09:15

Andrey Zabolotsky

PhD in Engineering Sciences,
Magnezit Group, Russia

Section 1: Computer simulation

Modeling the initiation of destructive cracks in refractories during thermal shock

With the use of digital methods, the effect of operation conditions of refractories and their properties on the incipient stage of the crack development under thermal shock is considered. It is illustrated that at this stage the cracks development in ceramics mainly occurs as per fatigue mechanism. The examples are given for quantitative assessment of the defects development rate, which is not contradictory to available experimental data.

There may be changes in the time schedule.
See the current information on the website

09:40

Qiang Wang

PhD in Engineering Sciences, Wuhan University Technology, China

Section 1: Computer simulation

Numerical investigation of interaction between refractory lining and molten steel

A transient 3D numerical model has been established using volume of fluid-discrete phase model technology to study the gas-oil-water three-phase flow in a RH degasser water model. The breakup and coalescence of gas bubble was taken into account, the bubble diameter being changed with static pressure. The wall shear stress and turbulence intensity were employed to predicate the erosion rate of the lining refractory, while the diffusion coefficient of the refractory material and the slag property at high temperature were used to consider the corrosion rate. The effects of the operational parameters on the refractory wear rate were clarified.

In order to study the effect of refractory graphite content and heating temperature on carbon pick-up of ultra-low-carbon steel from magnesia-carbon refractory, a transient axisymmetric mathematical model has been established. The momentum, heat and mass transfer between the refractory and the molten steel was modeled by using porous medium. Arrhenius law was employed to define the rate of the carbothermic reduction reaction of the magnesia. Besides, a series of experiments were carried out to verify the model.

There may be changes in the time schedule.
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10:05

Fangguan Tan

PhD in Engineering Sciences, Wuhan University of Technology, China

Section 1: Computer simulation

Creep behavior of purging plug during its periodic service process: a numerical approach

Purging plugs are widely used in secondary metallurgy, and their service life determines the downtime and usage efficiency of the whole ladle. For achieving long service life, thermomechanical mechanism analysis of a purging plug is of great importance. This research aims to analyze the creep behavior of a purging plug in the periodic service process by numerical simulations. The creep model was employed to predict the failure of the purging plug, and the creep test at evolution temperature was applied to obtain the mechanical properties of the purging plug. The simulation results showed that the creep behavior mostly located at the working surface of the purging plug. The corner of rectangular slits is more likely to result in irreversible strain due to stress concentration. Furthermore, the thermal distortion of a purging plug with circular slits is less than that of a purging plug with rectangular slits, which could be the reason that a purging plug with circle slits has a longer service life.

Keywords: failure mechanism; thermomechanical; purging plug; plastic strain

There may be changes in the time schedule.
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10:30

Anna Knyazeva

Professor, PhD in Physical and Mathematical Sciences, Institute of Strength Physics and Materials Science of the Siberian Branch of the Russian Academy of Sciences, Russia

Natalya Bukrina
(joint author)

PhD in Physical and Mathematical Sciences, Institute of Strength Physics and Materials Science of of the Siberian Branch of the Russian Academy of Sciences, Russia)

Section 1: Computer simulation

Simulation of the synthesis of new materials under conjugated heat exchange conditions

The coupled heat exchange is important for assessment of heating unevenness and for selection of proper conditions for synthesis of alloys and composites.

As examples, the models of synthesis for the new materials in cylindrical reactor under varying heating conditions are presented; in a thick walls reactor under conditions of the associated mechanical loading; in area between two inert layers with application of mobile load (typical for LOM techniques and for combination of dissimilar materials; as well as for electrolysers with application of CBC located close to building).

11:05

Alexander Grigoryev

Section 1: Computer simulation

Simulation of deformation and destruction of brittle porous materials of composite composition under dynamic mechanical and thermal influences

PhD in Physical and Mathematical Sciences, Institute of Strength Physics and Materials Science of of the Siberian Branch of the Russian Academy of Sciences, Russia

Evgeny Shilko (joint author)

PhD in Physical and Mathematical Sciences, Institute of Strength Physics and Materials Science of of the Siberian Branch of the Russian Academy of Sciences, Russia

Andrey Dmitriev (joint author)

PhD in Physical and Mathematical Sciences, Institute of Strength Physics and Materials Science of of the Siberian Branch of the Russian Academy of Sciences, Russia

A part of refractory materials applied, for instance, for manufacturing the lining of metallurgic heat generating units or casting moulds, in terms of their structure are composite ones and characterized by multilevel pore structure (contain pores which typical sizes may vary within several orders of magnitude). Due to the special features of manufacturing technique for products made of these materials (including the process violation or operation conditions), their pore space may contain some amount of liquid. Under the high mechanical and thermal influence upon these materials, for example, upon their contact with molten metal, the significant thermal stresses and strains are formed inside them. The pore liquid, being heated up to the high temperatures within the short time intervals, will significantly increase the pore pressure and therefore may substantially contribute to the change of the local stressed strained state of material. With the small amount of liquid in refractory material, it provokes forming the damages that, however, do not result in the crucial destructions and violations in the product's performance. However, in case of a water saturated material, the influence of pore liquid can be comparable to the proper thermal stresses in matrix and can initiate the microscopic brittle crushing of material leading to the failures in the product's performance, accidents and losses. Thus, the investigation of mechanical behavior and destruction of the porous water bearing heat resistant and refractory materials under the strong thermomechanical influence is an important scientific challenge, which has a great practical importance. Carrying out the experimental researches aimed to obtaining the assessment of the pore liquid contribution to the stressed strained state of porous matrix and to the condition of destruction is a rather difficult task. Therefore, in this proceeding, this task is being settled with the use of computer modeling by the discrete element method.

In order to solve the task on the base of developed by the authors method of the homogeneously strained permeable discrete elements, the double-level bound thermomechanical model of the porous composite material is developed. This model considers: a) mechanical interaction of the pore liquid and the solid-phase matrix, as well as redistribution of liquid within the pore space of material; b) thermal expansion of the matrix and the pore fluid, as well as the conductive transfer of heat by the filtered liquid within the matrix.

With the use of the constructed discrete elemental model, the preliminary calculations are carried out, which allowed revealing the influence of pore liquid on the strength and fracturing behavior of refractory materials under the strong dynamic and thermal influence. In particular, a possibility of creating the generalized curves for dynamic value of refractory strength (including the case when the liquid is present in the pore space) under mechanical and thermomechanical stress from non-dimensional parameter analogous to Darcy number is discussed.

12:30

Grigory Volkov

PhD in Physical and Mathematical Sciences, St. Petersburg State University, Russia

Yury Petrov (joint author)

PhD in Physical and Mathematical Sciences, St. Petersburg State University, Russia

Ivan Smirnov (joint author)

PhD in Physical and Mathematical Sciences, St. Petersburg State University, Russia

Section 1: Computer simulation

Methodology for assessing the dynamic strength of quasi-brittle materials

The dynamic strength of quasi-brittle materials is investigated as illustrated by the samples from ceramic and refractory bricks. For testing, the equipment was used on the base of split Hopkinson pressure bar, as well as a weight dropper. A compression diagram and a cracking diagram for cylindrical objects are considered.

The analysis of the obtained experimental data is carried out using structural time approach with the use of an incubation time criterion. The assessment of the strength parameters of the tested materials is performed with the use of randomize method of distorted functions.

It is illustrated that based on relatively small number of dynamic tests, the developed experimental and theoretical methodology allows identifying, with the high degree of reliability, the material failure conditions under spontaneous dynamic loads.

There may be changes in the time schedule.
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12:55

Henrik Saxen

Section 1: Computer simulation

Interpretation of hearth state in blast furnaces based on wear model calculations

Professor, Doctor of Technology (Chemical Engineering), Abo Akademi University, Finland

Mikko Helle (joint author)

PhD in Engineering Sciences, Abo Akademi University, Finland

The results of a model estimating the inner profiles of erosion and buildup material of the hearth region of ironmaking blast furnaces are presented. The model is based on the geometry and thermal properties of the hearth lining material, as well as thermocouple information from the lining. Inverse static heat transfer problems for two-dimensional slices of the hearth lining are solved to provide a three-dimensional estimate of the inner profile. Special attention is paid to the robustness of the solution, yielding a generic model optimized for fast computation, which makes it possible to analyze the furnace hearth conditions over whole campaigns. The results of the model are illustrated for several different blast furnaces, and some conclusions concerning its potential for shedding light of the blast furnace hearth state are presented. The possibility to utilize the reconstructed inner profiles for force balance-based estimation of the floating state of the dead man is also discussed.

13:30

Marina Mikhaylova

Engineer at the Modeling Department, Severstal, Russia

Section 1: Computer simulation

Research of steel flows in the tundish of a two-stream continuous steel casting plant

This work numerically simulates the flow in a tundish and also investigates the factors affecting the appearance of non-metallic inclusions in the slabs. The effect of structural components of tundish, such as turbostops and filtering partitions, on reaching the outlet holes by molten material, is assessed. The issue of influence of turbostop destruction during operation on flows inside the ladle and melt discharge characteristics is investigated.

There may be changes in the time schedule.
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13:55

Michal Sulkowski

PhD in Engineering Sciences, ArcelorMittal Refractories, Poland

Section 1: Computer simulation

Development of steel ladle lining on the wear profile

Wear observations and demolition measurement are important indication for improvement of the ladle life and safety for the user. There are several typical wear patterns of the ladle lining, indicating the need to change the structure of the lining and material properties in the area of the chemical composition of raw materials, the type of binder, granulation and microstructure, as well as the selection of the type of products and shapes of bricks.

Characteristic images of zonal wear under the influence of local factors in a given area indicate the need to introduce zonal lining with materials adjusted to this factor. Examples of wear images based on scans and photographs after campaign as well as examples of solutions to local wear problems and modifications to the lining structure for mechanical and thermomechanical factors are given.

There may be changes in the time schedule.
See the current information on the website

14:20

Ilona Jastrzębska

PhD in Engineering Sciences, AGH University of Science and Technology, Poland

Section 1: Computer simulation

Ceramics in metals joining and new perspectives of streamlining the welding processes

The work presents the raw materials used in the production of refractory ceramics for welding technology as well as influence of the phase composition on slag properties and welding technique. The phase composition of different welding consumables (electrodes and flux-cored wires) was determined by the X-Ray Diffraction Technique. The analysis of slag chemical composition was conducted by X-Ray Fluorescency[1].

The second part of the work presents the new perspectives of remote welding with a surgical robot equipped with a digital camera used to observe the welding zone, in particular the difficulty in detecting the boundaries of the weld pool[2]. The idea can be supported by new methods of computer image filtration using the augmented-reality welding mask[3].

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[1] Jastrzębska I., Szczerba J., Stoch P., Prorok R., Śnieżek E. (2015): Effect of electrode coating type on the physico-chemical properties of slag and welding technique, Institute of Welding Bulletin, vol. 59, No. 1, p. 46–52.

[2] Prusak Z., Tadeusiewicz R., Jastrzębski R., Jastrzębska J., The advances and perspectives in using medical informatics for steering surgical robots in welding and training of welders applying long-distance communication links, Welding Technology Review, vol. 92, No. 5, p. 37–49, 2020.

[3] Tadeusiewicz R., Jastrzębska I., Jastrzębski R. (2016): The possibility of creating a welding mask with computer processing of spatial image instead of welding filters (in Polish), Welding Technology Review, vol. 88, No. 1, s. 17–22.

This work was partly financially supported by the statutory funds of the Faculty of Materials Science and Ceramics AGH in Krakow, and Spaw-Projekt Sp. z o.o. Krakow.

There may be changes in the time schedule.
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14:45

Valery Volovikov

Head of the Systems Modeling Group, CADFEM CIS, Russia

Section 1: Computer simulation

Flownex for modeling distributed process control systems

The report presents Flownex SE software, which allows describing and collectively investigating physical processes and management systems in complex technical systems. With its help, the management system can be worked out both in normal operation modes and in startup and shutdown modes. Also, the tasks of minimizing the power supply consumption can be efficiently solved, the optimal load-productiveness balance of facilities can be provided, and other tasks of engineering multi-level automation systems can be solved.

There may be changes in the time schedule.
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15:10

Andrey Feoktistov

Section 1: Computer simulation

Application of new possibilities of ANSYS and Rocky to model the production of refractories. Software customizing

PhD in Engineering Sciences, CADFEM CIS, Russia

Grigory Usupov (joint author)

Calculation Engineer of Mining and Mechanical Equipment, CADFEM CIS, Russia

The report presents the new possibilities of ANSYS and Rocky software for modeling the solid particles' dynamics in terms of process parameters of preparation and processing the materials for refractory manufacturing. The new possibilities are considered for customizing Rocky, version 4.4, both for pre- and post-processing tasks and for mathematic models applied in a problem solver.

There may be changes in the time schedule.
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09:15

Andrey Borzov

PhD in Engineering Sciences,
Magnezit Group, Russia

Section 2: Digital twin of production (Big Data)

Implementation of Hot Adjustment software complex for rotary kilns of Magnezit Group LLC

This report presents the algorithmic features to implement reading, processing and 3D visualization of data obtained by the laser scanning method for the current state of a rotary kiln. The calculation algorithms for the object oriented limiting parallelepiped (OOLP) by the method of searching the eigen numbers and the matrix vectors, as well as their visualization by graphic library OpenGL are given.

There may be changes in the time schedule.
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09:40

Kirill Kalashnikov

Postgraduate, Institute of Strength Physics and Materials Science of the Siberian Branch of the Russian Academy of Sciences, Russia

Section 2: Digital twin of production (Big Data)

Application of local non-stationary metallurgy for the additive manufacturing of metal and polymetal products

In the last decade, the additive techniques find their application in various branches of industry. In the first turn it is connected to the fact that the use of such techniques allows reducing expenses for materials in the course of production due to minimization of mechanical treatment, as well as to increase performance and reduce the manufacturing time of products. The key feature of these methods is a possibility to obtain the products of specified shape “as-built”, with separation of manufacturing to three stages: preparation of CAD-model of component, 3D printing of product as per selected model, and the final processing to obtain the final component.

For manufacturing the large sized products in aviation and aerospace branches, the most applicable is the technique of Electron Beam Additive Manufacture (EBAM) based on wires or rods. It possesses the most preferable features, comparing to the competitors: simple implementation and high manufacturing speed.

The Electron Beam Additive Manufacture from wire/rod is characterized by the process of local non-stationary metallurgy, when the wire is directly fed to a molten pool created by the electron beam. It allows to finely monitor the material microstructure and to control its properties in the different areas of the same article. Due to application of the multi-wire feed technique, there is a possibility to form polymetal products with a gradient of physical&mechanical properties, and the use of feeding the metal rods will allow to implement 3D printing of the heat-resistant alloy products.

International online conference

Digitalization of industrial thermal processes and units

MAGNEZIT
cooperation in creation

This report will illustrate the basic features and possibilities of equipment for the Wire Electron Beam Additive Manufacture which is produced at the Institute of Strength Physics and Materials Science of the Siberian Branch of the Russian Academy of Sciences, as well as the examples of its application in the real economy sector, and also the promising trends of using EBAM in commercial production.

There may be changes in the time schedule.
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NOVYE (NEW REFRACTORIES) OGNEUPORY

ЧЕРМЕТ информация

ЦЕМКЛУБ

10:05

Ao Huang

PhD in Engineering Sciences, Wuhan University of Technology, China

Section 2: Digital twin of production (Big Data)

Computational modeling and prediction on viscosity of slags by Big Data mining

The properties of slag (such as viscosity and conductivity) are significantly affecting metallurgical process and slag recycling. Existing research studies related to slag properties mainly used traditional experimental measurement and theoretical modeling approaches. Nowadays, the idea of data-driven decision making has been widely used in many fields instead of expert experience. Therefore, first of all, this study investigated the prediction of electrical conductivity based on Big Data mining methods. The results show that the slag conductivity can be predicted through constructing predictive models, and the Gradient Boosting Decision Tree (GBDT) model is the best prediction model with 90% accuracy and more than 88% sensitivity. The robustness result of the GBDT model demonstrates the reliability of prediction outcomes. Secondly, an advanced dual-stage predictive modeling approach is proposed in order to accurately analyze and predict the viscosity of slag. Compared with the traditional single data mining approach, the proposed method performs better with a higher recall rate and low misclassification rate. A two-equation model of six-degree polynomial combined with Arrhenius formula is also established for the purpose of providing theoretical guidance for an industrial application and reutilization of slag.

10:40

Pavel Boriseyko

Deputy Head of Sales, Engineering Analysis and Technical Support Department, Sarov Engineering Center, Russia

Section 2: Digital twin of production (Big Data)

Comprehensive approach to creation of digital twins by the Sarov Engineering Center

The program presents a complex of applied solutions on creation of digital twins by Siemens company.

The information is presented in a general way about STAR-CCM+, NX, Amesim, Heeds and their interaction while creating a digital twin.

Moreover, a ready example of a digital twin developed by the Sarov Engineering Center for a gas-turbine engine designed by AO “ODK-Klimov” and PAO “ODK-Saturn” is presented.

There may be changes in the time schedule.
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11:05

Stanislav Voronin

Expert on Digitalization, Siemens, Russia

Section 2: Digital twin of production (Big Data)

Virtual Commissioning

Virtual Commissioning or virtual putting into operation is a generic term for a complex of software solutions which allows creating highly-accurate digital twins for technical proceses, for DCS, SCADA and HMI systems, both at local and global levels.

The created digital twins are universal and can be used by engineers of various disciplines to carry out the virtual tests of DCS, for optimization of some element/mechanism/process/logical link, assessment of ergonomics, prevention of emergency scenarios, associated with errors while programming systems of automatic control, as well as for personnel training. This, therefore, leads to the significant saving of costs and time at all stages of engineering and commissioning.

There may be changes in the time schedule.
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13:20

Ilya Skryabin

CEO (Chief Executive Officer), Connective PLM, Russia

Section 2: Digital twin of production (Big Data)

Digital twin of production. Practice of creation and economics of implementation

The following will be considered in the course of reporting:

- Purposes for which a digital twin is required at an enterprise.
- Which enterprises require implementation of a digital twin.
- Typical mistakes to be avoided when implementing such a tool.
- The concept of a digital twin and stages of its creation.

There may be changes in the time schedule.
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12:55

Nikita Dolgushev

PhD in Engineering Sciences, almaGRID — Digital Platforms, Russia

Section 2: Digital twin of production (Big Data)

Use of network (graph) mathematical model for analysis of cause-effect relationships and probabilities of equipment breakdowns

For efficiency management of production assets, it is necessary to apply a model of equipment reliability with the use of which it is possible to estimate the probability of equipment breakdown and to assess the potential severity (negative effects) of breakdowns for the enterprise.

Application of almaGRID software is used to create a network (graph) mathematical model of interrelationship between the equipment units, their state parameters and their operation factors in order to identify the rules (concepts) for performance of maintenance and repair (MaR) which will provide the sufficient reliability of equipment to assure the acceptable level, with the minimum expenses:

- risk for personnel at work places;
- risk for public outside the enterprise;
- risk for business interruption;
- risk for environment.

Implementation of the model will allow:

- to estimate the risk of equipment/components/assemblies breakdowns;
- to perform the ranking of breakdowns as per criticality for achievement of the maintenance purposes (assurance of production continuity, client's satisfaction, industrial safety, etc.);
- to reasonably select the MaR methods (run-to-failure, scheduled maintenance, maintenance as per condition/residual operation life, proactive maintenance);
- to develop a plan of actions to reduce the risks of critical breakdowns.

There may be changes in the time schedule.
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13:20

Yury Pakhomov

Reviewer, independent IT expert, Russia

Section 2: Digital twin of production (Big Data)

Big Data and artificial intelligence: out of industry specifics

The report considers the application of Big Data and artificial intelligence methods for solving non-sector specific tasks. These are tasks typically solved by departments such as marketing, sales, human resources management, juridical and financial services, IT-service and information protection service, PR-service, which are present in every company and industrial sector. The report is illustrated with cases having references to organization or particular expert who provided the case.

There may be changes in the time schedule.
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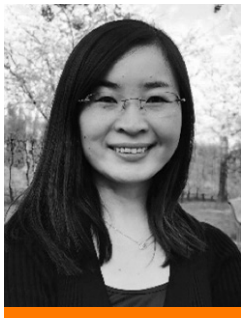
13:45

Aidong Hou

Section 2: Digital twin of production (Big Data)

Application of an artificial neural network to predict the thermal and thermomechanical behavior of refractory linings



Doctor of Mining-Metallurgical Sciences, University of Leoben, Austria

To facilitate industrial vessel lining design for various material properties and lining configurations, the back-propagation artificial neural network (BP-ANN) was applied to predict the thermal and thermomechanical behavior of refractory linings. A steel ladle from secondary steel metallurgy was chosen for a case study. Ten geometrical and material property variations of this steel ladle lining were selected as inputs for the BP-ANN model. A total of 160 lining configurations nearly evenly distributed within the ten variations space were designed for finite element (FE) simulations in terms of five orthogonal arrays. Leave-One-Out cross validation within various combinations of orthogonal arrays determined 7 nodes in the hidden layer, a minimum ratio of 1.6 between dataset size and number of input nodes, and a Bayesian regularization training algorithm as the optimal definitions for the BP-ANN model. The thermal and thermomechanical responses of two optimal lining concepts from a previous study using the Taguchi method were predicted with acceptable accuracy.

There may be changes in the time schedule.
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14:20

Sebastian Sado

Postgraduate, AGH University of Science and Technology, Poland

Section 2: Digital twin of production (Big Data)

Practical aspects of low-temperatures oxidation of MgO-C refractories

Low-temperature oxidation resistance is one of the key factor influencing the lifetime of refractory (MgO-C type) lining in heat unit used in the steel industry. In this researches the Designing of Experiments Methodology (DoE) was used to asses the importance of different factors in modeling low-temperature oxidation resistance of refractory materials. Authors used the full factorial $3^{\wedge(3-0)}$ plan with 3 factors on 3 different levels. Factors selected for the experiment: type of graphite, open porosity of materials (modelled by the unit pressure during the forming process) and time of exposure for oxidation atmosphere. For statistical analysis, ANOVA tests were taken, forecast models were developed by the regression techniques implemented in DoE module in Statistica 13.3 Software. Factors associated with response function were divided into different groups by using CART Trees. For improving the forecast, Artificial Neural Network were applicated.

14:45

Ivan Kolbin

Head of Technical Experts for Automation and Electric Drive, Schneider Electric, Russia

Section 2: Digital twin of production (Big Data)

Digital transformation at the mining enterprise. Ball Mill Optimization decision

Ball mills are widely used at the enterprises of the mining and metallurgical industries, they are one of the most energy-intensive technological units and at the same time determine the overall performance of the enterprise as a whole. In this regard, many leading mining and metallurgical enterprises not only in Russia, but also in the world are seriously interested in finding a solution to increase the efficiency of the ball mill. Schneider Electric has such a decision in its portfolio.

The solution proposed by Schneider Electric is based on the latest information technologies related to the processing of large amounts of data, using the digital ball mill model, as well as using machine learning algorithms.

There may be changes in the time schedule.
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15:10

Ilya Pugachev

Head of ML Department,
CADFEM CIS, Russia

Section 2: Digital twin of production (Big Data)

Automated system of predictive quality management in the line of continuous production

The report presents an innovation software solution based on IIoT techniques and computer-aided training which, by data from sensors at the process line in continuous mode, defines the optimal parameters of process and submits them to production staff. The main purposes and the achievable results regarding reduction of rejected items and the raw material costs have been discussed.

There may be changes in the time schedule.
See the current information on the website