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USING MODELLING AND SIMULATION BASED STUDY METHODS IN COAL INDUSTRY TECHNOLOGICAL IMPROVEMENT

The trend towards the increase of the role of coal in the electricity production reveals its importance among the primary energy resources balance. So, from the point of view of the structure of the primary energy, the evolution forecast performed by IEA highlights that in the future, a quarter of the worldwide used energy primary resources will be based on coal. The share of coal in energy production will grow, as the total energy demand growth with 60% in the next 20 years.

It can be deducted the importance and the opportunity of the analysis performed in the present thesis, in accordance with the recently delivered Energy Strategy of Romanian Government which pleads in the favor of the increasing role of domestic coal , mainly the lignite in the total national energy balance.

From the point of view of the technological infrastructure, it must be noticed that the main equipment asset is obsolete. Maintaining them in operation implies major works of rehabilitation in order to replace the worn parts and of modernization in view to increase their performance.

Previous experience has shown that only the increase of technological level of the equipment is not enough necessarily the needed outcome in terms of performance as it is stated in the prospects. This implies that beyond the modernization and/or replacement of assets, the connected technological problems must be solved, among which the adaptation of the equipment to the operating environment, reduction of downtimes through an appropriate maintenance policy, correlation of the equipment chain parameters, improving operational management, making flexible of production lines, adapting the production capacities to the variations of the demand and management of intrinsic process variability are the main actions to be performed.

All these aspects are related to the technological components of the restructuring, which is one of the main topics of the process.

Correlating the data regarding the coal industry evolving trends, and the energy policies worldwide, taking account the pro and counter coal utilization increase arguments, we can conclude that worldwide, as in Europe and Romania, the coal will play an important role in the energy mix due to its important reserves, relatively uniformly distributed, and at accessible price and the inherent evolution of the extraction and beneficiation technologies towards the reduction of its aggressiveness against the environment.

The main idea related to the restructuring of Romanian coal industry issued from the new "Strategy of Romanian Coal Sector Development" is that the future development of the Romanian coal sector follows the resuscitation of overall activity in view to cover the internal demand of solid fuel in a perfect compatible way with the requirements of the European energy market.

The low technological level, the difficult and complex geological mining conditions, the oscillating shape of the demand curve and of the market price, the quasi permanent financial blocking imposes the restructuring of all components of the coal industry, i.e. technical, technological, managerial and financial ones.

All the delivered strategies consider the coal as an important and indispensable element of the energy strategy, at medium and long term, and place the technological issues of the restructuring process among the first ones.

In the coal industry restructuring, the synergic combination of technological, economical, environmental and social aspects is compulsory, deals with the main conceptual elements of the technological restructuring which the aim is the improvement of the technical and economical performances of the involved production systems.

The theoretical background of the technological systems modernizing is able to scientifically fundament the restructuring solutions in the case of coal mining production systems.

The main ways towards the technological restructuring of these systems were request to be treated in a different way the two representative issues, i.e. the technological systems for underground hard coal mining and the open pit lignite extraction.

For the first topic, a theoretical study of the underground longwall fully mechanized faces performance, in a multi-criterion approach can be an example of scientific approach, and the implementation of top coal caving fully mechanized technology can be a possible solution of technological restructuring.

For the second topic, the open pit lignite extraction technology, the methods to support the rehabilitation, reengineering and modernization of the assets and the open pit mine layout redesign are to be considered.

In this respect, studies were performed in order to delivery some models assisted by computer applications towards detailing several aspects of the optimization of technological processes from coal industry in view to improve their performance in the framework of technological restructuring process.

Starting from the idea , widely disputed in the literature that in the process industries and namely in the coal mining industry the production processes are characterized by an accentuated variability of outputs, an analysis of this phenomenon was performed using new analytical tools.

In this sense, a classification of the variability sources was realized, which were explicated using the probability distribution representation. Due to the randomness of the variability sources – the intrinsic process variability and the external factors induced variability – it was concluded that these phenomena can be described using the concepts of uncertainty theory. For this reason, using in a new context the concepts and relations issued from the process reliability theory, simulation models in conditions of uncertainty of continuous production systems used in coal industry can be delivered.

Another kind of models of simulation of production systems operation which is taking into account the statistical

distribution of the duration of operation with imposed succession and parallel deployment as in case of underground longwall faces in which the operation of the three main equipment is realized in partially superposed, can also be delivered.

In this kind of models inter-conditional dependence between different operations is modeled using graphs, and the critical path method, but taking into account the influence of the random character of the duration of each operation.

As results, having the panel width as independent variable, we obtain the working cycle duration which is the base for calculating other face performance metrics.

The face performance is influenced by a large variety of factors, having different nature, with inter-conditioned and even contradictory action, direct or indirectly affecting the result. In order to describe the influence of these factors on a significant performance metric, such as the face advance rate, multi-criterion analysis allows to establish the optimal advance rate in different conditions.

The use of such methods and models allows to establish the technical factors (e.g. the yield capacity of the cutting machine) geological mining ones (methane flow from the face) and economic ones (realizing a requested output) which are limiting upward or downward the face advance rate.

Defining and quantifying the technological aspects of the coal industry restructuring lead to the approach of the following elements :

- upgrading and/or renewing the asset inventory with correlated solving the related technological adaptation problems;
- adapting the equipment with the concrete geologic/mining conditions existing in each coalfield;
- reducing the downtimes of equipment by an appropriate maintenance policy;
- correlating the equipment in the production lines;
- adopting operative management measures;
- making the production lines flexible in view to adapt the production capacity to the variation of the demand fluctuations;
- managing the intrinsic variability of production process.

In a scientific approach, these issues can be solved when using up to date asset management and industrial engineering tools, such as:

Simulation models in conditions of uncertainty of the continuous production systems from coal industry, using in a new context the concepts of process reliability theory;

Simulation models of operation of production systems, which is taking into account the statistical distribution of the duration of operation with imposed succession and parallel deployment as in case of underground longwall faces in which the operation of the three main equipment is realized in partially superposed, imposed by the technology

Multi-criterion analysis based models which allows establishing the optimal advance rate in different conditions, such as the output reduction need by lack of demand or upstream downtime in order to ensure a hazardless low advance rate to avoid harmful effect of roof convergence on the support shields.

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