall energy reduction of 9%, while adding Calumite to an amber container furnace reduced total energy consumption by 4%. During a Calumite trial in a green container furnace, the electrical energy consumption was reduced by over 25%, due to increases in furnace bottom temperatures that resulted from the faster melting with Calumite. In addition to these energy savings, improved refining with Calumite typically reduces the seed count by at least 50%.

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Burners for Glass Melting Furnaces

Neil Simpson, Eclipse Incorporated, USA

Historically, Eclipse has focussed on burners for glass melting furnaces. More recently, in order to meet the glass forming needs of our customers, Eclipse has developed oxy-fuel forehearth burners to improve glass conditioning and distribution in glass fibre, container glass and speciality glass applications.

To meet the needs of float glass manufacturers, Eclipse has demonstrated the use of radiant tube burners for auxiliary heating for the tin bath. This provides Eclipse with the most comprehensive portfolio of burner products for the glass industry.

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Energy Savings and Glass Quality Improvement by Mathematical Modelling and Advanced Furnace Control

Petr Schill, Glass Service, the Czech Republic

The goal of the latest strategy in glass companies is to decrease the cost of production while maintaining or increasing the glass quality. There are several perspective ways leading to this goal: optimization of the heating system, modification of the furnace design, or implementation of the new advanced control system. Optimization of the heating system can be achieved by installing modern burner system, re-arranging the burner locations, changing the type of fuel, or installing the electric boosting into the existing furnace. Using the advanced control system leads mainly to the stabilization of the furnace operation which results in energy savings and glass quality enhancement.

The use of the CFD modelling capability represented by Glass Service Glass Furnace Model (GS-GFM) and the use of advanced control represented by GS Expert System III™ (ES III™) are presented in this contribution.

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The Glass Surface and Ways of its Modification

Ferdinand Trier, Munich University of Applied Science, Germany

Ulrich Ranke, Ormo Print GmbH, Germany

Many glass products benefit from the modification of its originally surface. For many glass products, a surface modification is even essential to achieve the desired functionality.

The reasons for a surface modification may be motivated either from:

- Changing functional properties of the product
- Decoration of the product

For the modification of a glass surface, there are different techniques in use. These modification techniques can be generally classified into three groups:

- Removing material from the glass
- Adding material to the glass surface
- Exchange material at the glass surface (a simultaneous removing and adding process)

Techniques from all of these three groups are currently used in the glass industry for hollow glass, flat glass as well as for special glass applications.

Techniques, where material is added to the original surface are also known as coating techniques. The thickness of these coatings may be from a few nanometer up to millimetres, while the number of layers may be from one layer up to 100 layers and more. In the last decades, several new materials and processes could be introduced for coatings on glass.

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Advanced Technologies for Glass Decoration

Martin Hehl- Heinz, Marabuwerke GmbH& Co. KG, Germany

- Segment Evaluation Glass
    - ° Market Nisches in Glass Printing
    - ° Differentiation
    - ° Positioning

- Influence of cold-end-coating on printability
- Three kinds of surface coated packaging glass and differentiation of decoration
- Surface characteristics flat glass and influence on decoration
  => Flat glass TSG – tempered safety glass – process and printability
  => Flat glass MLG – multi layer glass – process and printability

- Requirements of glass for packaging
- Requirements of Restaurant glass
- Pre treatment and post treatment
- Benefits of glass decoration in comparison with label printing
- Cost comparison organic and thermoplastic ink systems
- Technical benefits Organic Ink Systems
- Summary

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The Benefits of Vacuum in Bottle Production

Daniel Hilfiker, Pneumofore, Italy

Depending on the applied IS technology, vacuum can be relevant or absent. Many hollow glass plants world-wide still run without the support of vacuum, as additional form of energy to improve the moulding process. Still, starting from a certain complexity of the glass container like for higher 'esthetical' quality standards as required for high end perfume bottles, sophisticated engravings or for changing wall thickness, vacuum does strongly influence the moulding process. Besides reduced rejection rate, also moulding speed is improved. Different vacuum pump solutions and practical examples will be explained by Pneumofore, the world-wide leader of vacuum systems for glass works.

The example of the Gerresheimer factory in Mumenmier, Belgium states productivity increase of 6 % since the implementation of vacuum on their is machines. Provided vacuum is present, Pneumofore does engineer a dedicated solution for the long-term, durable and efficient design of the vacuum system. The frequent mistake of considering purchasing price only without analysis of additional costs can generate unpleasant surprises down the way.

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CG Iridium – Metal for the 21st Century

Christophe Couderc, Paul Williams and Duncan Coupland, Johnson Matthey – Noble Metals, UK

Iridium is a precious metal that has just been launched by Johnson Matthey for use in the glass industry. It is used by numerous glass customers due to its extensive chemical and mechanical properties. Iridium has the potential to be as well known as Platinum or Rhodium/Platinum alloys for high quality glass manufacturing process in the near future.

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Reverse Engineering in Glass Mould Engraving Design

Emre TACIR, Merkad Glassware Moulds Ltd., Turkey

To meet the needs of float glass manufacturers, Eclipse has demonstrated the use of radiant tube burners for auxiliary heating for the tin bath. This provides Eclipse with the most comprehensive portfolio of burner products for the glass industry.

As computer-aided design (CAD) has become more popular, reverse engineering has become a viable method to create a 3D virtual model of an existing physical part for use in 3D CAD, CAM, CAE and other software. The reverse engineering is the process of taking a finished product and reconstructing design data in a format from which new parts or molds can be produced.

Reverse engineering is very effective way of relief modelling. The most preferred method is 3D scanning. Process steps are as follows:

1- The physical object (glass product, mould, plaster model etc.) can be scanned using 3D scanning technologies. A 3D scanner can be used to digitize free-form or gradually changing shaped components as well as complex decorations, textures or logos.
2- Scanning process is performed with probe contact scanning machine.
3- The scanned or measured data alone, usually represented as a point cloud (A point cloud is a set of three-dimensional points describing the outlines or surface features of an object.) lacks topological information.
4- The point cloud processed and modeled into a more usable format such as a triangular faced mesh, a set of surfaces or a CAD model.

Merkad successfully utilizes the reverse engineering for relief creating. With this particular method, a sample relief model is scanned and then copied in 3D. After making all necessary and requested changes on the model, Merkad carries out the precise wrapping of the relief on a new base surface. After the design details have been finalized, Merkad submits the data, in DXF, STL or IGS file format, to the client for approval. The procedure is primarily computer-based, so any modifications can be made quickly and easily.

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Optimising Glass Melting Processes with Energy & Mass Balance Calculations

Hans Mahrenholtz, Andre Ommer, Linde AG , Ogis GmbH, Germany

Furnace: Serves for the creation of new furnace variations which are then shown in the summary. Two furnaces have been pre-installed as samples and can be edited or deleted as per your requirements. The furnace menu also offers the option to define gases, oils and refractory materials in detail and as and when required and also to modify our input values. Raw material The raw material menu serves to determine the ideal glass composition. Add a chemical analysis (if available) to each raw material, including the economic data such as cost per ton etc.

Batch/ Glass Calculate the glass characteristics for the selected batch composition on the basis of the glass composition. The following parameters can be calculated: viscosity, fusibility, density, specific thermal capacity, thermal expansion and conductivity, elastic characteristics, electrical conductivity, kinetics, dielectric properties etc, using more than 45 different models of, e.g. Lakatos (VFT), Sasek, Appen, Ledererova, Braginskii, Huggins and Sun. The Wizard Technology allows to add or remove raw materials from the database during batch composition calculation.

Energy Balance One of the most comprehensive menus within our engineering program! There are no limits to the option to have the furnace energy balance calculated for an existing or newly created furnace with integration of an existing batch composition. This function is supported by a .pdf export so that the results can easily be transferred to another computer or team member.

The output parameters are among others the gas consumption resp. the gas consumption of the additional burners, the specific energy, the specific energy cost, the computed exhaust gas volume as well as the combustion air volume in Nm^3/day, just to name a few. The option of variation calculation shows quickly and concisely which important parameters change when f.ex. the cullets are supplied preheated at 300°C or the air pre-heating is increased by 100°C.

A further feature is the O^2-conversion with determination how temperatures and consumptions or energy ratios change when melting with pure oxygen or when converting from oil to oxygen firing. The segment oxy-boosting offers the option to calculate, how much an O^2-boosting burner consumes to achieve a capacity increase of f.ex. 10% or vice versa or which measures have to be taken to keep the capacity while reducing the exhaust gas volume. All these calculations respect the initially set batch composition.

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Latest Vision Technologies Offer News Horizons for Hollow Ware Inspection

Jean-Luc LOGEL, IRIS Inspection Machines, France

In the global search for innovations totally devoted to customer satisfaction, the glass industry is facing technical challenges, between a pressing need for quality improvements and the essential target of maximized profitability. Part of this challenge is the ability of inspection machines to discriminate between saleable containers and non commercial ware. Innovations in optics and image processing increase the selectivity of inspection and have a direct pay back in term of reduced number of claims and better productivity.

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WALTEC'S Triple Gob Production Line for Press Ware, Ultimate Reply to Challenges of Market

Klaus Poeting, Waltec Maschinen GmbH, Germany

The competition among the tableware producers becomes bigger and tougher. The manufacturer, who can offer better price conditions due to a higher production speed and who can additionally produce a better surface quality due to better polishing equipment, has the best chances to get the order.

Based on these facts WALTEC has developed the triple gob production line :

Feeding by electronic feeder with triple gob equipment for highest gob weight constancy and electric precision shears. State of the art control systems with highly efficient operator-orientated control panels.

Press Machine.

The optimized gearless torque motor enables very short indexing times and therefore higher production speed at the same pressing sequence. The servo hydraulics of the 3 press cylinders has been developed for the pressing at high speed. With the help of position, speed and pressing force control it is possible to realise shortest press cycles. Reduction of down time due to a pneumatic quick-clamping unit at the press cylinder for the plunger/ring spring cage unit and quick-changing cages for the moulds.

Further features: Cooling air manifold, completely height-adjustable and vertically movable cooling tubes for highly efficient article cooling. Each cooling tube can be switched off manually or automatically. Mould temperature indication for each mould.

The High Speed Take-out has been used for many years for high speed application. Therefore speeds up to 60 cycles/minute can be achieved without any problem. Direct loading of the fire polishing machine eliminates faults by supplement handling.

Rim and Surface Polishing Machine.

It is a servo-driven linear type, continuously running and directly loaded by the take-out. An automatic synchronisation to the take-out guarantees an exact positioning of the articles on the polishing spindles. The servo-driven spindles are speed-adjustable. The servo-driven slide for the burner assembly follows the spindles during the polishing time. By using short gas/oxygen burners an oxygen and gas saving of up to 70% can be achieved.

Transfer to Cross Conveyor.

The transfer is done by a star wheel with grippers. It is mechanically synchronised with the polishing machine. The transfer is realised directly from the fire polisher to the cross conveyor.

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About Department of Glass and Ceramics, ICT Prague and Laboratory of Inorganic Materials

Aleš Helebrant, Lubomír Němec, ICT Prague, Department of Glass and Ceramic, Laboratory of Inorganic Materials, the Czech Republic

Department of Glass and Ceramics is one of largest departments at the Faculty of Chemical Technology, which is part of the Institute of Chemical Technology in Prague. The department members are 2 full professors, 7 associate professors, 10 assistant professors and scientific co-workers and 6 technicians. The department is responsible for teaching in bachelors, masters and PhD. programmes in the field of *Chemistry and technology of inorganic materials* and *Materials chemistry and engineering*. It is also cooperating with other departments of the faculty in study programmes *Conservation - restoration of cultural heritage objects – works of arts and crafts* and *Synthesis and manufacture of pharmaceuticals*.

The courses provide students with and understanding of relations between the chemical and phase composition, and of the microstructure and properties of glass and ceramic materials. Students learn about modern methods of chemical analysis, the structure and microstructure of glass and ceramics, and processes in the manufacture of inorganic materials. They get acquainted with new types of glass and ceramic materials, including biomaterials and glass-ceramics. They learn to apply basic engineering disciplines in the processes of inorganic materials manufacture, and gain an understanding of the fundamentals of management, economics and automated control systems.

Graduates find employment in the area of research, engineering, management and commerce.

Both in education and in research, the department cooperates with the Laboratory of inorganic materials which is the joint research facility of ICT Prague and the Academy of Science of the Czech Republic.

Research in the Department and in the Laboratory is pursued in the form of both targeted basic research, which is mostly funded from grants, and contract-based cooperation with industrial companies on solving their specific problems. A broad range of addressed problems concerns primarily chemical aspects of materials sciences and engineering. Research into new materials and theoretical fundamentals of production processes concerns in particular:

- development of new types of glass and ceramics, including bioceramics and bioactive glasses for bone implants, construction ceramics, glasses for waste immobilisation, lead and lead-free crystal glass, and fast ion conducting glasses, glasses for optical waveguides, glasses for fotonics;
- development of functional layers by sol-gel methods;
- refractory fibrous composites with a cement binder;
- alkali activated inorganic binders (geopolymers);
- transport and colloid-chemical phenomena and their effect in the manufacture of traditional and modern ceramics;
- physical, mathematical and experimental modelling of glass melting furnaces and processes;
- reactivity and evaporation of silicate melts, electrochemical processes in glass melts;

- chemical interaction of materials with the environment, mathematical description of glass corrosion;
- chemical resistance of glasses for medical, pharmaceutical and food processing purposes;
- development of new applications of electron microscopy and micro-analytical methods for the assessment of inorganic materials and for the analysis of solid surfaces, modelling of glass structure

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Application of Computer Simulation in Automatic Glass Producing

František Novotný, Ivo Matoušek, Marcel Horák, Vlastimil Hotař, Department of Glass Producing Machines and Robotics, Technical University of Liberec, the Czech Republic

The article presents a summary about the scope and methodology of the use of C-technology applications used for the solution of technical problems in the Department of Glass Producing Machines and Robotics, Technical University of Liberec. The attention is focused on three fundamental directions of numerical simulation used for the solution of technical problems in glass industry, as follows: numerical simulation of glass forming processes based on FEM, application of computer modeling in a sphere of robotic manipulation, principles of fractal geometry.

Possibilities of virtual simulations use for effective problem solving are shown on concrete examples from production practice. Numerical outputs are presented in the form of temperature and strain (strain rate) field process during individual stages of glass forming cycle. The approach to the optimization of glass forming with a view to glass forming tools optimization is outlined too. Special attention is paid to the problem of virtual simulation of two-step forming of domestic glass producing by press and blow process. The applied approach is effective way for the identification of potential technological problems and their subsequent optimization especially in the production of nonstandard products with extreme technological requirements.

Computer modeling possibilities of dynamical forces are presented below. Results of numerical solutions are used by solving complicated handling tasks in the sphere of a robotics manipulation and contact tasks for a design of special grippers. The paper describes records of research in the field of modeling of an automatic dynamic handling with thin glass sheets. Methodology of the computer modeling is focused to the problems of simulation of gripping head system, gripping elements and object of handling *(glass sheet)*. Material properties, a design of contact bodies and character of contact surfaces are respected and the real courses of handling cycle are described by specific initial and boundary conditions. Concrete results are summarized to the database system for an optimalization of a computer design of vacuum gripping heads.

Finally, principles of fractal geometry and examples of application possibilities are shown for the objective specification of defects in glass products, for evaluation of data set captures in the form of time series and for a glass production control. A new principle of a corrugation test objectification for the evaluation of glass sheet quality with a possibility of its full automation is significant results.

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Robotic Handling with Flat Glass

František Novotný, Marcel Horák, Department of Glass Producing Machines and Robotics, Technical University of Liberec, the Czech Republic

Automatic handling in the glass industry has been applied both on cold and hot ends of production lines. It is obvious it concerns the handling processes, which differ in a handling task character that is given especially by shape stability of the object handled. This stability is determinated with different viscosities (temperatures). Handling technique on the hot end of the line can be used when hot products are moving from a pressing device to an annealing lehr when requirements for higher thermal exposition must be taken into account. It is necessary to turn attention to an effector's design so as to meet conditions for careful and non-destructive handling. Of course, the setting-up of drive kinematical parameters of handling devices is also connected with that.

The project has analysed behaviour of the system vacuum gripper - glass sheet during dynamic handling at the flat glass production using latest computation means.

The accent is put on the description of the contact task solutions using various types of contacts aiming to apply knowledge obtained not only for optimisation of four vacuum grippers but also for optimisation of machines and equipments. Present possibilities of software based on FEM principle are relatively wide and can be applied in many branches. A sufficient informative level of results of the simulations is considerably influenced by the quality of input data acting in parameters of initial and boundary conditions. Great attention must be paid to material properties of contact bodies, which are gripping element, elastomer, and glass in our case.

The article presents results of the research relating to vibrations of thin glass sheets during robotized handling with a great dynamic loading. When solving the numerical simulation of gripping the sheet using active vacuum gripping heads, elastic contact bonds with elastic behaviour of the sheet and hyperelasticity of suction cups were took into account analysing the behaviour of contact bonds of the system: object - gripper. Results of the simulation can be used for an optimization of suction cups arrangement as well as for adjustment of drive parameters of the handling device.

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Computer Modelling and Optimisation of Glass Forming Cycle

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The claims on ensuring high quality of manufactured products and improving efficiency of the glass forming can not be ensured by conventional methods of the forming cycle proposal already. The effective approach to the identification of weak points of glass forming cycle itself and its subsequent optimisation already in pre-manufacture stage is an application of tools of virtual modelling. Computer model enables monitoring of individual stages of the whole glass forming cycle and its application already in pre-manufacture stage allows reducing physical prototyping, the rate of product rejects and material waste as well as accelerating cost-effective product development.

In the paper the approach to the prediction, localisation and identification of potential technological problems is shown. Used methodology is based on the general concept of virtual modelling of glass forming cycle. The computational analysis is based on fully coupled thermo-mechanical strategy. Constitutive behaviour of glass melt is described through generalised non-Newtonian viscous model. Close attention is paid to reliability of acquired outputs and to the problem of prediction of technological defects already in pre-manufacture stage. Therefore, based on the analysis of defects and technological problems typical for manufacturing pressed assortment, criteria allowing their identification and localization are suggested.

In the contribution the process of optimisation of glass forming cycle is also presented. Attention is aimed mainly to the problem of effective modification of temperature fields' distribution in glass forming tools. Due to the complexity of solved problem (quasi-stationary character of temperature fields in glass forming tools) determination of optimization criteria is not simple. Therefore time discretisation of the forming cycle, which allows focusing on two, from the technological point of view, the most important time intervals: molten glass feeding and pressing, has been used.

In the conclusion the concept of controlled cooling of glass moulds is mentioned.

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Surface Profile Evaluation Using Statistic Tools and Fractal Dimension

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A lot of natural structures in industry applications can be hardly described by conventional methods – statistic tools, because they are complex and irregular. A relatively new approach is the application of fractal geometry that is successfully used in science, but an application in industry is sporadic and experimental only. However, the fractal geometry can be used as a useful tool for an explicit, objective and automatic description of production process data (laboratory, off-line and potential on-line).

Industrial data (from production processes, quality control, production tools, etc.) may have a form of digitalized pictures, time series or a topologically one-dimensional interface (especially a surface roughness or a surface profile). The data in a digital form can be described by the fractal geometry, which expressing the complexity degree of structured data (ideally) by means of a single number, the fractal dimension.

On this account, we are developing three off-line software tools that can be converted to on-line control tools in the future. The software tools use mathematical statistics and fractal geometry. The results of our research show that the fractal dimension is potentially a powerful tool for explicit, objective and automatic description and quantification of complex data and in a near future the methodology can be used for an off-line and an on-line measurement.

Our presentation is intended on application of the fractal geometry with combination of statistic tool for the evaluation of 2D pictures of surface defects and classification of dividing lines (a surface profile or a surface roughness evaluation) for a quantification of metal surfaces changes of relatively new materials: iron aluminides in comparison with currently used chrome-nickel steels in contact with the glass melt.

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