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IMPLEMENTATION OF QUALITY MANAGEMENT SYSTEM FOR PRODUCTION OF TMCP TREATED 10MN2VNBAL STEEL HEAVY PLATES

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INTRODUCTION

The quality of hot-rolled steel products depends on technological means as a complex of mechanical, environmental, surface, and other operating properties of rolled products that determine its suitability to meet certain customers' needs [1]. To obtain an increased level of plate steel mechanical properties, a number of effective but energy-intensive heat treatment process flows with preliminary modification of alloying elements and formation of multiphase structures[2] are used: ART treatment of steels with an average manganese grade, isothermal hardening of nanostructured steels with carbide-free bainite, Q&P and D&P processing. In most hot plate rolling mills, more energy-efficient thermo-mechanically controlled process (TMCP) technologies are suitable for implementation, but to obtain rolled products with increased quality indicators, the quality control system should be continuously improved[3]. To ensure the full functioning of the enterprise or company and its development in all process areas, from raw material supply, including supplier management and equipment maintenance, to customer (consumer) management, the quality management system is essential for implementation in accordance with the ISO 9000 and ISO 9001 requirements. For complex rolling operations at full-cycle steel-making facilities, the development of a proactive quality management system becomes especially important when developing new product types and improving existing technologies.

1. Literature Review

The quality management system (QMS) at steel-making enterprises has long been formed around technologies by the introduction of global certification and implementation of Total Quality Management (TQM)

[1] Sheyko S., Matiukhin A., Tsyganov V., Andreev A., Ben A., Kulabneva E. Energy power parameter effect of hot rolling on the formation of the structure and properties of low-alloy steels. *Eastern-European Journal of Enterprise Technologies*. 2021.No. 6. P. 20–26.

[2] Markulik S., Nagyova A., Turisova R., Villinsky T. Improving Quality in the Process of Hot Rolling of Steel Sheets. *Applied Sciences*. 2021. Vol.14. Issue 12. P. 5451.

[3] Bleck W., Brühl F., Ma Y., Sasse C. Materials and Processes for the Third-generation Advanced High-strength Steels. *Berg Huettenmaenn Monatsh*. 2019. No. 164. P. 466–474.

principles using a number of selected quality initiatives and practices[4,5]. The involvement of a quality system in steel-making infrastructures is formal, but not everywhere. The paper[6] shows that ISO 9001 is the world's most popular QMS, certifying over 1 million different companies; moreover, Europe and the Far East make up nearly 90% of all ISO 9001 certificate amounts. These are mainly infrastructure and manufacturing companies whose adherence to QMS principles contributes to global competition. There are positive experiences of TQM implementation in the industrial sectors of developed[7] and developing countries[8]. Special expert evaluations and questionnaires were developed to identify components (factors) affecting the efficiency and sustainability of enterprises. The study[9] proposes a model confirming that the TQM practices have a positive relation with sustainability and organisational performance and showed that leadership, continuous improvement, customer satisfaction, training and education, and customer relations have the greatest influence on organisational effectiveness. To develop the TQM strategy, the authors[10] suggest using a qualitative research technique to collect secondary data from empirical studies and literature reviews. This work[11] is presented as the implementation guide for QMS and follows the four pillars of ISO 9001: quality management principles, process approach, risk-based thinking, and Plan-Do-Check-Act (PDCA, or Deming) cycle.

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[4] Kukhar V.V., Kurpe O.H., Prysiazhnyi A.H., Khliestova O.A., Burko V.A., Balalayeva E.Y., Yelistratova N.Y. Improving of preventive management for flat rolling products quality indices. IOP Conference Series: *Materials Science and Engineering*. 2021. Vol. 1037. P. 12024.

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[6] Tervonen P., Pahkala N., Haapasalo H. *Development of TQM in Steel Manufacturers' Production*. IBIMA Business Review. 2009. Vol. 1. P. 14–21.

[7] Priede J. Implementation of Quality Management System ISO 9001 in the World and Its Strategic Necessity. *Procedia – Social and Behavioral Sciences*. 2012. P. 1466–1475.

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[9] Safar H., Bielova O. Implementation of Total Quality Management Components in Libyan Iron & Steel Company "LISCO". *Economics, Finance and Management Review*. 2021. Vol. 2. Issue 6. P. 81–91.

[10] Wassan A., Memon M. S., Mari S. I., Kalwar M. Impact of Total Quality Management (TQM) practices on Sustainability and Organisational Performance. *Journal of Applied Research in Technology & Engineering*. 2022. Vol. 3. P. 93–102.

[11] Bisho A. H. A.I., Sam M. F. B. M. Total Quality Management Integrated Strategy: Its Implication to Organizational Success. *Proceedings on Engineering Sciences*. 2022. Vol. 4. Issue 3. P. 371–378.

The combination of the ISO 9001 quality system with the tools of the Lean production system[12] shows effective results, ensuring long-term competitiveness with lower losses while manufacturing in exact accordance with consumer requests. A proactive quality management system should be formalised according to the SMART principles: Specific, Measurable, Attainable, Relevant, and Time-bound[13]. In rolling production, such integrated approaches are still being developed, and the following analysis tools, which are widely used in the Lean system and statistical processing methods[14], can be used, among other things, to monitor the status and continuously improve the quality system: process mapping, benchmarking, the Ishikawa (fishbone) diagram, and the Pareto principle.

Articles[15,16] show that an effective formalisation under ISO 9001:2015 is risk-based thinking, which allows us to identify factors causing deviations in the rolling technology and quality indicators from the planned results. The process of thermo-mechanical processing of rolled products is highly sensitive to the process stability, making the risk-based approach assessment reasonable. Data on already manufactured products and the results of their quality control (at the enterprise and following customer feedback) is the basis for creating control criteria. Corrective actions are integrated into QMS processes as an element of Deming cycle (PDCA), which is successfully implemented in relation to TMCP rolling of low-carbon, low-alloy steel heavy

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[12] Farinha L. Guidelines for the Implementation of a Quality Management System in Industrial Companies. *The Romanian Review Precision Mechanics, Optics & Mechatronics*. 2016. Vol. 50. P. 195–201.

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plates[17]. It follows[18,19,20] from papers that each production builds its quality control system, which takes into account the specifics of its structure and management methods. At the same time, proactive quality management systems[21,22] are widely used, including methods of controlling technological parameters[23,24], testing quality indicators[25,26], and forecasting based on mathematical models (e.g., statistical[27,28] or neural network[29,30]). Thus, in

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[17] Kukhar V.V., Kurpe O.H., Prysiazhnyi A.H., Khliestova O.A., Burko V.A., Balalayeva E.Y., Yelistratova N.Y. Improving of preventive management for flat rolling products quality indices. *IOP Conference Series: Materials Science and Engineering*. 2021. Vol. 1037. P.12024.

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[19] Markulik S., Nagyova A., Turisova R., Villinsky T. Improving Quality in the Process of Hot Rolling of Steel Sheets. *Applied Sciences*. 2021. Vol. 11. Issue 12. P. 5451.

[20] Bashynska I. Realities of Ukrainian industrial enterprises on the way to smartization. *Economics Finances Law.* 2019. Vol. 12. Issue 2. P. 34–37.

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[27] Prysiazhnyi A., Kukhar V., Hornostai V., Kudinova E., Korenko M., Anishchenko O. Mathematical Models for Forecasting of 10Mn2VNb Steel Heavy Plates Mechanical Properties. *Materials Science Forum*. 2021. Vol. 1045. P. 237–245.

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order to control the production process and ensure the predicted quality of thermo-mechanically processed rolled products, it is necessary to develop a proactive quality management system to establish and control the relevant technological factors, which is the objective of this study.

The study aims to improve the structure of quality management methods as applied to the plate manufacturing processes by thermo-mechanically controlled rolling to upgrade the mechanical properties of 10Mn2VNbAl steel products.

2. Methodology of Research

Establishment of indicators. Technological indicators affecting quality parameters (other indicators can also be determined, if necessary) that need to be monitored can be established in the following ways:

– establishing already known indicators stated in the process flow documentation, etc.;

– setting indicators using the Ishikawa diagram, Fig. 1.

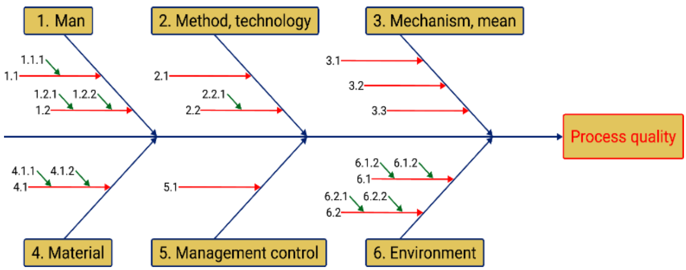

Fig. 1. General view of the Ishikawa diagram

1.1, 1.1.1, 1.2, 1.2.1, 1.2.2 – levels and sub-levels of indicators through which the ‘Man’ category (compliance with the production method, experience, qualification) affects the quality parameters;

2.1, 2.2, 2.2.1 – levels and sub-levels of indicators through which the ‘Methods and Technology’ category (production method, level of technology used, control methods) affects the quality parameters;

3.1, 3.2, 3.3 – levels of indicators through which the ‘Mean, Mechanism’ category (equipment, devices for control, tests, research) affects the quality parameters;

4.1, 4.1.1, 4.1.2 – levels and sub-levels of indicators through which the ‘Material’ category (used material, properties, anisotropy) affects the quality parameters;

5.1 – the level of indicators through which the 'Management Control' category (means of control and timely correction of technological parameter deviations) affects the quality parameters;

6.1, 6.1.1, 6.1.2, 6.2, 6.2.1, 6.2.2 – levels and sub-levels of indicators through which the 'Environment' category (conditions under which the production process and tests are carried out) affects the quality parameters

Indicators can be established for a set of quality parameters in general or for individual parameters/groups of quality parameters. Additionally, benchmarking results on similar production facilities can be used for establishing indicators if such data is available. The list of indicators can be endless. Therefore, in some cases, controlling only the significant indicators is possible and necessary. Determining a list of significant indicators affecting product quality is possible using the Pareto method, Fig. 2. To determine significance, it is definitely necessary to have an array of factors.

Establishment of indicator values. The values of technological indicators can be established directly on the basis of: an analysis of manufacturing similar products, statistical processing of available data, scientific research, literature, and other technological or statistical methods.

Statistical data accumulation. In the production of rolled products, it is necessary to monitor the values of all established indicators and store information that will be the basis for processing and improving product quality in the future. The established technological or other indicators should be combined with product quality parameters using a traceability system. A traceability system is a mandatory requirement for modern production, without which tracking and quality improvement are impossible.

Processing of accumulated information. Processing is carried out as a multivariate analysis. Each of the quality parameters should be analysed separately or in a group with parameters of a similar level. For example, a group may include all or some parameters of mechanical properties, some parameters of roll geometry, and others. The first step of the analysis is to build distribution diagrams for each of the quality parameters with a limit set according to the 3σ or 6σ rules, depending on the process, Fig. 3.

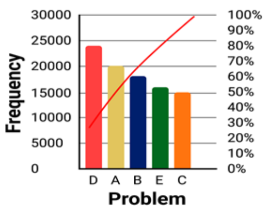

Fig. 2. General view of the Pareto chart

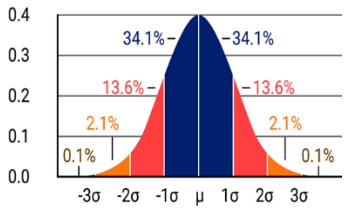

Fig. 3. General view of the normal distribution diagram

It should be borne in mind that the limits set should be consistent with or stricter than those stipulated in the relevant product standards or other regulatory documents. That is, if, according to a distribution, the yield stress of rolled steel is 235 MPa with a standard deviation of +/-10 MPa, and the limit according to the regulatory document is 210–255 MPa, then according to the 3σ rule, the yield stress distribution is 205–265 MPa. In this case, the set limit should not exceed the limits of 210-255 MPa according to the regulatory document.

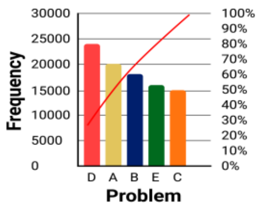

Fig. 2. General view of the Pareto chart

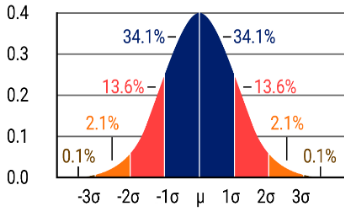

Fig. 3. General view of the normal distribution diagram

If the process is not stable enough, limits can be set at the level of regulatory requirements. The gradual narrowing of limits will further improve the stability of the production process. Only those quality parameter data that meet the set limit are used for further processing of the array. Next, for each technological indicator that affects the quality parameter under consideration, it is necessary to build distribution diagrams and set limits that ensure the desired quality result. Separate setting of limits for interdependent technological parameters should be avoided, as well as setting different limits for the same parameter that affects different quality indicators. To set limits, including those for interdependent parameters, it is recommended to use comprehensive statistical models based on the data arrays obtained. Such models can be conveniently built into specialised software applications or the Microsoft Excel analysis package.

Setting markers and boundaries. Coloured markers, which help visually assess a process' state, have been recently widely used. When setting limits of technological indicators/parameters, coloured markers can be applied as follows, Fig. 4:

– a red marker is set when the technological indicator/parameter deviates from the limits that ensure obtaining a quality parameter in accordance with the standard;

– a yellow marker is set when the technological indicator/parameter deviates from the limits that ensure the increased requirements set within the limits of the quality system management while the parameter is still within the limits of compliance with the standard;

– a green marker is set when the technological parameter meets the limits of the established (increased) requirements.

Quality index / technological indicator	Levels of the process				
	process failure	needs attention	stable	needs attention	process failure
Yield stress	<210	210-214	215-250	251-255	>255
Finishing rolling temperature	<800	800-809	810-830	831-840	>840

Fig. 4. An example of using colour markers to assess the rolling process state

Depending on the current state of the quality system and technology, as well as at the initial stages of technology development, only red and green markers can be set. It should be noted that this approach not only helps to stabilise the technological process and improve product quality but also provides an opportunity to reduce production costs within the framework of a combination of ISO and Lean systems by applying restrictions on extremely high levels of quality parameters. For example, stable maintenance of the mechanical properties of rolled products at the average level of requirements allows us to save microalloying elements.

Tracking the Shewhart chart result. Tracking the result and monitoring compliance with the established limits on technological parameters should be carried out using any convenient methods available at the enterprise. This can be direct control by a quality control officer at the place of parameter locking, using a visualisation (control) system of technological parameters, or using an automatic process control system. One of the most well-known ways to analyse the results of tracking process stability is through Shewhart control charts[31], which are a graph of changes in a sample of parameters, usually the mean value and standard deviation, which is calculated while accumulating data, Fig. 5.

[31] Ratter E., Nader S. The Use of Lean Management Tools in Production Companies with Implemented Total Quality Management (TQM). *European Research Studies Journal.* 2022. Vol. XXV. Issue 3. P. 357–368.

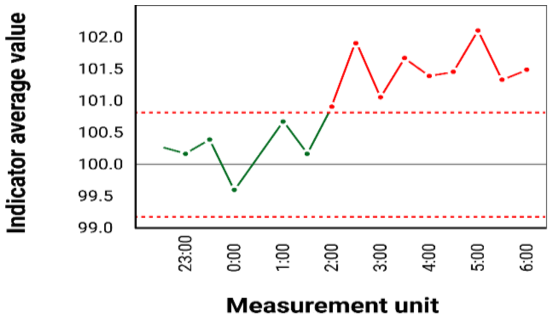

Fig. 5. General view of the Shewhart control chart

If the permissible level of deviation is exceeded, or if the indicator falls into the yellow or red field, the process staff ensures the indicator enters the required limits/green field. A product unit, batch, or other product manufactured outside the green field must be tracked separately.

Decision-making on products manufactured with deviations from the standards. Obtaining information on deviations allows us to manage the further fate of such products in accordance with the requirements of Clauses 8.6 and 8.7 of ISO 9001[32]. Batch products, every single unit of which has indicators within the green marker during the production, are considered conforming. Batch products, some units of which have indicators within the yellow marker during the production, are subject to additional quality control. Products with indicators within the yellow marker are subject to additional control/testing. Products with yellow markers are considered conforming only after confirmation by the results of additional control. This method can be used up to the point of individual product inspection, unless the customer objects.

Batch products, some units of which have indicators within the red marker during production, unless agreed with the customer, are considered non-conforming and are transferred to lower quality or rejected. A batch of rolled products may contain a set of units with a combination of any markers, if agreed with the customer, or be separated into different batches according to the markers.

When manufacturing new products, the basic limits of technological parameters may be the parameters of analogue products, if any. In general, the proposed method is applicable to products that have passed the assimilation stage and are produced on an industrial scale. The proposed principle can be applied to partner companies that provide manufacturer's products with additional added

[32] Bajaj S., Garg R., Sethi M. Identification of TQM Practices for Successful Implementation of TQM in Steel Industries: A Review and Analysis. *International Journal of Engineering and Management Research.* 2016. Vol. 6. Issue 3. P. 208-214.

value (e.g., additional surface treatment of rolled products) if the final product is sold by the manufacturing company or its affiliated companies or to process product quality data based on data provided by customers.

Methodology improvement. Thus, the quality management methodology, which involves setting and establishing the values of technological indicators affecting product quality, their control, accumulation, processing, and improvement mechanisms, as a separate element of the quality system, is subject to the PDCA cycle and confirms the integrity of the quality system in general and its individual elements. The presentation of the proposed methodology in the form of the PDCA cycle is presented in the paper[33].

The update period of the PDCA cycle may vary for different products. The data update period can be static or dynamic. A stationary, or 'scheduled', period is a time-based update frequency for a specific product type, depending on the production volume, for example, every 50 thousand tons, or depending on the production time, for example, every month or every quarter.

The dynamic, or 'operational', update period is applied for a specific product type or range and can be divided according to the following principles:

– cycle update when a set limit for the non-compliant products is exceeded, e.g. 3%;

– cycle update when the set limit for the number of indicators falling within the yellow and/or red markers is exceeded;

– cycle update when the set limit by the number of products requiring additional control is exceeded, for example, by more than 10%.

Cycle performance is closely related to the technology, as it is continuously monitored and analysed, and technology is adjusted to improve quality. The technological information used and its processing results are part of an enterprise's general 'Knowledge Base'.

3. Result of Research

Application example. Let us consider the application of the developed methodology to establish the current level of quality and directions for improving such indicators as yield stress (YS), ultimate strength (US), and percentage elongation (E%) in the production of 14 mm thick plates using 10Mn2VNbAl steel produced by thermo-mechanical rolling with accelerated cooling on the 3600 mill. The indicators affecting the quality parameters, such as yield stress, ultimate strength, and percentage elongation, were taken from the plant's technological documentation. The indicators include the chemical

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[33] Sheyko S., Matiukhin A., Tsyganov V., Andreev A., Ben A., Kulabneva E. Energy power parameter effect of hot rolling on the formation of the structure and properties of low-alloy steels. *Eastern-European Journal of Enterprise Technologies*. 2021. Vol. 6. P. 20–26.

composition of steel with the following elements affecting the mechanical properties (C, Mn, Nb, V, Mo, Cr, Ni, Cu) and technological parameters: rolling start temperature in the roughing stand (TRSr), the temperature of the beginning of the second rolling stage in the roughing stand, which is caused by the onset of recrystallisation inhibition (TIR), the temperature at the rolling start and finish in the finishing stand (TRS, TRF), the metal temperature at the accelerated cooling start and finish (TACS, TACF).

To identify indicators affecting the quality parameters under study, we will build the Pareto chart for each of the parameters from the entire specified list of indicators, Figs. 6–8.

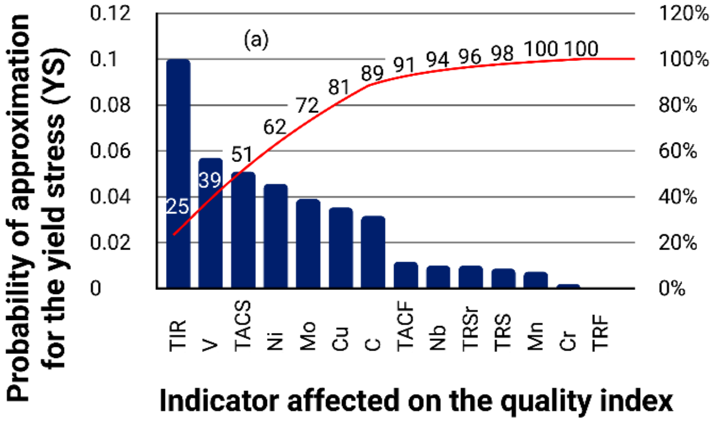
The basis for building Pareto charts is the value of the approximation probability R^2 and the value of the Pearson correlation coefficient (modulo), which are obtained when determining the correlation between each indicator and the quality indicator. For the array used in the calculations, the critical value of the Pearson correlation is 0.17 (significance level 0.05). Indicators with the Pearson correlation coefficient to the respective quality parameter less than 0.17 are insignificant.

Indicators that are significant according to the results of statistical data processing are listed in Table 1. Actions on quality improvement processes are developed only for significant indicators.

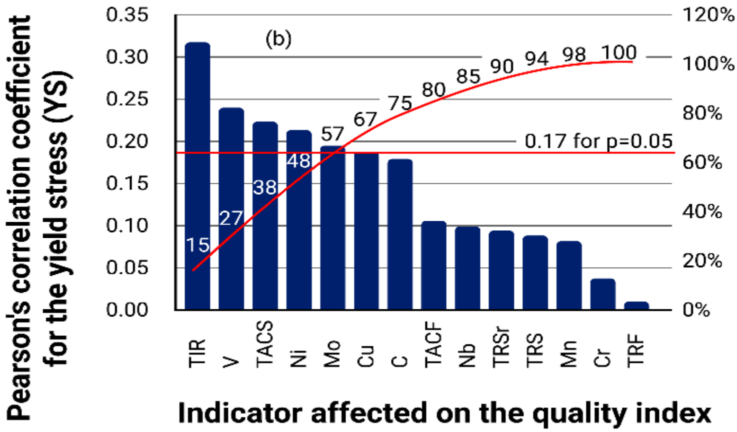
Table 1

Significant indicators in determining the quality parameter regarding the production process of thermo-mechanically treated 10Mn2VNbAl steel

Indicator	**Pearson correlation values for quality parameters**		
	YS	**US**	**E%**
TIR	0.316	0.379	-
V	0.236	0.252	-
TACS	-0.224	-0.334	-
Ni	-0.213	-0.219	-
Mo	-0.196	-	-
Cu	-0.188	-0.202	-
C	0.178	0.246	-
TRF	-	-0.241	0.412

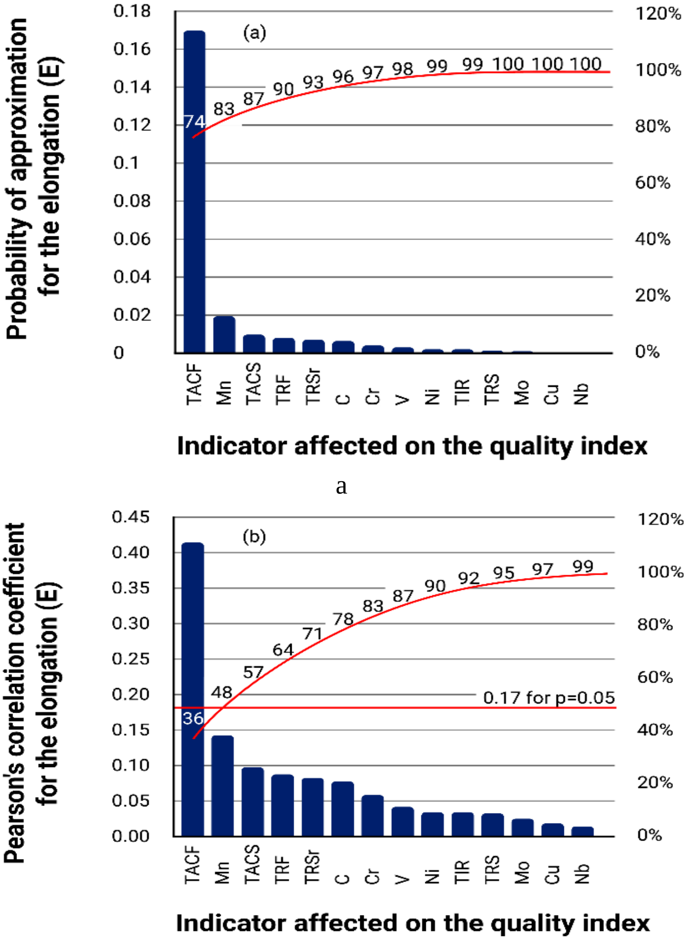


a



b

Fig. 6. Distribution diagrams of the approximation probability (a) and the Pearson correlation coefficient (b) according to the indicators affecting the yield stress of rolled products made of thermo-mechanically treated 10Mn2VNbAl steel



a

b

Fig. 8. Distribution diagram of the approximation probability (a) and the Pearson correlation coefficient (b) according to the indicators affecting the percentage elongation of rolled products made of thermo-mechanically treated 10Mn2VNbAl steel

Insignificant indicators remain at the level set by the technology. Let us build distribution diagrams by quality parameters to determine the current state of the technology for the production of 14 mm thick rolled products using 10Mn2VNbAl steel on 3600 mill, Fig. 9–11.

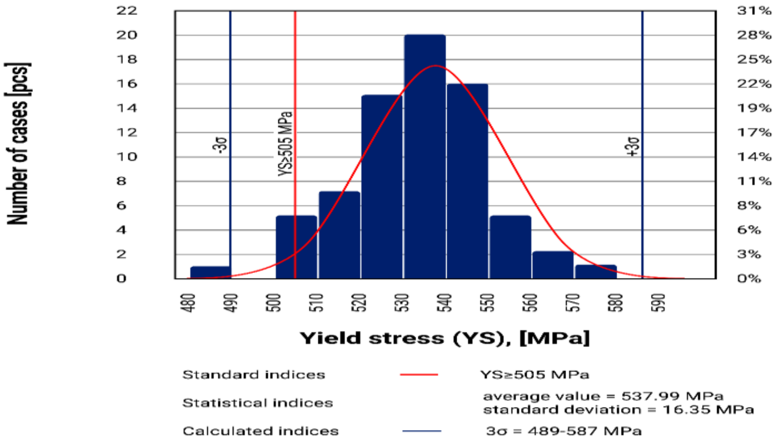


Fig. 9. Yield stress distribution for 14 mm thick rolled products made of 10Mn2VNbAl steel

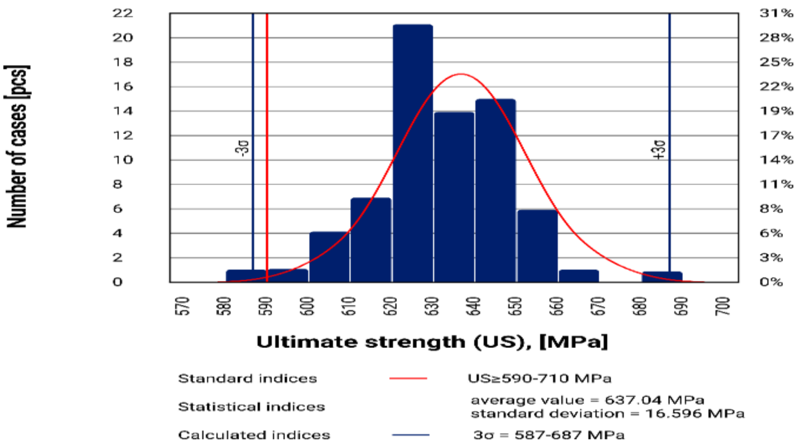


Fig. 10. Ultimate strength distribution for 14 mm thick rolled 10Mn2VNbAl steel

According to the distribution diagrams (see Figs. 9–11), we have the following quality status of the rolled products under study:

– the yield stress distribution has cases of below-standard and borderline with minimum standard requirements. The overall distribution is shifted to the lower level of requirements;

– the ultimate strength distribution also has cases of below-standard requirements;

– the percentage elongation distribution has many cases of below-standard requirements. The percentage elongation distribution indicates the instability of the technological process in obtaining this quality parameter.

To stabilise the technological process and improve product quality according to the parameters under study, let us set the following restrictions, Table. 2. In order to obtain the required level of technology indicators according to the set quality parameter limits, we will use filters to leave only those data in the data array under study that correspond to a stable or green level of the process and set their limits, Table 3.

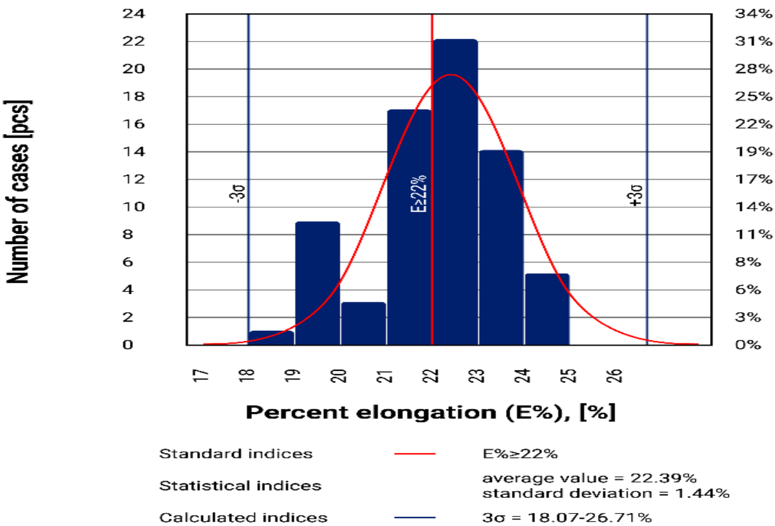


Fig. 11. Percentage elongation distribution for 14 mm thick rolled 10Mn2VNbAl steel

Table 2

Setting limits on quality indicators

Quality parameter/ technological indicator	Process levels				
	process non-conformances	attention required	stable	attention required	process non-conformances
Yield stress, MPa	<505	505–510	511–570	571–580	-
Ultimate strength, MPa	<590	590–600	600–660	661–710	>710
Percentage elongation, %	<22	22–22.5	22.5–25	25–26	-

Table 3

Set limits of indicators and corresponding quality parameters

Quality parameter/ technological indicator	Process levels				
	process non-conformances	attention required	stable	attention required	process non-conformances
Yield stress, MPa	<505	505–510	511–570	571–580	
Ultimate strength, MPa	<590	590–600	600–660	661–710	>710
Percentage elongation, %	<22	22–22.4	22.5–25	25.1–26	
TIR	<876	876–908	909–1008		>1008
V	<0.055	0.056–0.059	0.06–0.08		>0.08
TACS	<717	718–720	721–737		>737
Ni			0–0.29		>0.29
Mo			0–0.07		>0.07
Cu			0–0.28		>0.28
C			0.08–0.11		>0.11
TRF	<541	542–595	596–640		>640

Filtering should begin with the most unstable parameter, which is the percentage elongation in our case. Because the list of significant indicators overlaps between quality parameters, they will be the same for all three parameters. When setting the yellow and red levels, it is necessary to consider the Pearson correlation's negative or positive value, see Table 1. Boundaries of the yellow level for the indicators are the data that meet the limits of the regulatory requirements for the quality parameters.

Also, the quality of the initially developed technological process plays an important role in setting process levels when using this method. In this case, the plant developed a false technology of thermo-mechanical rolling with accelerated cooling, which does not allow obtaining the required mechanical properties by cooling, which is evident from the negative correlations of cooling parameters.

The required properties are achieved mainly through the rolling process parameters. The advantage of the proposed method is the additional possibility of detecting errors in the developed technologies. After establishing the required levels of technological indicators to obtain stable quality parameters, we have the following distribution, Figs. 12–14.

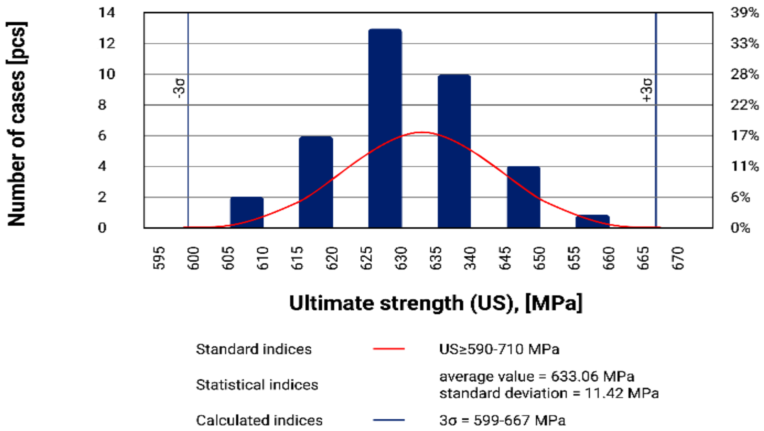


Fig. 12. Yield stress distribution of 14 mm thick rolled products made of thermo-mechanically treated 10Mn2VNbAl steel, green level of the process

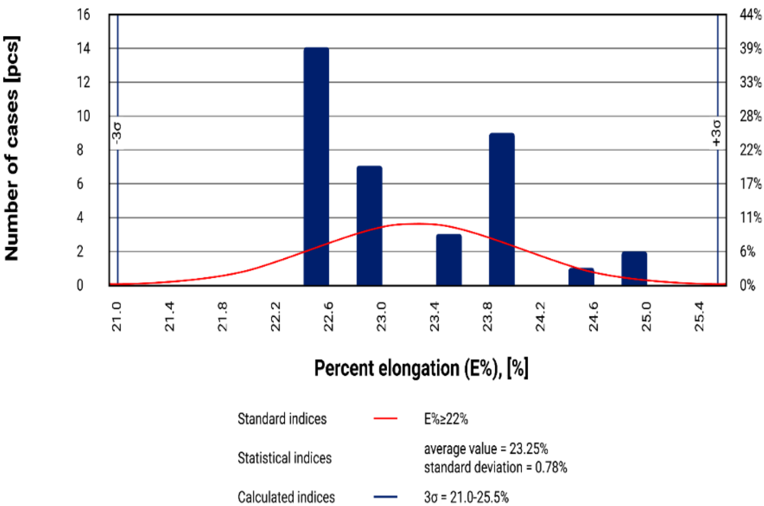


Fig. 13. Ultimate strength distribution of 14 mm thick rolled products made of thermo-mechanically treated 10Mn2VNbAl steel, green level of the process

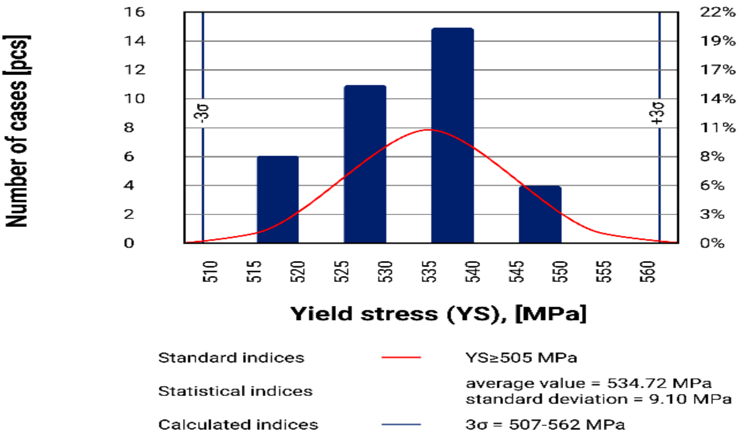


Fig. 14. Percent elongation (E%) distribution of 14 mm thick rolled products made of thermo-mechanically treated 10Mn2VNbAl steel, green level of the process

Thus, the green level of the process ensured that mechanical properties were obtained within the regulatory requirements, while decreasing the standard deviation of yield stress, ultimate strength, and percentage elongation by 44%, 31%, and 46%, respectively, indicating an increase in the stability of the technology and the results obtained. The distribution of percentage elongation is not normal, but after the appropriate changes are introduced in the technology, its results should stabilise.

Therefore, within the framework of proactive quality management, a methodology for establishing and identifying the values of technological indicators affecting product quality, their control, accumulation, processing, and improvement mechanisms has been proposed and formalised for the first time. It uses the Pareto principle, 3σ, and the Pearson criterion and aims to continuously improve the quality of technological processes and products.

CONCLUSIONS

Based on the analysis, it has been found that additional requirements for rolled products exceed the values established by regulatory documents and need to be taken into account when developing technologies. It has been proved that based on the relationships between the technological parameters of rolled products and the mechanical properties of the finished TMCP rolled steel established using a set of statistical data processing methods, which are incorporated into the quality management methodology, it is possible to improve the stability of rolling processes. The verification of the proposed methodology showed a reduction in the standard deviation of yield stress, ultimate strength, and percentage elongation by 44%, 31%, and 46%, respectively, from the primary data obtained during the rolling of 10Mn2VNbAl steel on a heavy plate mill 3600, which indicates the possibility of increasing the stability of the thermo-mechanical rolling process.

SUMMARY

The goal of the work was to formalize and implement in the conditions of a heavy plate rolling mill shop the quality management methodology for 10Mn2VNbAl steel flat products produced by a thermomechanical controlled process (TMCP) rolling with a predicted increasing of mechanical properties indices. It is shown that the quality management system is relevant to be implemented in all process areas, from the supply of raw materials to the processes of working with consumers of products, in order to operate and achieve the enterprise development. On the basis of the analysis, it has been established those additional requirements for quality indices of rolled products exceed the values established by normative documents, which should be taken into account when developing technologies. The proposed methodology includes the use of Ishikawa's approaches to establish factors affecting quality indicators, processing of statistical information with the construction of Pareto charts and determination of compliance of the distribution of indicator values with the normal law. Designation for stability of the process and indicators levels performed by the method of coloured markers with tracking of results (by Shewhart charts, as an example). Decision-making on technology improvement with control of influencing factors of the thermomechanical rolling process, as a separate element of the quality system, is subject to the Deming cycle (PDCA). The testing of the proposed methodology showed decreases in the standard deviation of yield strength, tensile strength and percent elongation by 44%, 31% and 46% respectively, regard to the primary data obtained when rolling 10Mn2VNbAl steel at heavy plate mill 3600.

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