UNIVERSITY OF PETROŞANI
DOCTORAL SCHOOL
DOMAIN: MINES, OIL AND GAS

SECURING AND MONITORING CIVIL USE EXPLOSIVES IN ROMANIA

DOCTORAL THESIS

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KEY WORDS

Key words: explosives, means for initiating, monitoring, securing, SAP.

SUMMARY OF THE DOCTORAL THESIS

The doctoral thesis includes 10 distinct chapters, of which the last one sets forth the conclusions and the personal contribution of the author. To these, an introduction, a bibliographic list that displays 121 titles, of which 9 belong to the doctoral student.

The doctoral thesis has 126 pages and includes 26 calculation relations, 28 figures, drawings, schemes and graphs and 13 tables.

Let's also mention that the bibliography consulted includes 133 references from Romanian and foreign specialised works as well as a series of articles and works that disseminate results of their author's research.

The results of the research were disseminated in 9 scientific works as a single author or co-author.

The analysis of the content of the thesis pinpoints a series of aspects that characterize each chapter.

The thesis deals with the explosives that are substances or mixtures of substances, which, as a result of heating or mechanical factors, undergo explosive changes that determine the instant reaction of these mixtures that suddenly and violently decompose, while reaching temperatures of hundred degrees and very high pressures in the environment such changes occur. The thesis approaches the issue of rehabilitating and modernising the industrial systems belonging to the mining units. The guiding principle of the thesis is represented by the technologies employed in scientific research, considered as a privileged field for intellectual work, and having resulted in conceiving, designing and implementing certain solutions that provide functionality, increased exploitation duration, work safety and economic efficiency.

The thesis is structured in 10 chapters, of which the last one displays the conclusions and personal contribution of the doctoral student.

The **first chapter** of the hereby thesis, called **Characteristics of Civil Use Explosives**, displays aspects that are connected with the scientific research of the paths in the field of mining, while setting forth a worldwide and national comparison. A description of the features of civil use explosives employed in the mining industry is also carried out here. The principles for the elaboration of civil use explosives, the classification, description and parameters of the civil use explosives employed in Romania are also exhibited here. The doctoral student carried out an extended description of the civil use explosives employed in the mining industry. He also pinpointed the principles for the elaboration of civil use explosives and their use.

The doctoral student also displays a short history that regard the discovery, classification and description of the explosives, their parameters and use as well as the principles for the elaboration and use mining explosives.

Chapter 2, called **Manufacture of explosives for civil use**, The chapter deals with manufacturing of civil explosives base on nitro-glycerine, ammonium nitrate shell - cased explosives, explosive gels. The monitoring of technological fluxes is also described here.

The identifying of the danger points along the technological flux, the possibilities of decreasing the risk, the manufacturing of explosives and the monitoring of the production fluxes of explosives are also carried out here. The doctoral student shows the fact that the use of SAP software while monitoring the technological fluxes for manufacturing civil use

explosives is going to determine the elimination of the risks when using mining industry explosives.

In this chapter, the doctoral student deals with the technical and economic implications of implementing European legislation in the field of civil use explosives. Nitro-glycerine explosives, shell – cased ammonium nitrate and explosive gels are also considered. The doctoral student also carries out the identifying of the danger points along the technological flux and of the possibilities for the decrease of the risks through employing SAP software in monitoring the technological fluxes for the manufacturing of civil use explosives.

Chapter 3, called **Initiation Means**, a classification and description of the means of initiation is carried out. The chapter also presents a series of aspects that regard the use at the workplace of the means on initiation and the measures for decreasing the risk when using the means of initiation.

In **Chapter 4**, called **Rules that Regard the Transportation of Civil Use Explosives. Means for the G.P.S. Monitoring of the Transportation**, the doctoral student presents the transportation and storage of initiation means as well as the monitoring of the transportation and the handling of the initiation means. Also here, standards that regard the transportation of the civil use explosives and the monitoring of the transportation of explosive stuff through G.P.S. are displayed.

Chapter 5, called **Rules that Regard the Storage Space for Civil Use Explosives**, deals with the construction and designing of storage places, the conditions imposed for storing the civil use explosives and the monitoring of storage and management of civil use explosives.

Chapter 6, called **Employing Civil Use Explosives**, deals with the technologies employed in quarries and demolitions. The chapter displays blasting methods used at surface, the monitoring of the work place through SAP software and IT solutions for decreasing the risk of employing civil use explosives. It also pinpoints the need for harmonizing the legislation in the field of explosive stuff at the level of the EU.

In **Chapter 7**, called **Risks that Might Come out during the Processes of Manufacturing, Storage, Transportation and Employment of Civil Use Explosives**, the doctoral presents the potential risks that might come out when manufacturing, storing, transporting and employing civil use explosives.

Chapter 8 displays a **Case Study Regarding the Non - Compliance of Transportation Rules for Ammonium Nitrate**, carries out a presentation of the situation that concerns the transportation of ammonium nitrate, of the onsite research in post-explosion situations for ammonium nitrate mixed with AM1 gas oil due to non-compliance of the legislation in the domain of explosive stuff. The doctoral student investigated, analysed and displayed the conclusions of the causes that determined the accident in Mihăilești – DN.2 km. 85

Chapter 9, called **Methods, Techniques and Technologies Used in Screening, Detecting and Identifying the Various Types of Explosives and Improvised Explosive Devices**, presents the achievements and actions under development at the level of the EU as well as the European response capacities in emergency situations.

Chapter 10, **Final Conclusions and Personal Contribution**, includes 36 conclusions, which resulted from the research carried out as well as 26 personal contributions to the settling of the topic.

The main conclusions having resulted from the analysis of the thesis are as follows:

1. The thesis analysed the manufacturing, storage, transportation and use of explosive stuff in the context of the digital revolution, which are turned into an essential requirement

for the daily functioning of all fluxes, from supply to manufacturing and using the finite products.

2. Rock extraction cannot be imagined today without the use of explosives.

3. SAP is the software, which is AI – integrated and includes analytical functions that connect, through the Internet of Things, all the applications of a company that carries out its activity in the domain of explosive stuff.

4. Robotizing and automation of production processes, transportation and use of explosive stuff gives the companies the opportunity to improve these processes and to check, in each moment, from a distance, both the condition of their transportation means and the quality and safety of the stuff used.

5. Intelligent sensors, artificial intelligence, all collect information in real time, while, by means of automated learning algorithms the information will be analysed with a view to take the best decisions for improving production and decreasing the risks.

6. Artificial intelligence will issue reports relying on the analyses, through which it will warn the human factor about the potential dangers that regard workers accidents as well as possible deficiencies of the robots involved in the production processes while setting forth methods for avoiding or settling such issues in the case they occur. Artificial intelligence will be able to transfer all the basic processes required for administering a company, beginning with the financial and human resources, the supply chain, production and use of industrial explosives and also operate risk management.

7. The domain of industrial explosives for civil use should become part of the new digital architecture.

8. The processing of data and the automation of RPA robotised processes as well as the planning of the resources of the company enable the connection with each organisation and turn organisations into technological entities.

9. With a view to support global safety in the case of manufacturing and securing explosives, companies should implement software solutions that will enable them monitoring all the needed steps of a manufacturing process.

10. The producers of explosives should work together in order to acquire an increased ability; they also need an IT architecture able to offer stability, reliability as well as the control of safety and monitoring of civil use explosives.

11. The digital core is fundamental for the basic processes of companies, which should permanently and uninterruptedly operate, while offering real time transactions and analyses, the capacity to work with Big Data, and connectivity with the external pillars of the system.

12. Digital assets and services represent the equipment companies provide to the operators, which should connect the companies with the digital core.

13. The flexibility and adaptability of the providers and partners are essential so that they become easily incorporated and for transferring the requests to the providers of raw materials required for the manufacturing process of the various types of highly efficient explosives that will reach global market.

14. More flexibility is required when recruiting the members of the specialised department as well as the maintaining of a well-prepared labour force.

15. The use of SAP Digital Transformation Framework methodology will lead to the increase of productivity in the explosive stuff industry, with direct effects upon the decrease of employing human resources that may determine errors during the explosives planning, manufacturing, marketing, transportation, storage and use processes.

16. Non-compliance with the marketing conditions of explosives as well as a series of labour accidents may result in disasters, losses of human lives and huge material damages.

17. SAP program is able to create processes for the complete and correct identification and recording of each type of explosive during all the stages of the manufacturing and sale processes.

18. The implementation of the technology has as a result the increase of the productivity and quality of explosives and the providing of a high safety standard through almost completely eliminating the shortcomings determined by human errors during the technological processes required for manufacturing such products.

19. SAP system will analyse the risks existing in explosive environments, will notify the beneficiaries upon the equipment and protection systems that should be designed and manufactured after a series of analyses of the possible functioning shortcomings and technical shortcomings are analysed with a view to avoiding dangerous situations as much as possible.

20. The risks of explosion may occur in any moment, in all the activities and technological processes required for the manufacturing and use of the explosives, which involve gas, vapours, inflammable fogs and combustible dusts that result during the wrong handling or due to a series of manufacturing defects.

21. SAP will permanently monitor, by means of sensors, the level of such gas, vapours, etc. existing at the place they are produced and stored or whenever explosive stuff is used, while quickly issuing alerts when their level reaches a critical level of danger; in accordance, both the persons who effectively work with explosive stuff and the personnel responsible with labour protection and fire extinction stop working and decide upon the measures required for eliminating the dangers and resuming the activity in full safety.

22. SAP collects the data from all the interconnected systems and analysis in real time the risks of potential explosions, while setting forth concrete measures for decreasing such risks down to an acceptable level; this method will have, in the future, a major importance for providing the health and safety of people and of the technologies that employ artificial intelligence for manufacturing industrial explosives.

23. The artificial intelligence employed by SAP has the capacity to assess the potential explosion risks in places that are might be affected by explosions, while paying an equal attention to the industrial equipment and devices that produce explosive stuff as well as to the individual protection equipment of the personnel that operate the devices (EIP), so that these are designed, manufactures, installed and maintained in a manner that makes impossible for them to become the source of fires and explosions or prevent them from accidentally determining such accidents.

24. The manufacturing, marketing, transportation, storage and employing of civil use explosives should observe all the requirements that regulate such activities as well as the means for preventing explosions and taking all the required measures to annihilate such accidents; these requirements are stipulated by laws, decisions, rules and specific standards and a part of them involve the assessment of the risk of explosion and of the compliance of equipment and devices.

25. Through the SAP monitoring of the inconsistencies that might come out, the user is no more confronted with a series of issues, which disappear and result in maximum efficiency.

26. The companies that own plants equipped with technical devices for the production and storage of civil use explosives meant to produce and store civil use explosives should improve the monitoring and safety activity of unwelcome events, such as explosions, through implementing SAP type software.

27. The implementation of SAP technology in the administering of labour safety and health during the process of manufacturing and storing industrial explosives will determine

the achieving of a full control of the dangers able to produce accidents, while a major policy for the prevention of accidents and a system of safety management will also function.

28. SAP software prevents accidental explosions, absconding and the use of explosives in terrorist attacks and provides a computerised probabilistic assessment of specific risk.

29. Artificial Intelligence (AI) might forecast possible accident scenarios during the manufacturing, storage and use of explosive stuff and will also elaborate safety documents. Such documents have as a main goal the elimination or decrease of human lives losses as well as the diminishing of goods destruction, the prevention and decrease of the prejudices brought to the environment in the case when an accidental explosion or a terrorist event occur

30. The SAP program predicts the areas that will be affected, fatality zone, the zone of major or irreversible damage / the zone of minor or reversible damage, depending on the risk curves, the QD curve, the distances or directions of the fragments projected that result after an incident with explosives stuff or with an improvised explosive device, based on fatality indices deaths, major or minor lesions, degree of building destruction.

31. The basic structure of the safety document, is designed by means of the machine learning algorithms and augmented reality, by SAP; it includes sections that display aspects of the entire objective for which the document is drawn up, while the appendices present all the elements that are part of the objective and are relevant for its safety and the safety of the neighbouring areas.

32. The safety document should take into account the following: the stipulations of the laws that regulate the prevention and fight accident dangers involving dangerous substances, such as civil use explosives.

33. The use of robots, of the machine learning algorithms, on the artificial intelligence integrated with SAP software in the mining industry has become a major requirement all over the world.

34. Mining companies should develop and design their own SAP product and begin the changes with a view to be able to benefit from the power and intelligence of a software that will provide solutions based on intelligent technologies that support the best practices of business processes.

35. The automation of the production processes, of the machine learning algorithms, of augmented reality, of the artificial intelligence integrated with software, such as SAP, in the management of manufacturing industrial explosives will determine the decrease of expenditures and create a complex and efficient vision.

36. The use of SAP software and the designing of the resources of the company (ERP) represent software employed for administering the activities in the economic, project management, risk management, compliance and distribution chains operations fields as well as the introduction of robotised processes representing the intelligence of machines as compared with the intelligence expressed by people and animals.

The contributions brought by the author to the topic of the doctoral thesis as well as the original elements are as follows:

1. He analysed the production, storage, transportation and use of explosive stuff in the context of the digital revolution, which has become an essential requirement for the daily functioning of all systems, from supply to the manufacturing and use of the finite products.

2. He introduced SAP technology, which is software that connects through the Internet of Things all the applications of a company that carries out its activity in the domain of explosive stuff.

3. He displayed the need for robotisation and automation of the production processes, transportation and use of explosive stuff, able to provide the companies the opportunity for

improving their processes and for checking, in each moment, from a distance, both the condition of the machines and the quality and safety of the materials used.

4. The doctoral student showed that artificial intelligence issues reports based on analyses, which warn human factors about the potential dangers determining accidents of the workers and possible deficiencies of the robots involved in the production processes; it also designs the methods for avoiding and settling such issues, in the case they come out. Artificial intelligence is able to take over the basic processes with a view to administer a company, beginning with the financial and human resources to the supply networks, manufacturing and use of industrial explosives.

5. He showed that the producers of explosives should improve through an IT architecture, able to provide both stability and reliability and the control of securing and monitoring civil use explosives.

6. The author of the hereby thesis shows that the use of the SAP Digital Transformation Framework methodology will determine the increase of productivity in the industry of manufacturing explosives, with direct effects upon the use of human resources that might determine errors during the processes of planning, production, marketing, transportation, storage and use of explosives.

7. He showed that through SAP – monitoring of the inconsistences that might come out, its users eliminate possible issues that completely disappear determining a maximal efficiency of the activity.

8. He showed that the implementation of SAP software prevents accidental explosions, absconding and the use of explosives in terrorist attacks and provide a computerised probabilistic assessment of specific risk.

9. He proposed the use of the SAP Digital Transformation Framework methodology for increasing the productivity in the explosives manufacturing industry, with direct effects upon employing human resources that might determine errors during the processes of planning, manufacturing, marketing, transportation, storage and use of explosives, non-compliance of explosives marketing conditions as well as labour accidents with disastrous effects, resulting in losses of human lives and huge material damages.

10. The doctoral student analysed the basic structure of the safety document by means of the machine learning algorithms and SAP – augmented reality.

11. He showed that the use of robots, of machine learning algorithms, on artificial intelligence integrated in SAP software in the mining industry has become a major requirement worldwide.