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Quality projection of manufacturing processes relating to environmental protection

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Abstract

Within the implementation of the quality provision system according to ISO 9001 from 2000, technological processes are being projected through standard operating procedures in order to provide defined quality of products. The conservation of the environment it is of great importance in such a system, especially the disposal of sewage containing dangerous reactants. Also, by proper exploitation of both the reactants and energy, the required quality can be achieved having in mind also the economy of the process. By the implementation of a TQM approach as well as co-relational analysis as a mathematical method of quality projection of the manufacturing processes regarding the environment, the technological process of steel hardening becomes optimised by the use of the MATLAB programme, simultaneously having in mind the costs of working.

According to the technology, the steel hardening process is conducted within a temperature interval of 820-860°C, with 1-10% solution of sodium hydroxide (NaOH), and the normalisation of the steel is executed at a temperature of 600-610°C. By the application of co-relational analysis, the optimal values of the parameters of the steel hardening process are determined , i.e. a temperature of 820°C and NaOH concentration of 2.38%, which aids the achievement of the defined quality of steel firmness of 195

Brinel. Thus, both the loss of electricity and consumption of NaOH have been calculated on a yearly level, according to the hardening conditions which were implemented by now with the standard operating procedures in the factory.

The sum of the total savings regarding the hardening of 100,000 pieces of steel per year amounts to €18033. By the implementation of this method, the defined quality can be achieved with the lowest possible costs of work.

Apstrakt

Në praktikimin e sistemit për sigurim të cilësisë sipas ISO 9001 nga viti 2000, proceset teknologjike projektohen nëpërmjet procedurave operative standarde me qëllim që të sigurohet cilësia e definuar e prodhimeve. Në sistem të tillë, e patjetërsueshme është nevoja për mbrojtjen e ambientit jetësor, posaqërisht mënjanimi i ujrave të ndotur me reagensa të dëmshëm. Gjithashtu me përdorim të mirëfilltë të reagensëve dhe energjisë mund të arrihet cilësia e kërkuar duke pasur parasysh kursimin gjatë procesit.

Me zbatimin e TQM-së dhe analizës korelative si metodë matematikore për projektim të proceseve në funkcion të ambientit jetësor, avancohet procesi teknologjik i kalitjes të çelikut, me përdorim të MATLAB programit, gjithnjë duke pasur parasysh shpenzimet e punës.

Sipas teknologjisë, procesi i kalitjes realisht kryhet në interval temperature prej

820-860°C me 1-10% tretësirë të hidroksidit të natriumit (NaOH), ndërsa normalizimi i çelikut bëhet në temperaturë prej 600-610°C. Me zbatimin e analizës korelative janë përcaktuar vlerat optimale të parametrave në procesin e kalitjes të çelikut Ç1530, e kjo është në temperaturë prej 820 °C dhe koncentrim të NaOH prej 2.38 %, gjatë të cilës arrihet cilësia e definuar e fortësisë e çelikut prej 195 Brinel. Me këtë, janë llogaritur edhe humbjet e energjisë elektrike dhe shpenzimi i NaOH të bëra gjatë vitit, sipas kushteve të kalitjes të cilat janë praktikuar gjer më tani, sipas procedurave operative standarde të projektuara në fabrikë.

Për kalitjen e 100,000 copave çelik në vjet, kursimi i përgjithshëm arrin sumën prej

€18 033. Me zbatimin e kësaj metode mund të arrihet cilësia e definuar me shpenzime minimale gjatë punës.

Апстракт

Во практикувањето на системот за обезбедување квалитет по ИСО 9001 од 2000 - та година, технолошките процеси се проектираат преку стандардни оперативни процедури со цел да се обезбеди дефинираниот квалитет на производите. Во таков систем, неопходно е да се води сметка за заштита на животната средина, нарочно отстранувањето на отпадните води со штетни реагенси. Исто така, со правилно искористување на реагенсите и енергијата може да се постигне бараниот квалитет водејќи сметка за економичноста на процесот.

Со примена на ТЉМ пристапот и корелационата анализа како математички метод за проектирање на квалитетот на процесите во функција на животната средина, се оптимизира технолошкиот процес на калење на челик, користејќи ја програмата МАТЛАБ, притоа водејќи сметка за трошоците во работењето. Според технологијата, процесот калење реално се изведува во температурен интервал од 820-860°C, со 1-10 % раствор на натриумхидроксид (NaOX), а нормализирањето на челикот се врши на температура 600-610 °C. Со примена на корелационата анализа се утврдени оптималните вредности на параметрите на процесот калење на челик Ч1530 , а тоа е температура од 820°C и концентрација на NaOX од 2.38 %, при кои се постигнува дефинираниот квалитет на тврдоста на челикот од 195 по Бринел. Со тоа, се пресметани загубите во електрична енергија и потрошувачка на NaOX кои се прават годишно, според условите на калење кои досега се практикуваа со проектираните стандардни оперативни процедури во фабриката.

За калење на 100,000 парчиња челик годишно, вкупната заштеда по таа основа изнесува €18 033. Со примената на оваа метода може да се остварува дефинираниот квалитет при најмали трошоци во работењето.

Introduction

Every company, regardless of its size and function, presents a part of the environment – it both influences and changes the environment. The environment can differ in various aspects: chemical-technological, technical, economic, judicial, sociological-psychological, etc. Concern about the environment is becoming more and more real owing to the apparent endangerment of people, animals and plants. Therefore, companies must not limit themselves only to the most critical aspects of environmental degradation, but also they have to master completely environmental management and practice eco-protection systems as well. Environmental management should solve the contradictory gap which appears between the economic and the ecological requirements of the organisation.

ISO 14 000 standards allow companies to manage their influences over the environment, but how successful the implementation is depends on the understanding and support of the management team, as well as all the employees in the companies. ISO 9000 standards, which refer to a system of quality provision of companies, have been designed to protect customers from a low-class product or service. ISO 14 000 standards are complementary to them; their common goal is creation of quality processes and products for protection of the environment.

Basis of theory

Environmental management within companies

The basic thing that one company should do in regard to protection of the water, air and soil from pollution is determining a system for eco-management. Beside the measuring, registering and evaluation of pollution, it is of essential importance to have integrated and planned activities for protection and application of the environmental protection programme. The activities should also be aimed at:

- setting a cataster of pollutants with a revision of all emissions into air, water and soil by quantity and chemical compound, based on project values, counted data and measured values;

- identification and quantification of the eco-aspects and influences connected to the working process;
- re-engineering of the processes and treatment of waste;
- eco-construction of the products;
- conservation of resources by monitoring energy and material consumption;
- implementation of protection and improvement of the environment in all programmes for development;
- formation of a unique informative system on the environment;
- reinforcing the eco-awareness of the employees.

To realize these activities, the company's willingness to organize working processes with decreased negative influence on the surroundings by means of a consistent and documented system for eco-management is of great importance for the conservation of resources, by monitoring the energy and material consumption.

Quality projection of manufacturing processes regarding the environment

Concern for the environment must be present from the very beginning of quality projection of the manufacturing processes. At the same time, we should bear in mind not only the danger of pollution, but also the conservation of resources. All available resources should be taken into account while making the projection: the employees, raw materials, machines, energy, etc. This is important so that good quality at optimal conditions can be provided. (Cepujnoska & Cepujnoski, 1993a, 1993b). With this type of approach we can get good quality, more efficient work, eco-protection, all at the lowest possible cost.

The provision of projected quality should go according to Deming's circle of quality: Plan – Do – Check – Act (Deming, 2000), which puts the act of planning in first place, than provision of all conditions for realization of what is planned, followed by control of whether it has been realized. If not, corrective measures should be put in place in order to stop reoccurrence of the same mistake. In other words, the provision of quality requires proper, correct, expeditious realization of all activities of the projected quality of the manufacturing processes, as well as provision of suitable eco-conditions. Also, the tasks of all the employees should be clearly defined in a form of a matrix of obligations and responsibilities.

Quality control of the manufacturing process regarding the environment

The control of quality is a very necessary activity within eco-management. A quality control service is required to collaborate with the marketing and development function due to its participation in forming definitions of the standards for quality of products, fulfilling eco-requirements, defining the methods of measurement and evaluation of quality according to the needs of the customers and the conservation of resources.

This collaboration needs to be spread with the procurement function, for control of the incoming eco-materials as the first ramp of quality.

For successful control, the data output based on environmental facts should be rapid with pre-determined feedback mechanisms, so that corrective measures can be applied according to Deming's circle of quality (Chepujnoska & Chepujnoski, 1995, 1996; Gyma, 1998; Deming, 2000). Customers' claims for compensation should be analysed and systematised so that corrective measures and cost analysis can be applied, in order to conserve resources and to meet the requirements of ecology. To establish a proper system of control regarding the environment, education as well as training of employees for continuous care and concern about the environment is of great importance, as is the mastering of new techniques. This is a task of employees in the quality service which must introduce education for the issue of safety and environment, lectures, various types of training with instruments for testing of quality and eco-aspects. The control should provide expeditious, proper and correct measurement of eco-influences and draw objective evaluations about the condition. The collected data should be provided in adequate form, at the right time and place. An efficient control requires: selection of adequate people; selection of proper control-points; application of adequate statistical methods; and working with lowest possible costs.

The people should be selected according to their level of knowledge; willingness to master the methods of measuring eco-influences, the amount, intensity and durability of these influences, the causes of their appearance, the cost of changing them, reflection over other activities, etc. They should be responsible, able to co-operate, disciplined, able to work with facts and arguments and point out expeditiously the possible problems.

During the selection of the control places, it is important to note that only eco-aspects that influence the environment are measured. These are emission of air, water drainage, waste management, soil pollution, resources management, and influence on the community. Finding the right places where the eco-influences can be measured is very important.

By analysing the subordination of the control places and costs it becomes noticeable that by increasing control, costs increase too. Thus, an optimal control should be projected in order to meet the requirements of the environmental control system. It is desirable that the control is connected to the manufacturing processes as much as possible, due to the possibility of faster examination, provision of data on the eco-aspects and conducting corrective measures.

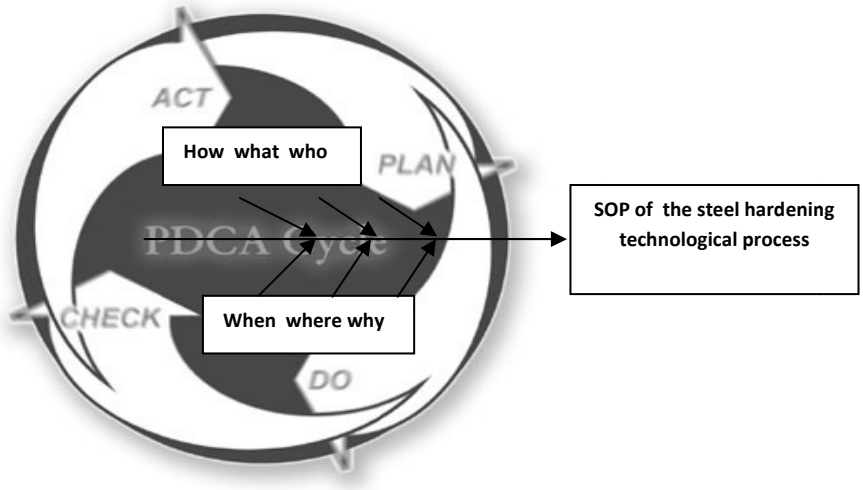
Application to practice

Quality projection of the technological process of steel hardening S1530

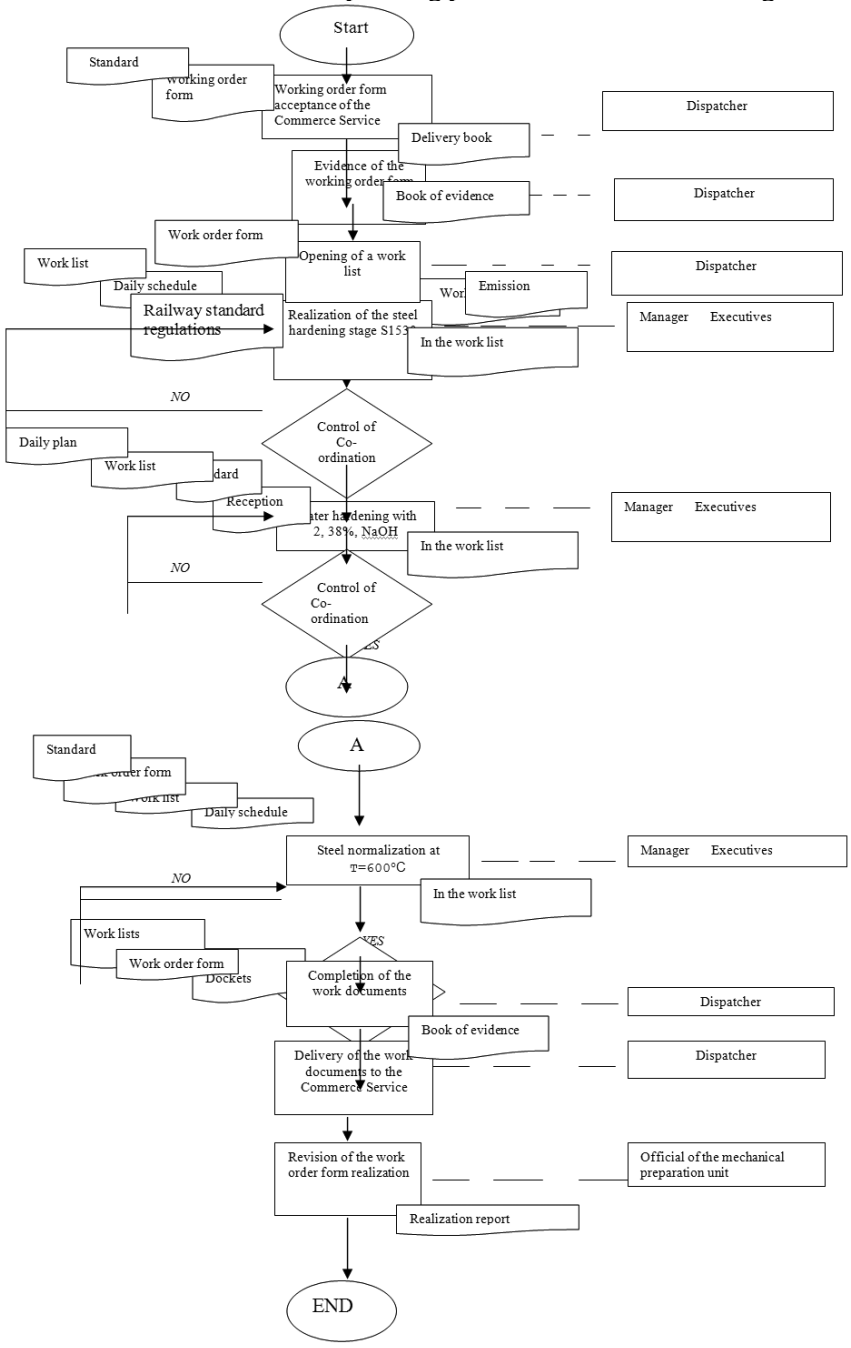
While practising the system of quality provision according to ISO 9001 from year 2000, the need to project and apply the standard operating procedures for all working processes became stressed in order to achieve the defined quality and to protect customers from faulty products. The factory's management put in front of them another task – to improve the system of managing the environment, which includes lowering the amount of waste, lowering the pollution of the air, water and soil, conservation of resources by following energy and material consumption, as well as adapting to all national and local regulations and norms which refer to the environment.

According to ISO 9001 standards, the standard operating processes have been projected by the QC-CE (Quality Circle-Cause and Effect) model, [picture 1] and the standard operating procedure for steel hardening [picture 2].

Picture 1 – Application of QC-CE model at the projection of quality of the steel hardening S1530 technological process



Picture 2 - Standard operating procedure of steel hardening



In accordance with the process of steel hardening, we have set a task for us to follow energy and material consumption in order to determine the optimal parameters. With mathematical casting we can follow the changes in the characteristic parameters in the process within a given space and time in order to determine the optimal parameters, because the mathematical description presents a sum of subordinates that link all parameters in a system of equations.

The technological process of steel hardening takes place at the mint department by which particular characteristics are achieved and are suitable both to the standards and the railway regulations.

As a subject of examination we have shafts with f 35x180 made of steel S1530, with chemical compound of:

chemical compound	*C*	*Si*	*Mn*	P	S
%	*0.42-0.50*	*0.15-0.35*	*0.50-0.80*	*0.045max*	*0.045max*

In the planning phase we project the technological process of steel hardening considering the theoretical parameters of quality hardening, the parameters of hardening in the real system and the results gained by mathematical cast of the process with the MATLAB programme. According to theory, the mechanical characteristics of the shafts after hardening, and in order to achieve the steel hardening quality, should be:

Firmness (HB Brinel)	Plastic deformation (N/mm^2)	Extraction (N/mm^2)
195-207	380-420	600-670

Theoretical parameters of quality hardening develop in three stages:

Warming temperature of furnace °C	Hardening in water at a temperature of (18-19)°C and concentration of NaOH %	Normalisation of the material at a temperature of °C
820-860	(2-7)	(550-660)

According to the measurements gained in the real process of steel hardening at the factory, the mechanical characteristics of steel S1530 after hardening are as follows:

Firmness (HB Brinel)	Plastic deformation (N/mm^2)	Extraction (N/mm^2)
195-210	380-420	600-610

This quality of steel hardening S1530 in the real system can be achieved with the following parameters:

Warming temperature of furnace °C	Hardening in water at a temperature of (18-19) °C and concentration of NaOH %	Normalisation of the material at a temperature of °C
860	(5-7)	(600-610)

With the use of the mathematical cast, we have determined the subordinance of the steel firmness (HB), the concentration of NaOH at temperatures of T= 820°C and T = 860°C.

By entering experimental data for % of NaOH (co-ordinative variable) and firmness HB (ordinative variable) in the MATLAB programme (Pratap, 2005) at temperatures of T = 820°C and T = 860°C, with determined firmness of steel of 195 HB, we get the following results: At a furnace temperature of T = 820 °C by determined steel firmness of 195 HB we have determined the optimal concentration of NaOH as 2.38 %; at a furnace temperature of T = 860 °C the defined steel firmness of 195 HB can be achieved with a 3.06 % solution of NaOH. Considering the loss due to warming temperature of furnace of T=860°C as well as the additional costs for the NaOH solution, we have determined the optimal concentration of NaOH by constant firmness. We can conclude that the optimal parameters for achievement of steel firmness of 195 HB are the following: NaOH concentration of 2.38% and temperature of 820°C.

Results of the application of the projected quality of the technological process of steel hardening S1530

To realize the activity according to Deming's circle, it is of great importance for us to provide all the required conditions. This means that the model has to be tested, because, by its nature it is a presentation of the natural process, but it cannot enclose all of the variables from the surroundings. Thus, it is necessary to compare the model results with the real condition. However, one established model which provides good solutions does not mean that it will function well in the future due to the expected changes within the surroundings or among some of the factors. Eventual changes could lead to changes in the system's exit, so a controlling system for a proper functioning of the model must be provided. In most cases, the control is organised by establishing feedback. Due to this, the standard operating procedure is changed.

Conclusion

The politics of maintaining a healthy environment of the factory for reconstruction and maintenance of rail vehicles anticipates provision of quality in all of its processes and objects at any time and any place. This can be achieved if the factory submits to the laws and regulations, programmes and procedures which refer to a safe environment, because this presents an important component of training, construction of the activity, as well as the stimulation of employees.

Upon the basis of these researches, we have concluded that by the implementation of the MATLAB programme, i.e. by mathematical cast of the steel hardening process S1530 we can determine the most adequate parameters: temperature of 820 °C and concentration of NaOH of 2.38 %, in order to provide the defined quality of the steel shafts by firmness of 195 HB and lowest possible costs of energy and resources, which provides protection of the human environment. This research has proved the fact that savings of electricity amount to €0.13 per piece, while the savings in NaOH consumption amount to €0,05 per piece, which makes a total of €0,18 per piece. In other words, the total sum of savings per year for hardening of 100 000 shafts would amount to €18033. The application of the system for eco-management allows lowering of the dangerous influences over the environment, but also lowering of the expenses required for maintenance of the environment, which creates a good image of the company.

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Results of projects undertaken by students on the MSc in Environmental Management course

Collated and edited by the Research Office

Abstract

Students on the MSc in Environmental Management course were invited to submit reports of their work to the SEEU Review, as it is editorial policy to encourage young researchers. Lack of space prevents us from publishing the full selected texts, which are available from the Institute for Environment and Health Sciences. Here we report a summary of the findings of six projects in relation to environmental issues affecting R Macedonia and/or Kosovo.

Abstrakt

Studentëve të studimeve pasuniversitare, në lëndën Menaxhimi i ambientit iu kërkua të dorëzojnë raportin e punës së tyre për SEEU Review dhe kjo është në përputhje me politikën redaktuese që të inkurajojë hulumtuesit e rinj. Mungesa e hapësirës na kushtëzon neve të mos i publikojmë të gjitha tekstet e zgjedhura të cilat i kemi marrë nga Instituti i Ambientit dhe shëndetit. Këtu ua paraqesim një rezyme për punën e pesë studentëve lidhur me çështjet e ambientit që kanë të bëjnë me Republikën e Maqedonisë dhe Kosovën.

Апстракт

Студентите на магистерски студии по Менаџмент на животната средина беа поканети да ги достават извештаите за нивната