SUPPORT FOR MAINTENANCE AND TECHNOLOGY CONTROL ON SLAB DEVICE OF CONTINUOUS CASTING

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Abstract

In this paper is described proposal and development of monitoring and information system for support of crystallizer maintenance control and increase quality of processes which are performing basic functions of monitoring and localization of crystallizer’s desks, crystallizer lifetime prediction and prediction of blank defects. Target of the system is to optimize preventive maintenance of crystallizers desks, with utilizing maximum count of relevant data from technological and maintenance processes.

Keywords: Crystallizer, Defect, Maintenance, Software

1. 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 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 sufficient 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 lowering unplanned time delays, breakdowns and increase device’s service life. 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 can fulfill 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 effective statistical prediction, other quantitative and qualitative methods and to models suitable for prediction, analysis and estimations of reliability indicators.

2. DEVELOPMENT OF MONITORING AND INFORMATION SYSTEM

In terms of project solution of TIP FR-TI1/319 development of new progressive tools and reliability 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 definition of the system's state,
- Option of methods type and progress to reach the goals placed od 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-line and off-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.

Base function structure of created reliability control system and maintenance is displayed on figure 1. From the picture is obvious, that system design contain several basic functions, which aim to achieve previously mentioned goals, which are:
- Monitoring and localization of crystallizer’s desks;
- Evaluation of the state and prediction of crystallizer’s desks lifetime;
- Quality prediction of blanks;

**Fig. 1** Basic function of the system

In present time is in progress interconnection of single modules, it means, that is create software environment for whole application – figure 2.

**Fig. 2** Screen of interconnected software of single modules
The system will be interconnected to TQ model (production and quality data from the process) and maintenance system. Now exists thoughts about usage the system by the maintenance workers from the view of control, ordering and cycling crystallizer's desks.

2.1 Monitoring a localizing

This part of the system serve as basic evidence functions with single crystallizer’s desks as are placing desks in specific crystallizer, position of crystallizers and desks, evidence of number of molten tons on each desk and so on. Basic user preview of the module are presented in figure 3.

![Fig. 3 Screens of Monitoring and localization module](image)

2.2 Evaluation of the state and prediction

This module perform basic function of evaluation of the crystallizer’s desks from the view of reaching of the limiting state and prediction on define time slot. This module connect an analytic access to solution of the problem, when is created a distribution function of probability of limiting state when presumption of Weibull probability distribution and in choice of degraded mechanisms impact the desks, time data relating to operation and maintaining of the crystallizer's desks and data from analytic and technical diagnostics each crystallizer's desks. On picture 4 is man screen of this module.

![Fig. 4 Evaluation of the state and prediction module screen](image)

The important part of the solution is the usage of results from analytic and technical diagnostics. Preview of user interface is presented on figure 5.
2.3 Blanks – prediction of defect

This module represent an analytic approach to the problem of prediction of defects on continuous casting device’s blanks, when with usage of artificial intelligence methods are single blanks evaluated and incorporate into the category without defect, with defect and with risks of the defect. On figure 6. is preview of user interface, which was created only for scientific testing of this module.

3. CONCLUSIONS

Inaccurate information about real operational time of production devices, inaccurate time schedule of preventive visits and maintenance, improper progress usage for maintenance, wrong evidence and planning of supplies and spare parts, unmatched usage of human resources, wrong reckoning of maintenance costs, these are some typical problem, which are occurring in the maintenance field in many metallurgical companies. By development and introduction of computing maintenance
control support with usage of artificial intelligence elements is a step to solve these problems. Artificial intelligence methods represent tools supporting a solution of wrong structured problems, which solving isn’t primary based on calculations with help of mathematical models, but on human thinking and judgment. Offering support has often character of given problem definition, production of solution variant. In contrast to decision making systems, which only supporting the user when solving decision making problems, the tools based on the methods of artificial intelligence can in given cases replace a human.

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BIBLIOGRAPHY