

## MANAGEMENT OF THE MACHINERY IN STEEL COMPANIES

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### Abstract

An important element of manufacturing process is the technical system which is aimed at maintaining the company's production capacity for a constant and a high level. The number of failures and downtime of production resources are crucial issues that directly affect the productivity of the whole production system. Technical problems related to frequent failures of machines lead to: destruction of the production plan, an increase of exploitative costs of machines, an increase of manufacturing defects number etc. The key role in maintaining the efficiency of the machinery is played by the maintenance services in manufacturing companies. Through a proper management of the machinery, i.e. the activities related to the planning and execution of maintenance tasks, a well-functioning technical system that eliminates problems associated with failure frequency may be created.

In many enterprises (also in steelworks) the maintenance department realizes assumptions of Total Productive Maintenance (TPM) conception which assumes the continuous improvement of the efficiency of the machinery by the system management and cooperation of the qualified maintenance technicians with workers. In this conception, prevention allowing to maintain proper parameters of work of machines and devices is significantly underlined.

The article discussed exploitative strategies used by industrial companies, especially TPM, paying attention to activities related to Autonomous Maintenance. On the example of steel companies the measures taken to improve the effectiveness of the machines were presented.

**Keywords:** Exploitative strategies, TPM, Autonomous Maintenance

### 1. INTRODUCTION

Costs associated with the operation of machinery and equipment in manufacturing facilities may constitute from 15% to 40% of total production costs. Almost 75% of these costs are associated with maintenance and overhaul, or method of use, while the biggest influence on these costs have decisions made already during the initial planning and design of machines and their maintenance systems. Therefore, enterprises draw attention to the need to increase economic efficiency and cost-effectiveness of the machinery, using the appropriate strategies related to maintenance processes handling [1].

Exploitative strategy is defined as a way of dealing with technical facilities aimed at achieving the desired state of exploitative system [2]. In the management of maintenance services the strategies should be considered in two respects [3]:

- as a decision-making process relating to the exploitation of individual technical objects - these are the base (classic) exploitative strategies, which could include, among others, strategy according to the service life, according to the technical state, reliability, economic efficiency;
- as a decision-making process relating to the functioning of a comprehensive maintenance organizations - these are complex operational strategies, which include the Reliability Centered Maintenance (RCM) and Total Productive Maintenance (TPM).

TPM is currently the most widely used strategy by industrial companies to improve the effectiveness and efficiency of the machine park. It is also one of the main pillars of World Class Manufacturing (WCM), which is a system focused on continuous improvement through the application of best practices developed in the framework of multi-functional work teams. WCM focuses on waste elimination and aims to achieve by the company a leading position in its operation class (world-class producer in the metallurgical sector is ArcelorMittal) [4, 5].

## 2. TPM CONCEPTION AND AUTONOMOUS MAINTENANCE

Total Productive Maintenance is defined as a continuous process of servicing machinery and equipment implemented within the entire enterprise by all operators and maintenance technicians. TPM focuses on maximizing the efficiency of the machinery by applying actions to prevent accidents during the whole period of use. Thanks to implementation of TPM every machine in the manufacturing process is capable of performing tasks, as there are no disruptions in the production process [6, 7].

TPM is a tool that helps to detect and reduce waste by means of three zeroes: zero breakdowns, zero defects, zero accidents at work. TPM program include actions in these five main areas [8]:

- educating all employees starting from top management positions to production line workers, with a view to changing their awareness concerning everything that constitutes an effective manufacturing system,
- creating a system whose all implementation actions would be based on teamwork,
- starting from the introduction of 5S method i.e. introducing order through the removal of unnecessary things, thorough cleaning and visualizing the process of management,
- creating a system of impartial assessment and comparison of results for the individual workplaces,
- developing and implementing the continuous workers' awareness management in the health and safety systems.

TPM theory is built on seven pillars, where the most important is Autonomous Maintenance. These are activities whose purpose is to enable workers in the maintenance of machines serviced by them, regardless of the maintenance department, e.g. detect anomalies, simple repairs, control precision. In the production plants of the traditional division of responsibilities there is a belief that for all activities related to the maintenance of machinery and equipment is solely responsible the maintenance department called upon to any incident. Operators working at their workplaces can spot irregularities related to their work best (excessive noise, vibration, leakage, etc.), and prevent potential damage. Therefore, engaging operators in simple maintenance tasks of Autonomous Maintenance can relieve the maintenance personnel and, above all, contribute to the progressive elimination of failure at the workplace. The main objectives of AM include, among others [7]:

- identifying and eliminating the causes of variability of performance,
- striving to improve performance,
- increase of the participation of operators in the maintenance of machines wich they operate, and thus increase their skills,
- increase of the responsibility of operators for the technical condition of the machines,
- integration of the production and maintenance,
- improving the quality of workplace.

The implementation of Autonomous Maintenance is carried out in seven steps, allowing workers to develop the right skills and what is expected of them (**Table 1**). The first five steps involves the so-called hard mechanical aspects of machine maintenance. These are activities to maintain suitable state of machines and to prevent excessive wear and their activities related to the development of standards for cleaning, lubrication,

tightening the fasteners, controls. Step six focuses on aspects related to organizing, standardization and visual management of machines maintenance. The last step is to conduct independent operations by workers [9].

**Table 1** Steps and activities of AM and support the maintenance department for AM [4, 9]

Steps of Autonomous Maintenance	Activities of Autonomous Maintenance	Activities of the maintenance department
1. Cleaning and inspection	Removal from the machine contamination, lubrication, tightening of screws, finding and solving problems	Cooperate work; detection and eliminating of failures; tips on how to identify minor defects
2. Eliminating sources of problems and hard to reach places	Removal of sources contaminants, improvement of access to all parts of the machine for easy cleaning and lubrication; shortening cleaning and lubrication	Regeneration and improvement; developing the skills of production teams; implementation of improvements on the machines
3. Designation of standards of cleaning and lubrication	Setting up operational standards for the effective conduct of the cleaning, lubrication, tightening the screws (draw up a work schedule of periodic)	Improving skills of general inspection; supporting the development of standards
4. Carrying out a general inspection of machine	Training based on the manual equipment, to carry out a general inspection of machines in order to detect and eliminate small irregularities	Provision of the technical training to operators
5. Carrying out an autonomous inspection of machine (developing the skills obtained in the fourth step)	Developing checklists for autonomous inspection; perform the inspection	Division of tasks between service maintenance and production
6. Introduction of visual management of equipment maintenance	Standardization and visual management of all activities associated with the maintenance of the machines. Developing a general system for maintenance management of machinery	
7. Introduction of a permanent autonomous management	Developing principles and objectives of the enterprise; introduction of improvement activities in their daily work	

During the implementation of the Autonomous Maintenance important role play the following factors [4, 10]:

- employees expertise in safety conditions existing at the workplace,
- understanding of the principles of machines through the instructions and organized one-point lessons,
- knowledge and ability to identify the symptoms informing about the improper operation of the machines, the ability to respond and take corrective measures,
- ability of operators to perform maintenance activities.

The important role of maintenance services in the communication and increasing knowledge and skills of operators, especially in the first four steps of the implementation of the Autonomous Maintenance (**Table 1**) should be emphasized - without their involvement and support it is not possible to acquire full autonomy by operators.

### 3. AUTONOMOUS MAINTENANCE IN STEEL COMPANY

In order to achieve the high efficiency of the machinery in ArcelorMittal, a re-organization of work maintenance forces started. The company had to go from the intervention work system to the preventive system involving all the workers of the company in the perfection of the manufacturing process by providing the reliability of the functioning of machines and devices [5].

In the ArcelorMittal Poland TPM pilot program started in June 2009. Stages of implementation of the TPM include: designation of areas of implementation and specifying the schedule of activities, training employees, developing a structure for the TPM system through the appointment of teams and their leaders responsible for implementation in specific area of the plant, the choice of pilot area with the determination of production machines, evaluation of effectiveness of actions.

Implemented system in metallurgical enterprise was defined as follows [11]:

- T (Total) - applies to all employees and all areas of the plant,
- P (Productive) - is synonymous with striving to be "above average",
- M (Maintenance) - is a belief in the viability of the company in a competitive market.

Based on the assumptions of TPM metallurgical enterprises have introduced the four pillars of improvement of the manufacturing process:

- Focused Improvement - assumption of work within the framework of multi-functional work teams. Specified operations are performed according to the work schedule to ensure the reliability of the machines. Operators taking care of the machines, looking for ways to improve their efficiency (they have the ability to identify the sources of losses and also indicate the possibility of their elimination);
- Autonomous Maintenance - inclusion of operators in comprehensive service of machines and equipment;
- Professional Maintenance (PM) - the essence of PM is mainly eliminate the breakdowns of machines and devices by actions which improve the reliability of elements of metallurgical machines. Actions which are conducted are preventive repairs which are performed by specialized teams of workers. Preventive repairs include inspection of the equipment condition (periodic inspection) and the repair of the device before major failure;
- Early Equipment Maintenance - is associated with the construction of a system to ensure the design, purchase, production of equipment easy to operate and maintain.

In the implementation of TPM system in every industrial enterprise attention is drawn to the aspect of engagement and staff awareness, especially at the operational level. Implemented in ArcelorMittal pillar of Autonomous Maintenance contributed to the increase of employees liability for operated machines and to the reduction of number of failures at the workplace.

Operators within the AM are required to assess the efficiency of their work station before starting work, for maintenance of cleanliness in accordance with the principles of 5S and for the removal any dirt. In addition, operators are required to maintain normal operating conditions of machines and equipment and restoring the initial conditions of operation. Operators inspecting machines and equipment are able to detect and eliminate irregularities related to their work, the irregularities are understood as: minor defects, improper operation of the machine/device, a small error associated with her work. In metallurgical enterprise the situations, to which are related such irregularities include: loose parts of devices, lacking parts in devices, leaks, spindrifts, vibration etc. Irregularities are subjected to identification by each employee who is required to complete the appropriate label (affixed in two places: on the machine and information board). Labels are available in two colors: blue - when the employee performs repair alone or with the participation of technical service workers and red - when irregularities are repaired by workers of Professional Maintenance). Labels are used for classification of machinery and equipment into categories. Each production plant determines which machines

are the most critical - that is, those whose failures result in complete stop or slowdown of production (referred to as Category AA). Other categories of machines are designated as A, B or C. Machines are also evaluated because of the impact of potential failures on the quality, safety or the environment [12].

In order to increase the efficiency of the machinery operators during the training deepen technological knowledge on the functioning of the machines and gain new skills. In addition, meetings of work teams are organized, during with the use of quality tools (e.g. Poka-Yoke, FMEA) or „soft“ tools (e.g. "Brainstorming" in the context of Kaizen) problems are solved and plans of action, which implementation is to provide lasting solution to the problem on the production floor are created. Thanks to the knowledge and skills acquired by the operators in ArcelorMittal process improvements resulting from the implementation of the ideas of employees are implemented, which translates into reduce repair costs, less frequent replacement of parts, quick response to problems and cleanliness of work stations.

#### 4. CONCLUSION

The main aim of TPM system is to strive for the elimination of a failure of machinery and increase the efficiency of its use. Achieving this goal is possible with the full involvement of all company's employees, especially machine operators. Other significant factors include i.a. care of machinery and equipment, removal of minor failures, teamwork on eliminating problems. Implementation of Autonomous Maintenance in metallurgical company contributed to the activation of operators involvement in maintenance operations and increase of responsibility for the workplace - which is reflected in safety, quality, failure frequency of processes.

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