P. ŠVEC, J. DAVID, R. GARZINOVÁ

ISSN 0543-5846
METABK 54(4) 657-659 (2015)
UDC – UDK 620.179.11:528.021.7:658.581:544.022.341=111

THE EVALUATION SYSTEM OF SURFACE INEQUALITIES AND DEFECTS OF MOLD'S PLATES

Received – Primljeno: 2014-07-10
Accepted – Prihvaćeno: 2015-02-10
Preliminary Note – Prethodno priopćenje

The paper goal is to familiarize with problems of operative control computing support in steel works. In the introduction, there is characterized operative control from the basic function parts point of view with focus on product scheduling data support and maintenance support. The basic proposal is realization of the operational data acquisition system from the steel works. It act as specific maintenance and technological data, which will represent the key information about operational states and mainly for issue solving support incurred on specific technological places.

Key words: mold's plate, surface, defects, diagnostic

INTRODUCTION

The results of operative control of production processes are also highly dependent on reliability of technological system or device. For the first is necessity to avoid such failures and accidents, which can threaten health and life of device's staff or environment. In metallurgical industry are that issues more serious, because economical loses from unexpected production failure are enormous, especially when operation of whole production complex is stopped by one device failure. This enforce the maintenance staff to gather earlier answers on three questions: where can the failure occur, with how probability and with how consequences. [1]

One of the options how to precede those type of failures and so unplanned failures in production process is to implementation of parallel technical state evaluation. This evaluation provide basic input information to determine probability time moment, in which the failure occur and will be necessary renew the operational state of the device (renewal realization, maintenance or reparation). Knowing this time point can help to decision when and in which order will be necessary to realize renewal and reduce the impact of imminent failure and which can be achieved by these ways:

- realization of preventive renewal in non-production time and prevent to occurrence of downtime
- realization of preventive renewal, to prevent occurrence of breakdown failures and prevent to arise of consequent failures.
- by organizational and technically remove the failure in time. [2]

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. [3] 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

P. Švec, J. David, R. Garzinová, Faculty of Metallurgy and Material Engineering, VŠB – Technical University of Ostrava, Czech Republic.

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. [4,5]

EXPERIMENTAL WORK

In term of research activities in mold desks diagnostics area was developed a prototype of laser meter ZMPV-01. The diagnostic device ZMPV-01 is intended to check the mold's slab surface as a part of continuous steel casting device. Operational tests proceeds in VSB-TU Ostrava laboratories and in Arcelor Mittal Ostrava a.s. [9].

The measuring chain of laser meter ZMPV-01 is proposed so that to be able to as precise as possible obtain information about slab's surface, with accuracy ± 0,02 mm.

The diagnostics device ZMPV-01 (Figure 1) is consist of three basic units.

1. The laser sensor ILD1300_E for ensure good optical measurement of mold's slabs surface and at the same time for transcoding surface data into unified analog signal with standardized values in range 4 – 20 mA. Laser sensor use triangular ways of measurement. This is due to increase measurement accuracy in low distance measurement and due to increase noise immunity.
2. The analog transcoding mathematical unit Frisch2 with multipurpose usage. This unit serves for conversion current analog signal to voltage analog signal with standardized values in range of 0 – 10 V. Converted analog signal the Frisch2 unit uses for calculation of output values on the basis of comparison with analog calibrating signal.
3. Digital imaging panel unit for visualizing calculated analog voltage values.

Laser meter ZMPV-01 contain an interface for selectable communication with oscilloscope or with other external visualizing device for measured data. The component of this diagnostic device is charging station with double checked, safe output voltage according to standard ČSN 33 2000-4-41 ed. 2:2007 intended to charging internal accumulators of ZMPV-01. [6,10]

Figure 2 Laser scanner's output is in form of small dot

Measurement it selves is provided by laser beam (Figure 2) in visible spectrum (red color). This beam come out from the bottom of the ZMPV-01 device. The source of laser beam is simple semiconductor laser diode with emitting power 1mW working on wave length 670 nm.

The output value from meter ZMPV-01 is an input for software system for evaluating mold's desks defects. Evaluating comes from expert system [7], which has been developed from the defects catalogue. Preview of software environment and evaluation result example is presented on (Figure 3).

In (Table 1 and Table 2) are samples of output results from molds plate's defects evaluation. [8]

Table 1 **Quality grade counts in each sectors**

Plate evaluation			measurement, VŠB narrow plate				
Sector	State	Sum of defects counts	1	2	3	4	5
1A	2	2	1	1	0	0	0
1B	2	5	2	3	0	0	0
2A		0	0	0	0	0	0
2B		0	0	0	0	0	0

Figure 1 Diagnostics device ZMPV-01

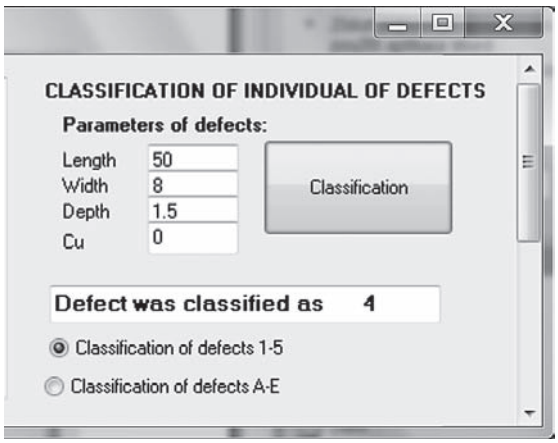

Figure 3 Software environment and evaluation result example

Table 2 **Defects evaluating**

Plate Casted Check date	measurement, VŠB narrow plate 14.03.2013							
					Occurrence in sector			
Defects #	Defect's type	Length	Width	Depth	1A	1B	2A	2B
1		280	1	0,1	2	0	0	0
2		80	3	0,1	1	0	0	0
3		390	4	0,1	0	2	0	0
4		65	7	0,3	0	1	0	0
5		45	5	0,2	0	1	0	0
6		400	1	0,1	0	2	0	0
7		150	8	0,1	0	2	0	0
Plate quality grade : 2								

CONCLUSION

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.

Acknowledgements

This article was created with help of financial support of ministry of industry and trade of Czech Republic: solution of grant project TIP evidence number FR-TI1/319 and project SP 2014/53.

REFERENCES

[1] Z. Jančíková, O. Zimný, P. Koštial Prediction of metal corrosion by neural network. Metalurgija 52 (2013) 3, 379-381.
[2] O. Krejcar, R. Frischer. Use of Accelerometers for Material Inner Defect Detection. Applied Electronics (2010), 179-182.
[3] J. David, Z. Jančíková, R. Frischer, M. Vrožina. Crystallizer's Desks Surface Diagnostics with Usage of Robotic System. Archives of Metallurgy and Materials 58 (2013) 3, 907-910. DOI: 10.2478/amm-2013-0098
[4] O. Krejcar, R. Frischer. Non Destructive Defect Detection by Spectral Density Analysis. Sensors. 11 (2011) 3, 2334-2346. DOI: 10.3390/s110302334
[5] R. Lenort. Methods of determining the buffer capacity before floating bottleneck in heavy machinery production. Metalurgija 52 (2013) 3, 391-394.
[6] Z. Gorny, S. Kluska-Nawarecka, D. Wilk-Kolodziejczyk, Heuristic models of the toughening process to improve the properties of non-ferrous metal alloys. Archives of Metallurgy and Materials 58 (2013) 3, 849-852. DOI: 10.2478/amm-2013-0085
[7] O. Krejcar, R. Frischer. Detection of Internal Defects of Material on the Basis of Performance Spectral Density Analysis. Journal of vibroengineering 12 (2010) 4, 541-551.
[8] I. Špička, M. Heger, O. Zimný, M. Červinka. Industrial Control Systems and Data Mining. Metal 2011. (2011), 1229-1234.
[9] P. Lichý, M. Cagala, J. Beňo. Investigation of the thermomechanical properties and microstructure of special magnesium alloys. Materiali in tehnologije / Materials and technology 47 (2013), 4, 503-506.
[10] 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.

Note: The responsible translator for English language is T. David