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THE COMPUTER SUPPORT OF DIAGNOSTICS OF CIRCLE CRYSTALLIZERS

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This paper is f ocused on c omputer aided t echnological pr ocesses of c ontinuous steel casting devic es. The paper characterized the fundamental aspects of creating computer aided control process of continuous steel casting operations. There is in detail described sof tware system AMKO (Algorithm Modelling conicities). The importance of software AMKO consists in extending the usability of copper enclosure in the case of its weariness and the possibility of its fur ther use. Using this sof tware to create graphical model of the w ear, which sho ws the c onicity of the studied mold along all its lengths and speciÃes the possibility of its further use in various compositions sequences. Such modelling and pr ediction is possible with usage of c ybernetic modelling principles and methods k nown as soft-computing.

Key words: crystallizers, diagnostics, computer support, software, conicity

INTRODUCTION

Increasing complexity of production devices and increasing demands to productivity and production quality demand the need of high reliability of devices and efficient control of maintenance actions with usage of systems of reliability and maintenance control. Maintenance control systems providing needed support for planning and controlling all of the actions interconnected with device maintenance from its installation until preventative or operative servicing. Contributions when introducing these systems can be found in improvement of decision making processes, when the system considerably oversimplify providing of the base information for planning of maintenance actions and evaluation of economical indexes. Cohesion of these system to system of acquisition of process data and technological data seems to be very good when monitoring and diagnose the state of production device and in determination of time, proper form maintenance when it is sufficiently confident about origin of limiting value of wear respectively predictive time to limiting value can origin. Consequential on monitoring of operational data and planning preventive maintenance with emphasis on optimization of the work and lowering time delays will bring efficient usage of the sources.

Reliability and maintenance control systems gives us an analysis of the maintenance actions, failure analysis, costs analysis spent to made actions and spare parts. It gives the answers to questions, which would be without a complex look over the data derived hardly – if the given crystallizer's desks can be used in operation or if is necessary to make its renovation. On history basis of previously actions or another historical data the maintenance control system gives suffi cient information for correct decision make. Thanks to recently made maintenance data collection the base for maintenance planning is improving. Introduction of reliability control system and maintenance further help to increase availability and serviceability of devices from the reason of lower - ing unplanned time delays, breakdowns and increase device's service life [1].

The system should give information about planning device revisions and about their state with the estimation of costs to planned revisions and preventive maintenance, but also help with better organization of work, increasing the share of planned maintenance in consequence to lowering idle times of maintenance mans and volume of overtime work.

From above mentioned result, that presumption from making an effective reliability control system and maintenance ensure working with longer time horizon is creation of feedback. Feedback function [2] can fulfll system for data acquisition which provides information for regulation of impacts on reliability in all phases of lifetime cycle, which is complete with diagnostic system. The system has to enable access to stored data about reliability, to ef fective statistical prediction, other quantitative and qualitative methods and to models suitable for prediction, analysis and estimations of reliability indicators.

DEVELOPMENT OF MONITORING AND INFORMATION SYSTEM

In terms of scientific research activities, the issues of development of new progressive tools and reliability

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control support systems for primary cooling on continuous casting devices for quality improvement of exacting flat products is making monitoring and information system of reliability and maintenance controlling, whose target isn't pure gathering of operational data and information, statistical estimation of given reliability indicators, but also usage of results for reliability control and resulting maintenance control. Modern system conception has to be equipped following basic stages, which making integral unit:

- Definition of the system and assessments on the object control system,
- Analysis of the system and defi nition of the system's state,
- Option of methods type and progress to reach the goals placed of device's system,
- Elaboration of scheme of information acquisition from operation advanced into unique way of expression and description,
- Elaboration of mathematic – statistic methods for processing of gathered data,
- Elaboration of corresponding mathematical models for calculation of the object characteristics,
- Making an analysis of results and applying technological changes in production and in operation according this analysis.

Regarding to above mentioned factors is important, to the reliability and maintenance control system be able to realize concept of maintenance according to real state beside the concept of preventive maintenance. Basic philosophy of solution preparation and implementation of maintenance processes when realization of maintenance conception according to the real state comes out from the demand of preservation of production device in operational and dispensable state.

Main system function should be:

- Trace actual state of each crystallizer's desks from the point of it's wear and position in technological operational cycle and maintenance in real time,
- Record and evaluate running of technological and operational quantities, which has influence to crystallizer's desk wear,
- Trace and record each maintenance actions,
- Trace operation cycles and crystallizer 's desk maintenance in relation to blanks quality,
- Quantification of reliability and economic indicators of crystallizer's desks,
- Ensure interconnection with diagnostic system and visualization of it results in on-lie and of f-line mode,
- Visualize history of operation and maintenance actions on each crystallizer's desks,
- Ensure integrated supervisor control in technical life of crystallizer's desks process,
- Ensure immediate availability detail production reports and data from production.

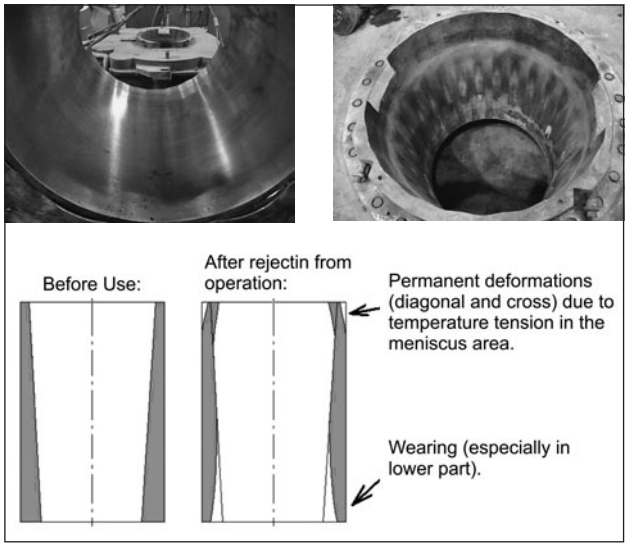

Figure 1 Crystallizer's wear

SYSTEM FOR DETERMINING CRYSTALLIZER'S CONICITY

One of the computer systems for management support in continuous casting systems is the system for determining crystallizer´s conicity. Importance of this system arises from technological importance of this parameter.

In the ingot molds is required dimensional stability , wear resistance and high thermal conductivity . Ingot mold is exposed to extreme cyclical, thermal and mechanical stress.

In ingot mold is a high temperature dif ference between the outer and inner surface, which is due to the high density of heat flow. This generates thermal stress and plastic deformation, which is undesirable from the operational point of view. Crystallizers are basically removed because of two reasons, due to loss of taper wear and also due to permanent deformation of the walls of ingot mold. The lar gest deformation is on the liquid steel surface and just below it. (Figure 1)

Experimental research of crystallizer is complex task because of the high temperatures and the danger arising from the presence of the molten liquid steel near the cooling water . Structural adjustment of the device before experiments are costly and may delay the production. Experimental research must always take a place in conjunction with the production company workplace, which must conform to the priorities of production. In addition to experimental research has an ir - replaceable position also mathematical modeling (for example finite element method, and so on) [3].

The material for the production of crystallizers is a copper, usually alloyed by small amounts of additives in particular for increasing the surface hardness and wear resistance. At the same time is also achieved increased of the recrystallization temperature. In particular, the alloying elements are P, Ag, Cr, Zr, Co and Be.

Alloying:

- Slows down the walls wear due to abrasive effects of casting and casting bark powder , increases re-

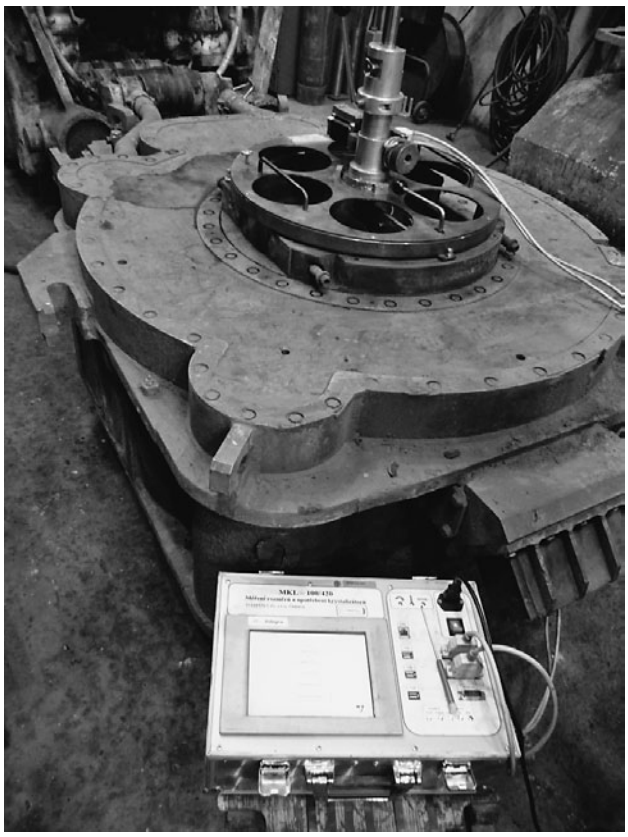

Figure 2 Measuring of crystallizer enclosure by MKL 100/420 system

crystallization temperature, increases elastic modulus, yield strength and tensile strength of the material, extends the life of the crystallizer´s inserts.

- Reduces thermal conductivity. Influence of alloying elements on the thermal expansion coeffi cient of the material is minimal.

From the above it follows that the problem solution of crystallizer's walls plastic deformation is not only in the choice of plate material. The technical solution is very exacting interdisciplinary problem that involves discipline of structure, strength and elasticity-plasticity, heat engineering, materials engineering, experimental methods and numerical methods.

As mentioned above, the technical and fi nancial requirements of diameter measurement crystallizer in practice (Figure 2), arise requirement to develop software that would allow to simulate the real environment and whose output is the state of the crystallizer after a specified number of cast steel melts of different brands.

Using the principles and methods of cyberspace (functional) simulation model [4, 5], that uses the so-called "black box", was created software AMKO (Algorithm Modelling conicities) allow the determination of the diameter of the crystallizer on 18 levels along the height of the crystallizer , which is subsequently deter - mined the resulting crystallizer's conicity.

On Figure 3 is presented basic screen of created software product AMKO.

The input section is composed of 120 inputs. Inputs 01-100 represent the count of steel grades, as well as the input data is value total weight of cast melts, their number and the initial dimensions of the crystallizer one the individual levels.

The output part represent the right half part of the screen with a graphic profi le of the crystallizer and the calculated values of the average levels of crystallizer from which are subsequently determined the crystallizer conicity value. [6]

CONCLUSION

Each steel grade is characterized by its chemical composition having different characteristics that significantly affect the life of the crystallizer. Suitable choice of casting steel grades and their casting sequence can be achieved its lifetime extending.

The importance of software AMKO consists in extending the usability of copper enclosure in the case of its weariness and the possibility of its further use. Using this software to create graphical model of the wear , which

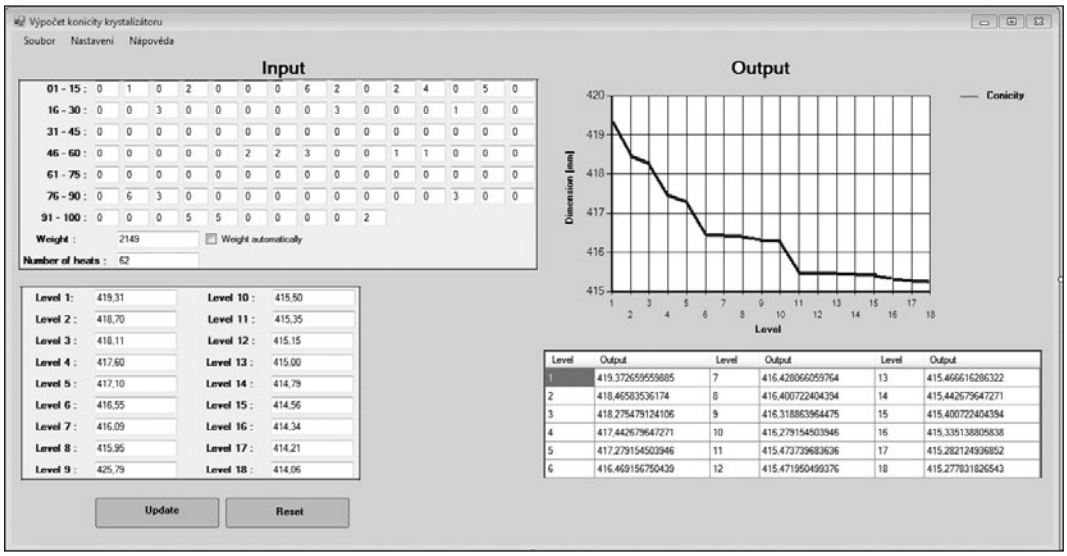

Figure 3 Basic screen of system AMKO

shows the conicity of the studied mold along all its lengths and specifies the possibility of its further use in various compositions sequences. Such modelling and prediction is possible with usage of cybernetic modeling principles (functional) and methods known as soft-computing.

Developed software will be used for the simulation and experimentation with the mold behavior in continuous steel casting devices and prediction its condition.

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REFERENCES

[1] J. David, M. Heger, M. Vrozina et al Visualisation of Data Fields. Archives of Metallurgy And Materials. 55 (2010) 3, 795-801.

[2] Z. Jančíková, V. Roubíček, D. Juchelková, D. Application of Artificial Intelligence Methods for Prediction of Steel Mechanical Properties. Metalurgija. 47 (2008) 4, 339-342.

[3] Z. Jančíková, O. Zimný, P. Koštial Prediction of metal corrosion by neural network. Metalurgija. 52 (2013) 3 379-381.

[4] Z. Gorny , S. Kluska-Nawarecka,D. Wilk-Kolodziejczyk Attribute-Based Knowledge Representation in the Process of Defect Diagnosis.. Archives of Metallurgy And Materials. 55 (2010) 3, 819-826.

[5] Z. Górny, S. Kluska-Nawarecka, D. Wilk-Kołodziejczyk, K. Regulski Diagnosis of Casting Defects Using Uncertain and Incomplete Knowledge. Archives of Metallurgy and Materials. 55 (2010) 3, 827-836.

[6] J. David, P . Švec, R. Frischer Modelling of crystallizer wear. Archives of Materials Science and Engineering. 58 (2012) 2, 193-198.

Note: The responsible person for English language is the lecturer from TU Ostrava