Growing competition on the market forces the organisations to be more technological and organisational flexibility, both in the range of ensuring the products’ quality and minimising the affect the surrounding environment as well as limiting the threats of the work safety. The studies proposed the way of consistent risk management of the operational discrepancies, based on the operational control, aiming at confirming the consistency of the key characteristics with the fixed operational criteria. The applied method guarantees avoiding the estimated risk, as unacceptable, and supervising and keeping on the even level the risk classified as the accepted one, which was used in the processes of the heat treatment.

**Key words:** heat treatment, quality, environment, occupational safety, integrated risk

**INTRODUCTION**

In the nowadays organisations it is impossible to fulfil the quality, environmental and work safety requirements in a coherent way exclusively by integration of the normalised management systems. The complex tools for shaping the quality in the technical, ecological as well as the social-economic meaning are written in the range of the contemporary commodity science.

Directing the commodity science towards realisation of the strategy of the balanced development enables: defining its main goal as ensuring the quality of the products deciding directly about the quality of life, running the environmental activity as well as taking care of the workers and their work environment.

Although the survey concerning the risk of the human activity currently are perceived as one of the most crucial systemic survey, they do not represent the integrated character, however, they are attributed to the educational discipline, within which the potential loss is analysed [1].

This is usually taken as a reason of lack of consistent and coherent approach towards the risk [2,3]. Within that range, one should notice the need of managing the risk, which finally will lead to its limitation or elimination [4-10].

**NEW INTEGRATED METHODOLOGY IN THE OPERATIONAL PROCESSES**

Risk proceedings

Independently on the nature of the identified risk, the management of it should include (Figure 1): identification of the processes, risk estimation as well as implementation of the proper activities, which allow for effective risk limitation. These can have pro-active or re-active character.

The “input” factors are described by the integrated requirements of the interested sides and integrated resources, whereas the “output” factors include the integrated products as well as the conformity degree with the integrated requirements.

During the risk acceptability evaluation it should be assumed that low risk (described by the small values of the Integrated Risk Ratio) is always acceptable. The high risk (described by very high values of the Integrated Risk Ratio) is always unacceptable. Evaluation of acceptability of the integrated risk described by the medium values of the Integrated Risk Ratio (IRR) is based on the ALARP rule - “as low as reasonably practicable”.

Pro-active approach uses the risk transfer consisting in the assignment of the responsibility for the realised process the risk connected with it on the other entity or avoidance of the risky processes.

Re-active approach accepts the making use of system solutions, also the procedural ones, in the range of both the monitoring the integrated risk management based on the quality criterion and the operational control.

Planning the risk makes the element of improvement in the risk management and is based on the results of operational control.

Operational control based on the integrated quality, environmental and occupational safety consists and it is the fundamental part of the integrated risk management. Scheme of the feedback realised as the operational control based on the quality, environmental and occupational criterion has been proposed on the Figure 2.
Integrated operational control forms a method of integrated risk management, which applies on the operational, and particularly technological, level. Flexibility of the risk assessment methods, tools and methods of evaluation and design of quality, methods of environmental influence, occupational risk assessment methods as well as dependences between causes of operational incompatibilities and potential operational incompatibilities allows for the usage of the algorithm connected with their occurrence. It includes:

- description of the character of incompatibilities and their causes,
- definition of the significance of incompatibilities,
- determination of the probability of incompatibility occurrence,
- integrated risk assessment, and
- identification of the significant incompatibilities described by the highest values of Integrated Risk Ratio (IRR).

Risk which is connected with occurrence of the integrated incompatibilities based on the quality, environmental and occupational criterion has been defined by the function of probability of incompatibility occurrence (described by priority ratio of incompatibility occurrence, PRO) and significance of incompatibility (described by priority ratio of incompatibility significance,PRS). As the effect - the risk has been described as the Integrated Risk Ratio being the product of priority ratio of incompatibility occurrence and priority ratio of incompatibility significance and expressed in the scale of 1-100.

Operational control based on the quality, environmental and occupational criterion, realised according to the procedure shown on the Figure 3, includes:

- integrated operational risk assessment as regards legal requirements, technical specification as well as the requirements of the others interested sides, especially of technological and construction character,
- determination of the Integrated Risk Ratio as well as the ratio of the difficulty of operational criterion assurance in the context of the realised processes, operational criterions and features with those processes connected and potential incompatibilities, their causes and effects,
- definition of the crucial operational criterions and features on the basis of the determined value of Integrated Risk Ratio and the ratio of the difficulty of operational criterion assurance,
- assessment of the process stability defined on the basis of variability character,
- determination of the process capability in the range of crucial operational criterions and features,
- integrated assessment of the process and its possible regulation in the case of the lack of the conformity with the required values of operational criterions and features.

Heat treatment processes

Technological process of toughening, being the subject of the analyses, includes: martensitic hardening and medium-temperature tempering.
The assessment of the integrated risk of the process has been realised according to the prepared risk proceedings.

Specification of the values of the Integrated Risk Ratio (IRR) as well as the values of risk of the fulfilling quality requirements (Quality Risk Ratio, QRR), environmental requirements (Environmental Risk Ratio, ERR) and occupational safety requirements (Occupational Risk Ratio, ORR) for processes of martensitic hardening and medium-temperature tempering has been shown in Table 1.

Table 1 Specification of Integrated Risk Ratio (IRR) as well as Quality (QRR), Environmental (ERR), Occupational (ORR) Risk Ratio values for the analysed processes of heat treatment

<table>
<thead>
<tr>
<th>Kind of process</th>
<th>QRR</th>
<th>ERR</th>
<th>QRR</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martensitic hardening</td>
<td>93</td>
<td>180</td>
<td>195</td>
<td>468</td>
</tr>
<tr>
<td>Medium-temperature tempering</td>
<td>88</td>
<td>160</td>
<td>182</td>
<td>430</td>
</tr>
</tbody>
</table>

The effects of the integrated risk assessment have been used in the range of operational control in the identification of the crucial operational criterions and features. One has assessed the character of variation and - on their basis - defined the capability of the realised processes and controlled their risk by monitoring of the test values and making the necessary regulations.

Risk of the realised heat treatment processes, both hardening and tempering, has been characterised as high. The factor deciding about the high value of Integrated Risk Ratio in martensitic hardening ($\text{IRR}_{\text{M}} = 468$) and medium-temperature tempering ($\text{IRR}_{\text{T}} = 430$) has proved to be heat treatment technology based on the heating, soaking and cooling treatment with usage of the heating and cooling medium of temperature even about $1200\, ^\circ\text{C}$.

There is no possibility to assure the designed mechanical properties by application of the equally effective technology of high temperatures. In spite of existing environmental aspects and impacts being the effect...
of assurance of high temperatures in the carried out heat
treatment and creating very high value of the Environ-
nmental Risk Ratio - not resulting from non-observance
of the law - risk of the processes has been defined as
acceptable.

CONCLUSIONS

In the time of the assessment of the integrated risk
based on the quality, environmental and occupational
safety criterion organisation performs the identification
of threats connected with processes and products as
well as evaluates the risk concerning the effects of those
threats.

The effects of threats identification are supplied to
the appropriate stakeholders and constitute the basis of
integrated risk management by planning and implementa-
tion of the organisational and technological solutions
minimising the risk. Those activities should be adequate
to the size and character of the integrated risk, based on
the solutions, which are the best in respect of organisa-
tional, technological and technical meaning as well as
fulfil legal provisions and the other requirements, both
external and consistent with good practice. Organisa-
tion has no obligation to apply the solutions, which are
the most expensive but only financial optimal and mini-
mising the risk the level, which is acceptable by every
interested side.

The result of the assessment of heat treatment proc-
cesses, grounded on the Integrated Risk Ratio values, has
been the undertaken activity in order to avoid the inte-
grated risk. Avoidance of the risk seems to be the best
way for its minimization or even elimination in the or-
ganisation. However, in case of the analysed processes
of martensitic hardening and medium-temperature tem-
pering there is no possibility to fulfil the requirements
by application of the other technical or technological
solutions. It is necessary to take advantage of organisa-
tional solutions in the form of operational control al-
lowing for the maintenance of the threats of heat treat-
ment processes in the supervised conditions.

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