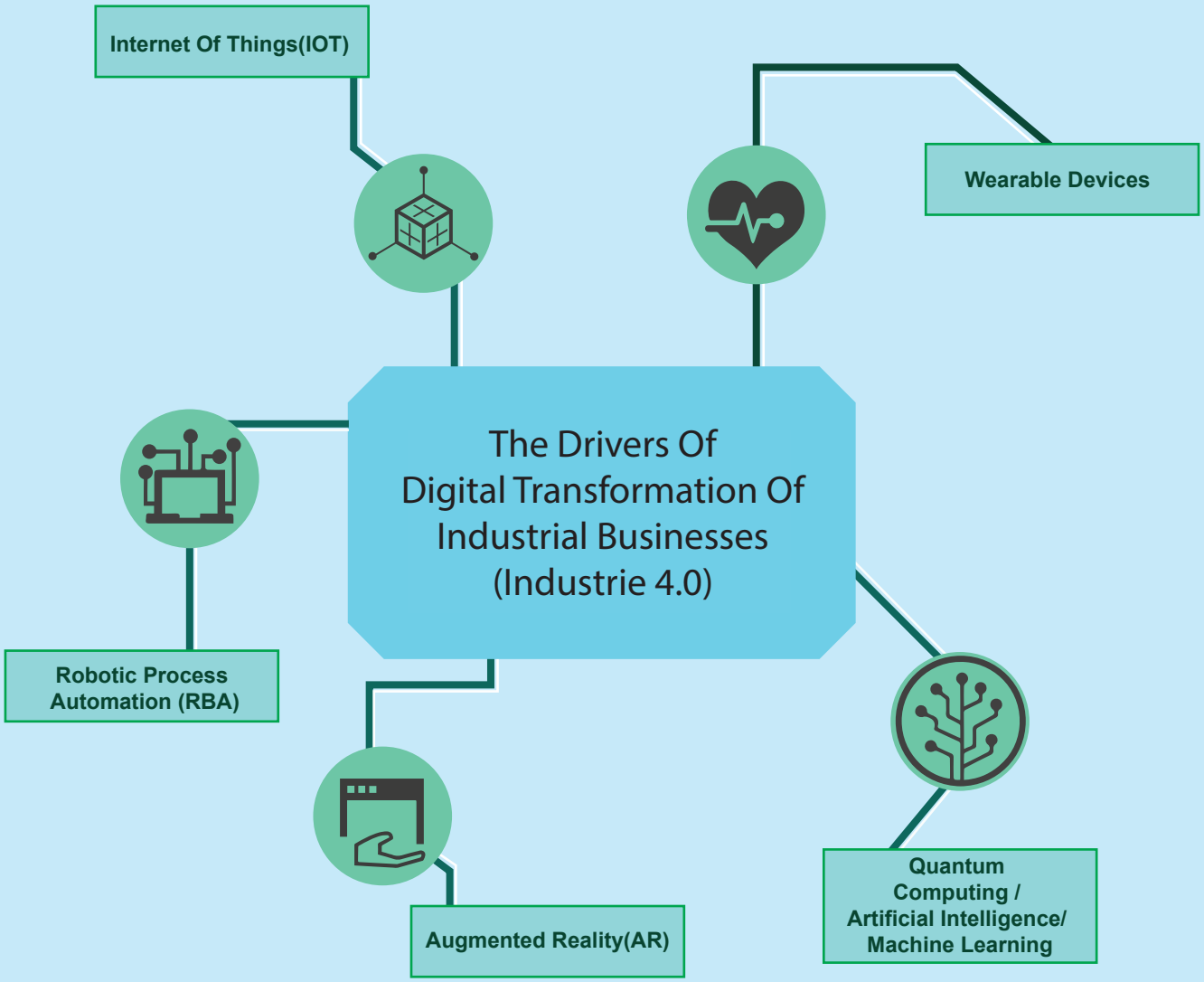
Vol. No. 13 : Dec - 2019

ISSN : 0976-4070

Visfotak®

JOURNAL OF THE EXPLOSIVES SAFETY AND TECHNOLOGY SOCIETY (VISFOTAK) INDIA,
DEALING WITH SAFETY AND TECHNOLOGICAL ASPECTS OF THE EXPLOSIVES INDUSTRY



" Digital transformation is the integration of the various digital technologies into all areas of an industrial business, resulting in fundamental changes to how business operate and how it delivers value to customers: A cultural change that requires organization to continually challenge the status quo, experiment often , and get comfortable with failures "

Cover Feature : Digitization Trends in the Industrial Explosives Business - An Overview

MISSION STATEMENT

"To proactively establish a sustainable interface between all major constituents of the Explosives Industry : The Users, the Regulatory Bodies, the Manufacturers, the Academic and Research Institutions, et.al., in order to foster and promote modern concepts and practices, relating to Safety and Technology of Explosives."

Editorial...

" We are what we repeatedly do.Excellence then is not an act but a habit – Aristotle "

" Industrie 4.0" is the 'Buzz' word reverberating the modern industrial world , holding forth prospects for 'Digital Technologies and Digital Data Analytics' to transform industrial businesses Whereas, the industrial explosives industry hasn't either been immune to the emerging trends, which deservingly is the thematic burden of the 'Cover Feature' of this edition.

Given the overwhelming primacy of 'Safety' above everything else, the explosives industry perforce been cautiously conservative; but nonetheless, also ready to adapt an emerging technology if it delivered additional safety dividends. For example, the development of first automated continuous explosives manufacturing process, relate to the production of Nitroglycerin with the objective to reduce the number of personnel exposed to the hazardous process and to cut down on the amount of explosives present in the installation . In this context, overall , a historically significant technological confluence , often missed out, occurred with the advent of digital technology almost contemporaneous with the development of a whole new genre of much safer, free flowing, bulk AN-Blasting Agents, that fostered an extremely favorable industrial eco-system spanning the entire second half of the last century, bringing about unprecedented advances in all important segments of the explosives business: Safety, Performance, and Economy !, be it automation in explosives manufacturing and handling processes wherever readily feasible, development of computer aided blast modeling and simulation soft wares, PLC operated Mobile Bulk Mixing and Delivery Units that now constitutes the bulk of the explosives market; and more recently the induction of programmable electronic blast initiation systems .

Specifically addressing the Indian environment, a heterogeneous mix of small, medium and large operators, a few relevant 'Case Studies' have been presented as 'Supplements' with the cover feature, to provide an insight into the current trends. Though early days yet, there are unique challenges? Aside from making provision for requisite investment, new smart solutions have to be developed to upgrade a variety of existing explosives manufacturing and handling processes / systems . In this regards , It's pertinent to note that beside the challenges of 'Technology', as importantly, if not more , it's also about people with relevant knowledge to make it work; therefore, investing in appropriately qualified personnel is a critical component ! India is amongst the top five producers of industrial explosives in the world, and therefore, must take on the challenges head on.

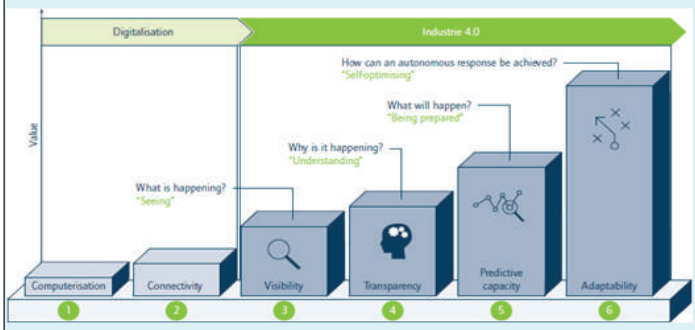
Wishing a very happy and peaceful 2020 !

Ardaman Singh

CONTENTS

COVER FEATURE & SUPPLEMENTS

A six stage development path : Maturity Index (Industrie 4.0)

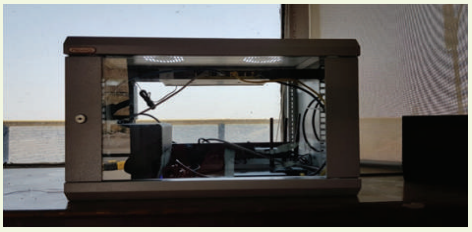


The Germany's Academy of Science and Engineering (Acatec) has produced , a six -stage development "Maturity Index' , progressively from basic Computerization to Connectivity , Visibility , Transparency , Predictive Capacity, Adaptability , and self optimization .

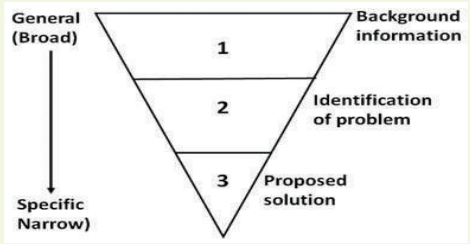
Supplements :

TECHNOLOGY ABSTRACTS / PATENTS / SPECIAL REPORTS

SCIENTIFIC / TECHNICAL PAPERS



Near Infrared (NIR) Camera Module



Conceptual model of introduction writing

ABOUT THE SOCIETY

INDEX TO ADVERTISEMENT

The claims made in the advertisements are solely of the advertisers and are not directly or indirectly endorsed by the Society.

COVER FEATURE & SUPPLEMENTS

COVER FEATURE

Digitization Trends in the Industrial Explosives Business An Overview

1 Prologue:

1.1 The history of the development and growth of the industrial high explosives ,given the innate linkages with the economic development of a country , makes a fascinating saga in ' Sustainability' , through ' Experience, Innovation and Performance ' , brought about by individuals skills and creativity , achieving ever greater safety standards and economic value.
The history is graphically chronicled in Fig.1 below ., since the discovery of NG.

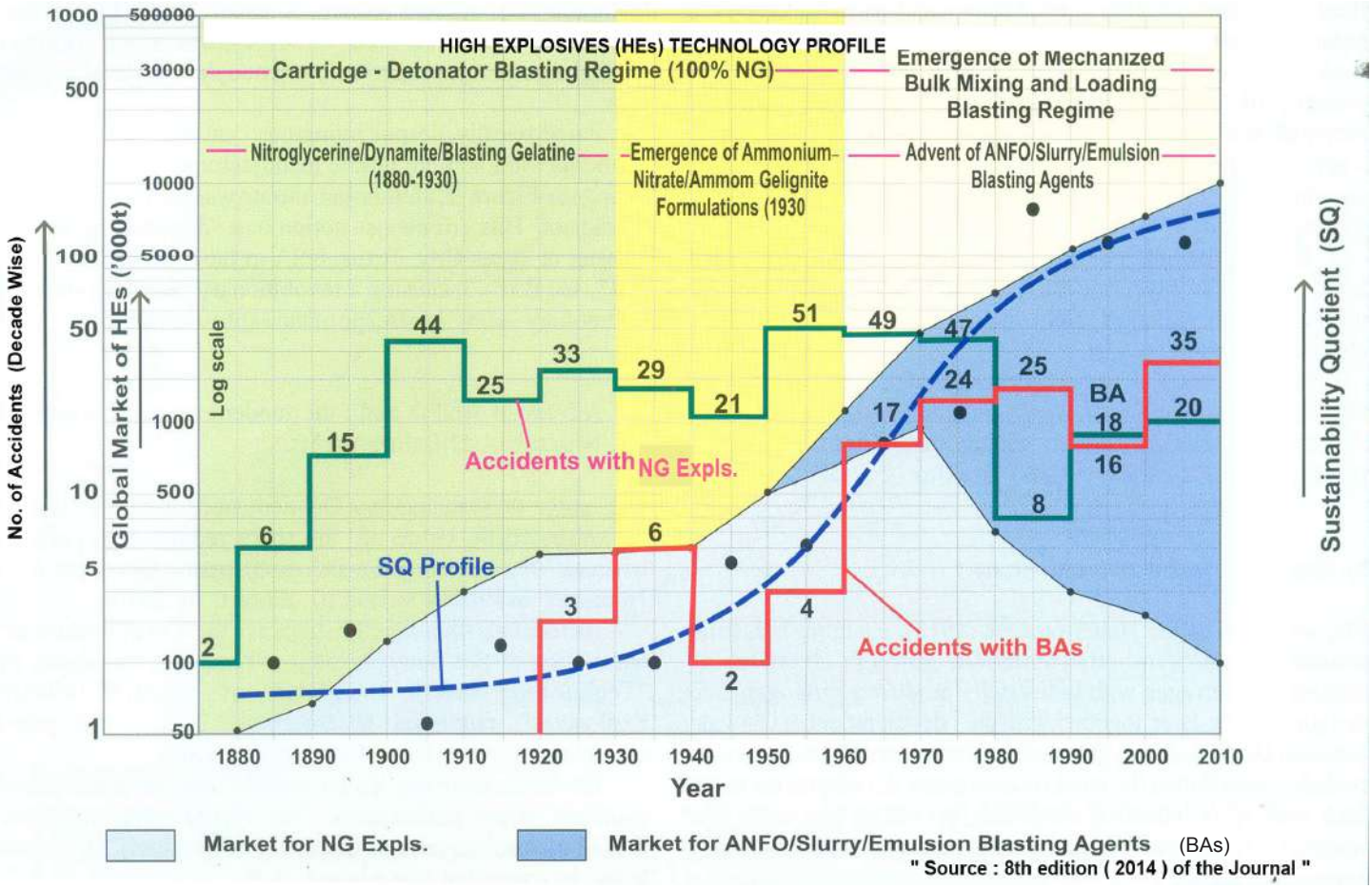


Fig 1

1.2 Advent of Electronics in explosives manufacturing :

1.2.1 The following quote from Dr. Baisutti's seminal book 'History of accidents with industrial explosives ' ,providing a broad historical sweep (first printed in 1978 and subsequently revised in 1985) , significantly alludes to the advent of electronics in the explosives industry , with the development of an automated continuous process for production of Nitroglycerin . : –

"The present period is characterized in all branches of technology, by the development of automation, with the principal objective being to reduce labour cost as well as increased safety .

Batch manufacturing processes have been largely replaced with continuous ones that not only allow to reduce the number of personnel but to also cut down on the amount of explosive present in the Installation. Further , a continuous process is more suited for remote control and automation "

(The "Cover Feature" is an 'In-House' contribution, as part of the running serial on "Challenges and Issues" of the Explosives Industry - Editor)

In the manufacture of nitroglycerine , a large American Company had lost , from 1915 to 1955 , 16 batch plants and 16 men. After reconversion to the continuous process, the same company lost , from 1955 to 1975 , one plant and no casuality."

As a conclusion , it can be stated that , although during the last 50 years , the production of explosives has increased fivefold , the number of accidents and the number of victims has considerably decreased "

1.2.2 The other significant milestones relate to innovative applications of electronics across the Rock Blasting Triad , viz , "PLC automated Drills with 'Measure while drilling Systems' , Computer Blast Modeling & Simulation , and Electronics Blast Initiation System " , the hanging fruits as it were ! on one common digital platform , chronicled in Table – 1 thereby ushering a new explosives business paradigm of 'virtual 'visualization and optimization of rock blasting system ; and consequentially , much improved environmental safety , efficiency , productivity and the resultant cost benefits , than ever before..

Period	Application
1970s	Lang and Favreau introduced Computer Modelling of Blast Design Electronic sequential Blasting Machine introduced. First electronic seismographs developed by Dallas Instruments.
1980s	Beginning of the Development of Programmable Electronic Delay Detonators. Laser profiling of benches for blast design and analysis developed in Britain.
1990s	PLC operated drills for surface mining , GPS hole spotting
2000s	Commercial induction of Programmable Electronic Delay Detonators. Digital Age of Virtual Visualization of Drilling & Blasting Process Design and Performance.

Table -1 Electronic Innovations in Drilling and Blasting Systems

1.2.3 The 'cover feature' discusses the prospective digitization trends in the overall context of the modern industrial explosives business , and presents a global over-view and the Indian scenario status with 'Case Studies' which appear later as 'Supplements'

2. Discussions :

2.1 State of the Art :

A brief perspective , with supportive excerpts from published literature , is presented as follows :-

2.1. 1 Advent of industrial computers / Programmable Logic Controllers on line : Digitization (Industrie 3.0)

*"The Automotive industry, spearheaded by GM , were the first proponent to harness benefits from electronics . The automotive industry had traditionally been a large buyer and user of electro-mechanical relays to control transfer lines , mechanized production lines , and other automated systems .

" In order to reduce the cost of new relays purchased each year , GM prepared the specifications for a programmable logic controller in 1968 , with the requirement s that the device must be programmable and reprogrammable ; it must be designed to operate in an industrial environment ; it must accept 120-V signals from standard pushbuttons and limit switches ; its price and installation cost must be competitive with relay and solid –state logic devices then in use ."

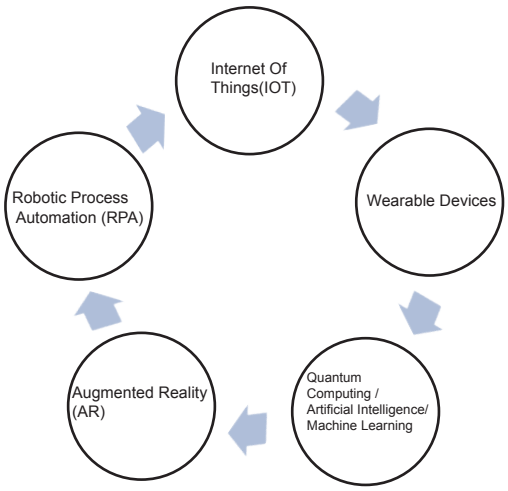
*"There are significant advantages in using PLC rather than conventional relays , timers , counters and other hardwire elements, for example, easier to program / reprogram than wiring the relay control panel ; takes less floor space than relay control panels, maintenance is easier and reliability greater , ; can be connected to the plant computer systems more easily than relays can."

*"Eventually, several companies saw a commercial opportunity in the GM initiative and developed various version of a special purpose industrial digital computers we now refer to refer to as the PLCs."

2.1.2 Digital Transformation of Industrial businesses : Digitalization (Industrie 4.0) :

The past two decades or so have witnessed an array of new ' break- through' digital technologies , notably , Quantum Computing , Internet of Things(IoT), Cloud Computing , Big- Data Digital Analytics , Artificial Intelligence / Machine Learning , etc , setting off a rapidly advancing process of digital transformation of all aspects of modern industrial businesses , heralding a smart Industrial age of Digitalization , also popularly referred to as the ' Fourth Industrial Revolution (Industrie 4.0)' . See Fig.2

Fig- 2 The Drivers of Digitalization (Industrie4.0)



a) " [3] Digital transformation is the integration of the various digital technologies into all areas of a industrial business resulting in fundamental changes to how business operates and how it delivers values to customers . It's truly " a cultural change that requires organizations to continually challenge the status quo,experiment often , and get comfortable with failures" .

b " [3] The real value is derived from the interaction of the various technologies ; and amongst them , the technologies likely to have the most impact across the broadest portion of the manufacturing process is the IOT and Big Data Analytics ; Intelligence is also being embedded in devices , supporting decentralized analytics and even some decision making . These technologies are forecast to influence all parts of the production lifecycle" , that is to say, "inducting smart manufacturing approach by identifying opportunities for automating operations and use data analytics to improve manufacturing performance with detailed real-time data at every point to achieve greater consistency and to create safer working environment . Staff can be alerted about potential hazards well in advance thanks to dedicated sensors placed throughout the plant/factory"

c)" [3] Substantial cost benefits are feasible from capturing and analyzing data across all stages of the manufacturing process, including production line and machine data, logistics and transportation, that makes it possible to identify new cost reduction opportunities. Importantly , it offers attractive customization options so that prices remain competitive

2.1.3 A six stage development path : Maturity Index(Industrie 4.0) [4]

a) TheGermany's Academy of Science and Engineering (Acatec) has produced , a six -stage development path - "Maturity Index' - progressively from basic Computerization to Connectivity , Visibility , Transparency , Predictive Capacity, and Adaptability , illustrated in Fig-3 .

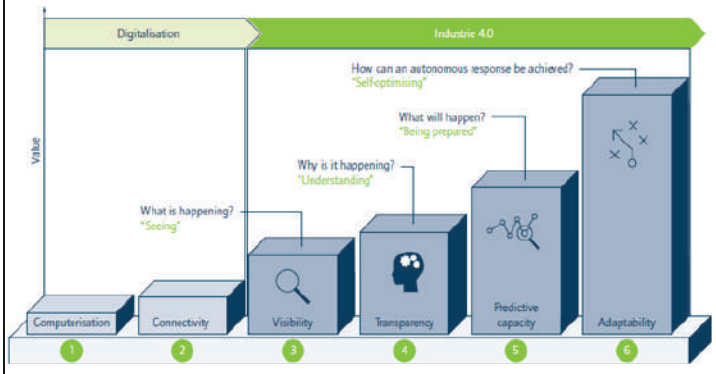


Fig- 3 A Six Stage Development Path : Maturity Index (Industrie 4.0) [4]

b) " [4] The development steps chart the evolution from simple digitization (adopting industrial computers (programmable logic circuit controllers and connecting them on –line) to being able to collect data , to understand what's happening and why in real-time on the factory floor , to reaching a point of anticipating and predicting , to self – optimizing in which autonomous responses could be achieved ".

How ever , there remains a long way to go before this vision is fully realized across a national or global economy . "For instance, despite all of smart manufacturing's promises , U.S. manufacturing productivity grew just one percent from 2011 to 2016, the slowest recorded rate since 1948 when the statistic was first measured. Even in Germany, which introduced the term Industry 4.0 into the lexicon, a 2015 survey of 4,500 German SME manufacturers found that less than 20 percent had not even heard of Industry 4.0, much less taken steps to implement it. Likewise, a June 2017 survey of 250 U.S. SME manufacturers found 77 percent reporting that they still had no plans to implement IoT technologies."

"In other words, it's still early, and manufacturers large and small alike face a number of hurdles in moving toward realizing smart manufacturing's promise. "

2.1.4 Challenges:

a) Budget limitations

"Leading a manufacturing facility through the digital transformation journey requires a substantial investment. The rewards are numerous, both short and long-term, but it's important to keep in mind that every business is different, especially when it comes to revenue and expense structures. . Manufacturers with a more limited budget should think big initially since having a long-term vision is important for reaching a truly valuable goal down the line. Once this vision has been explored, a solution with a solid ROI should be sought out as a proof-of-concept.

b) Lack of relevant knowledge:

Introducing technology alone is not enough without the relevant knowledge to make it work. Investing in employees' knowledge is an important part of integrating IoT into manufacturing

c) Unsuitable development processes

"Manufacturers need to understand that their technology stack and development processes will need to undergo numerous changes to suit the more agile nature of Industry 4.0.

d) Employee reluctance

"Not everybody is open to change. In fact, most people don't welcome changes to their work environment. The current digital disruption in manufacturing is experienced as a threat to many employees.

While no one can be certain of what the future holds, change is not something to fear. Commitment to the digital transformation process should start with executive management and be passed onto individual employees.

2.2 Epilogue : Prospective trends in the industrial explosives business :

If one were to rate the explosive business as of now ,on the 'six-step maturity index ' , illustrated in fig. 3 , the outcome is not uniform and varies depending upon the 'Technology – Safety' conundrum defining a particular operating domain of the explosives business , briefly discussed as follows .

2.2.1 Prospective scope :

The industrial explosives business is distinguished by four principal operating domains :

a) Production and delivery of the modern range of AN based Blasting Agents ;

b) Production and application of modern range of Explosives Initiation Systems ;

c) The emerging open-ended , consumer driven , business model offering 'Product Systems and Services (PSS), tailored to provide smart quality solutions that a customer wants ; and lastly –

d) Compliance with the statutory dispensations of 'Safety Rules and Regulations' in operation .

Briefly dealing with each domain :-

a) Blasting Agents:

The modern blasting gents (ANFO , Slurry . Emulsion and the various blends) , by virtue of their unique rheology , provide opportunities for bulk production processes in a continuous flow at high speed , easily adaptable for automation and digital systems for optimization of processes with complete safety , including the ability to modigy formulations on-line to match specific requirements . Further, importantly , the volume of 'In-Process' active formulation can be minimized and fully contained , thus substantially mitigating the severity and extent of collateral damages in the event of an accident during operations .

***Transition to Mobile Bulk Production and Delivery (MBPD) Units :**

Truck mounted MBPD modules carry ingredients from a base plant and the finished range of blasting agents are directly dispensed down the blast holes . The MBPD units in various designs and capacities presently service the bulk of the explosives market ; more than 95% in the USA , and around 70% in India

b) Explosives Initiation systems comprising Detonators , Detonating fuses ,shock –tube detonating system , Cast Boosters , etc .

The manufacture and handling processes entail extremely hazardous primary / secondary chemical explosives , for example , primary explosives such as Lead Azide / Lead Styphnate , and secondary chemical explosives such as PETN and the like , that clearly present unique challenges to overcome , assuring minimum exposure of workers to hazardous processes including environmental safe guards , with complete control over production processes . The following quotation from a recent publication by Sage Automation , Autralia , is note worthy :-

" [5] Technology challenges facing explosives manufacturers today include replacing aging control systems on equipments that may not be supported , with modern platforms and integrating control system(s) for a variety of machine, process and safety control functions in a number of physically separated process areas., complying with safety standards and regulations "

In this context , the development of ' programmable electronic detonators ' represents a revolutionary technological breakthrough , eminently geared to eventually replace all types of conventional detonators currently being used.

c) Emerging PSS Business Model:

According to the report of IBS World on US explosives market by 2016 , -" Growth in 'value adding' services such as virtual blasting or product delivery will continue to underpin the growth of the industry especially in mature market sectors , as well as provide means for differentiation" .

d) 'Digital Analytics' as key Value Drivers in the management of'Manufacturing Safety :

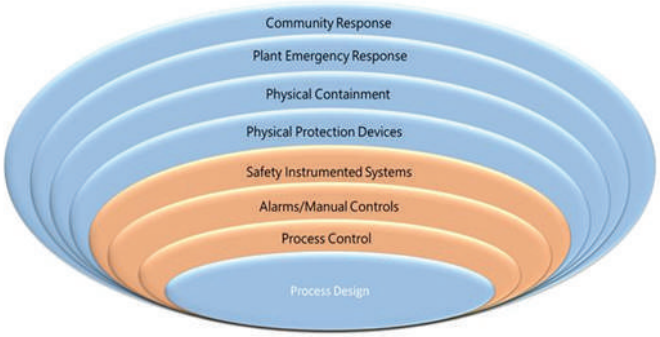
Some data provides insight after the fact, what's known as lagging indicators. For example ,the worksite may have had 26 lost-time injuries , 18 of which required medical attention, and 21 of which involved injuries to workers' hands. That's lagging data, because it's historical in nature and you can't go back and change it.

The other kind of data analysis uses predictive data. By subjecting large numbers of observations and incidents to data analysis, it becomes possible to predict the likelihood of safety incidents with surprising accuracy , revealing factors which may not have been considered.

*"[6] i) Digital Analytics provide smarter predictive alarming , helping operator to focus on the true problem by reducing distractions. This leads to more consistent operations , fewer unscheduled outages , and improved operating procedures.

> Cases have been documented in which analytics have helped detect deviations several weeks out . This gives operators plenty of time to discuss appropriate actions and implement the correct remedies.

" [6] ii) Understanding the Layers of Protection to improve manufacturing safety with analytics , as illustrated in Fig-4 , to provide defense-in- depth against accidents , and correspondingly improve manufacturing safety with analytics : a risk assessment method to evaluate the risk of hazard scenarios and compare that risk to a company 's risk tolerance criteria. The risk calculation use frequency of an event , frequency of the consequences , and the probability of failure on demand for each layer of protection. Changing any of these three changes the risk . Analytics can help quickly identify areas of improvement or risk ."



Levels of Protection Provide Defense-in-Depth

2.2.2 Case Studies:

Specific case studies , providing an insight into the digitization/ digitalization trends in explosives manufacturing and handling processes are appended as 'Supplements'

References :

1. Implementing a Digital Technology for improved Environmental , Health and Safety Performance , Accenture ,2013

2. Digitalization : The Future Mining , Tata Steel , 2018 .

3. Why is the best digital strategy a human one ? Leveraging digital technology for health and safety , Earnest & Young , 2018

4. Why manufacturing digitalization matters , and how countries are supporting it , by Stephan Ezell, Information Technology and Innovation Foundation (ITIF) , 2018

5. Explosives Control System Upgrade , SAGE Automation , Australia.

6. Improve Manufacturing Safety with Analytics – NASSCOM Community , The official community of Indian IT Industry , 2019 .

7. Five Top Trends : Digital Transformation in Manufacturing . Headland Machinery News , May,2019

COVER FEATURE & SUPPLEMENTS

SUPPLEMENT - 1

TRENDS IN EXPLOSIVES MANUFACTURING

Andy Begg
EXSAR Consulting Ltd. UK

A trend can be defined as a general swing or shift. This implies a relatively smooth transition from one state to another. Explosives manufacturing is no different in that respect to other activities. We rarely see a sudden change in the manufacture of explosives. Indeed, several of the processes that we operate today have basically been unchanged for decades. Having said that we have seen significant changes taking place in many of our operations in recent years – there are active trends at force. In this paper I will just consider explosives manufacturing – not changes in products.

What causes a trend? Why change?

There are many factors that could be the driving force for trends and these include:

- Emerging or new technologies
- Changing beliefs, moral obligation ("safety is our top priority")
- Legislation
- Corporate image
- Cost pressures
- Market forces
- Globalisation and need to remain competitive
- New handling technology
- Robotics for more hazardous operation
- New process control technology

Different companies will have different drivers but I offer the following based on my observations of visiting explosives plants in many companies in many countries over the last 40 years.

Observed trends

Safety

Safety is the top priority or perhaps ranks equally with production. The general trend is that safety to be given increasingly higher priority at the corporate level across most companies.

Safety management is becoming much more structured across the industry partly driven by the legislative requirement and partly by the belief that all employees are entitled to a safe place of work. It is no longer quietly accepted that "well he was working in a hazardous job and we have to expect accidents now and again". In one country where some years ago I frequently visited mine sites the safety performance board at the entrance to the mines would often show "Number of days since last fatality". This would not be tolerated today.

News of a serious incident is bad news and bad news travels very quickly around the globe. For companies that aspire to be international or global they must be able to respond quickly to such serious events – video coverage is often on the internet before corporate may have been informed. So a trend in many companies is to have effective internal communications systems and tested crisis management plans in place.

Recruitment and career development

For many years ago, I had heard experienced managers lamenting the loss of experience in the industry as the older generation retires and experienced people were not available to take on the roles and support the processes. I also see this today and this trend will continue – and it is not a positive trend. Young people today have quite different expectations and will readily move companies early on in their career especially once they receive training which makes them more attractive to potential recruiters. The industry then becomes more reliant on the services of experienced external consultants - and the number of these consultants is reducing as they retire. The challenge for the industry is to not just recruit bright people but to motivate them to stay, learn and develop the skills and experience needed to support the explosives operations.

Plant layout

In moving from dynamites to emulsions the industry had the opportunity to make substantial improvements in base-line safety as the newer products were basically insensitive to friction and impact – the main sources of initiation in many reported massive explosions in NG and NG based explosives operations. There was an immediate trend towards single building operation instead of the several isolated buildings that typified an NG line – the premise being the products and processes are much safer. It was not unusual to see 15 plus operators in a single building (Fig.1). However, after several explosions in emulsion plants with multiple fatalities, the trend is again towards operation/building separation once again. One example of the former was the explosion in the emulsion plant in Zambia with over 40 fatalities (Fig. 2). This compares to the explosion in Brazil where the plant layout prevented propagation to the packaging area and protection of the personnel working there.

Fig. 1 Several operators in a single building in an emulsion plant

Fig. 2 Explosion in the emulsion plant without separation in Zambia with over 40 fatalities

Fig.3 Explosion did not propagate beyond this point along the cartridge conveyor to the packing building. Which plant, which country?

The benefits of building separation are clear from these two examples. Unfortunately, the trend to building separation is not universally implemented.

Robotics and automation

This is a positive trend in the industry that widely robotics are being adapted and implemented to replace personnel from the more hazardous operations, particularly those involving primary explosives. Initially there was concern that the capital costs of advanced robotics would be a major deterrent to their adoption, particularly in areas where labour costs are low, however; this is not the case even in these areas.

Fig. 4 Personnel handling explosives/initiating devices before the implementation of robotics and automation Which plant, which country

Fig. 4 Personnel handling explosives/initiating devices before the implementation of robotics and automation Which plant, which country

Fig. 5 Replacement of personnel in handling explosives/initiating devices after the implementation of robotics and automation (courtesy of Austin Powder)

I have also seen similar adoption of automated packing lines where there are immediate safety benefits for employees in terms of reduced manual handling and for the companies there are significant long-term benefits in operating costs.
New developments have also resulted in dynamite operations being upgraded to remove or at least operator exposure.
These are very positive trends.

Safety Management System over-reliance

The safety management structure (system –SMS)) is a positive driver. We see it as an essential tool in helping manage safely all operations. Over the years, an increasing implementation of a formal SMS in most of the companies. There is a tendency for the SMS to be refined, made more detailed, expanded as time goes on. This is appropriate. However, there is a tendency for "management" to believe that a comprehensive formal SMS will result in good safety and place too much faith in the system at the expense of its detailed implementation at operational level. Management may want to see a single % compliance rating for an entire factory and while a year on year increase in overall compliance is positive it could hide the fact that there are some very hazardous specific conditions. A company, which was being awarded the highest national safety ranking of 5 gold stars based on independent audit in the year when nine people were killed in one incident, declined the award. Nevertheless, the industry is becoming more compliance focussed which –if managed correctly – will be positive. This over-reliance on the SMS must be curtailed.

Video monitoring

Another positive trend is seen in the use of video monitoring across explosives operations both remotely and locally operated. Monitoring is now becoming a standard feature in new plants and is often retro-fitted in existing plants. Operators in general are comfortable with the systems as they know it is for their safety. In the event of an incident, the video record can be invaluable in the investigation. Fig. 6 shows a modern PETN plant.

Fig. 6 A modern PETN plant.

Process control system

New plants are expected to be designed to include the best currently available control systems. Frequently these control systems will be "safety critical" meaning their purpose is to prevent or manage a safety deviation on a plant. This is a clear trend and one that in general should be positive. However, these systems are not as simple to validate as the traditional hard wired trips and alarms of yesterday. Today, in addition to a process Hazard Study (Hazop) there often will be the need for a Control Systems Hazard Study (Chazop) to assess the interaction of the various systems – this is specialist job.
Other trends
There are market trends that have an influence on production including
– switch from pyrotechnic to electronic delays
– switch to "green" detonators by replacement of lead primary explosives and lead-drawn delay elements
– conversion of underground packaged products to bulk systems.

Trend are noted within individual companies where the senior management have a vision and drive the changes to achieve that vision. Others wait - and follow the trend.

Conclusion
As the trend indicates, explosives plants are increasingly managed by personnel who have limited or even no explosives experience, are controlled by increasing sophisticated electronic systems and have increasing levels of automation. Each of these trends has challenges – it is for management to understand and address them.

CONTINUOUS PROCESS FOR MANUFACTURE OF PETN

R K GUHA
Solar Industries India Limited

1.0 Introduction

PETN (Pentaerythritol tetra nitrate) is made by the nitration of PE(Pentaerythritol) with CNA (Concentrated nitric acid). The age-old process of manufacture of PETN is by the batch process. Earlier, PE was manually added to CNA by an operator standing near the nitrator. The operator manually c ontrolled the feeding of PE keeping an eye on the nitrator temperature. Hence it was highly operator dependent and any untoward situation would lead to temperature rise and a decomposition in the nitrator exposing the operator to the hazards from this fume off.A slight improvement on such a process was by automating the PE feed rate using mechanical screw feeders, wherein the PE feed rate was interlinked with the nitration temperature. It eliminated need of the operator to stand near the PE hopper all the time, but he has to be in the room to replenish the PE in the feed hopper from time to time. Hence, he is exposed to any untoward incident in the nitration process.

PETN is a high explosive commonly used in explosives and accessories, and accidents have been reported in the batch process for its manufacture. With an idea that an automated manufacturing plant will be less prone to human errors in a batch process, Solar Industries India Limitedmoved towards continuous manufacture of PETN. This paper describes the various components and controls adopted in the continuous method of manufacturing PETN and the advantages of the improved technology.

2.0 Continuous PETN Manufacturing Process

Since all operations are continuous, the process requires several simultaneous operations to be performed at the same time. This is taken care of by process logic feed to the computer. Two designated operators are assigned for control DCS screens.The activities include:

- Feeding of PE
- Pumping of CNA
- Nitration
- Dilution
- Filtration
- Continuous transport of PETN
- Dissolution of PETN
- Neutralization
- Crystallization
- Final product collection and packing

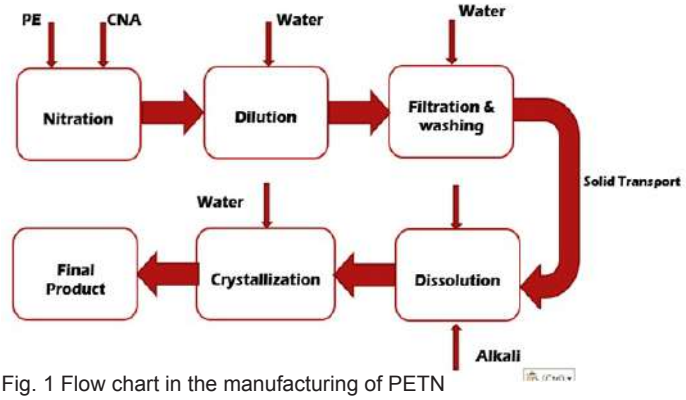


Fig. 1 Flow chart in the manufacturing of PETN

3.0 Focus on Automation

Synchronized Feeding System

Continuous nitration of PETN is safe, if acid concentration is above 80% and temperature is less than 27°C. Therefore, control of these parameters plays a vital role in the process. The acid concentration will always be on the safe side if the feeding of CNA and PE is within the stipulated ranges. The acid flow is monitored by a flow meter. The rate of PE addition is controlled by a scale under the feeding screw. The weight loss of the hopper could be viewed on SCADA screen as a confirmation that the mass of PE added per unit time is correct.

Temperature Control

To keep the temperature below 27 °C there is a constant flow of chilled water through the four heat exchangers; one at the bottom, one on the outside mantle and two rings at the inside. For this to work it is important that the liquid velocity on both sides of the cooling elements is kept high. Along with this, there are two temperature indicators inside the reactor for redundancy.

Process Liquid Transfer

Liquid transfer from nitrator to diluter is normal and safe due to overflow system. It avoids clogging and there is no accumulation of PETN.

Online Filtration Technology

Liquid coming out from diluter is automatically filtered and separates out solid and acid. There is no man movement or material handling which not only is the beauty of technology but also minimizes down time and enhances safety.

Transfer System

The solid we get from filter is facilitated with bucket conveyor which carries the material to another room and does automatic addition to the dissolver. Carrying PETN in moving object is a challenge, but the design of antistatic conveying pot and control on RPM eliminates such concerns.

Online Product Control

PETN addition to dissolver & mixing with solvent for dissolution is done in a synchronized manner. The amount of solvent feed is accurately done to maintain its proportion. Maintaining acidity is also very important as per product quality aspect. In this case synchronization of pH sensor and feeding of alkali does the neutralization effectively.

Crystallization

The process of Crystallization is an art. Maintaining feed rate of product, water addition flow rate, residence time of product inside reactor, heat -transfer, agitation, and discharge rate is very important factor to deal with. To maintain those parameters flow control valve, agitation control drives and heating cooling exchangers are provided along with process logic which takes care of every physical change.

Automatic Error Free Powder Feeding

Handling of PE (powder) is the most critical and important parameter to deal with.

To make it accurate, a vacuum feeding unit attached to feeder, which has a load cell in it, has been fitted. Load cell helps to calculate dosing amount and feeder with calculated RPM, pushes the material toward reactor. The discharge amount of product is governed by PID control which stops the system in case of any deviation.It is also associated with the amount of acid dosing. If the variation between both chemicals occurs, then it takes the system to safe state.

Effective way of Temperature Control

Since the reaction is exothermic, control of temperature is very important. Therefore, the cooling system is designed to prevent any unusual situation. Temperature control is controlled by chilled water with its cooling heat exchangers. To make circulation without any failure redundant pump is provided with UPS power backup. Reactor temperature is controlled by PID loop with control valve as controlling equipment. Another bypass valve is also provided in case of malfunctioning of control valve it will open and allow maximum flow of water to reactor to take care of rising temperature.

pH correction Automation

Generally, in process industries, correction of pH is a very common activity but control of amount of alkali dosing is very important for the product and the product cost.To have control on exact requirement,the system is designed with flow transmitter and dosing pump with minimum level control on transfer tank and maximum level on feeding tank. This is governed by PID control loop

Water Feeding and Agitation Control

Control on water addition & RPM is very important factor for crystallization. To make it effective the controlling loop is the governing flow meter, control valve and agitation. As an effect there is no deviation in final product compared to batch to batch for a batch process.

4.0 Technology

Hazardous Zone Classification

The purpose with the zone classification of the areas in the plant is facilitated with proper selection of equipment with any potential risks for sparks such as electrical or equipment with fast moving metal parts. Since solvent is extensively used in this plant it is important to strictly apply the rules for installations in different zones. All equipment containing solvent constantly is well above its Lower explosive limit(LEL2%).

Control Instruments

All the process control instruments are robust and highly suitable for work under acidic environment. Installed sensors are very commendable to mitigate with high energetic exothermic reaction.

Control System

The plant has all facilities with interlocks and alarms, which are controlled from DCS, to ensure safe operation by stopping/holding of the process, if any deviation occurs. In these cases, the DCS program will automatically put nitration into a state named “Hold”. This state means that the PE-feeder and CNA feeding pump are stopped. The reason for holding process is display on the screen. Once the reason is identified and corrected, the operator is allowed to restart the process.

Dealing with emergency

All buildings are equipped with sprinklers. There are three different means toactivate to open the valve to the deluge system.

- By the operator from Scada Screen
- By the heat resistors or flame detector placed inside the buildings
- By the red push bottoms placed at the escapes out of the plant and outside the control room

5.0 Elements Influencing the choice of Continuous Process over Batch

Start up and Shutdown Downtime

In a batch process, each equipment is engaged for a length of time leaving the others in idle state while the operation is quite easy in the continuous process, as all equipment’s and controls start working at same time. Even a change in different process stages is taken care of through control loops.

Feeding of Raw Material

A batch operation may have manual operation or individual control phases for raw material addition,but the continuous system moves easily from one phase to another through different controlling functions. Theupgradationto a synchronized feeding of raw material not only Page | 4improved productivity but also maintained correct and safe dosing ratio as compared to batch process.

Product grades and formulations

In a batch process, if there is a requirement to make a different grade of product, it will involve complex changes in operating parameters. While in a continuous process, only the rate of production is required to be fed into the system, and the relevant changes in process parameters will automatically take place.

Operator involvement

In a batch process, the operator is required to be always alert in view of different activities going on. While in a continuous process once the operating parameters are set in the operating panel, the operator’s presence is not required. Hence exposure of operators to hazards from any untoward event is negligible. The only manual operation is in the packing section.

Variability is trapped at endpoint.

In a continuous process, as there is online parameter measurement, we go through checking step by step while we prepare for final desired product. Any deviation or change can be identified, and necessary correction made. While in a batch process we are stuck with a bad batch with the possibility of scrapping the whole batch.

Batch process yield, production, quality

Sometimes it may happen people extend a batch cycle time to gain yield or improve qualityat the cost of production. Therefore, batch data analyses first, tries to identify which batches differ from the average batch and why.In case of continuous process operation such activities are not required. As there is less down time, easy measurement and flawless operation, productivity has improved 3-4 times with desired yield and quality, in comparison to the traditional batch process.

Online analyser and off-line analyser

In a batch process analysis results are often not available until the batch is completed. Whereas in a continuous process we can get all information online e.g. feed ratio, percentage of acid, pH etc. enabling analyses of data.

6.0 Conclusion

The changeover to automation and continuous manufacturing process of PETN at Solar Industries India Limited was quite significant with the following advantages:

- Around 40% reduction in overall manpower per tonne of explosive.
- No manpower is deployed in critical operations like nitration etc except in the packing section.
- Online checking of process and quality parameters has ensured uniform product quality.
- Compared to the batch process, output per shift has nearly doubled.

COVER FEATURE & SUPPLEMENTS

SUPPLEMENT - 3

IMPLEMENTATION OF PLC & SCADA BASED AUTOMATION IN EMULSION EXPLOSIVES MANUFACTURING – A CASE STUDY




Dr. S. N. Sharma
Sr. Advisor-P&D
Keltech Energies Ltd.
Garamsur, Nagpur

Mr. Atul P. Dwivedi
Dy. manger-T&S
Keltech Energies Ltd
Garamsur, Nagpur

Mr. S. Sai Viswanathan
Manager-P&M
Keltech Energies Ltd.
Garamsur, Nagpur

Mr. Atul A. Daware
Dy. Manager-P&P
Keltech Energies Ltd.
Garamsur, Nagpur

Keltech Energies Ltd.

Abstract

Commercial explosive industries are growing rapidly in India due to the increase in infrastructure development work that led to greater demand for explosives in the market. With an increase in the production rate, the safety involved in manufacturing of explosives has to be closely monitored and incorporated in the system. The quality of product also has to be maintained so as to get the desired results in fields. These requirements warrant the use of automation and introduction of PLC and SCADA in the explosive industry. This paper presents a case study on implementation of PLC & SCADA based automation at Keltech Energies Limited and its benefits.

Introduction

Large scale scientific mining and excavation has forced the development of modern mining equipment and methods and consequently reliable explosive products. The safety and working environment in mines have become most important parameters when the overall mining operation is evaluated. [1]

Cost effective explosives procurement and services will help the mining industry to save time and money. This process demands automation of the production of explosives with the goal to save time and manufacture safe and reliable products. [2]

In recent years, use of emulsion explosives has increased both in surface and underground mines because of its great advantages as compared with other types of explosives in the market. The advantages of emulsion explosive include safety, excellent resistance to water, increased velocity of detonation, transport, handling and storage, savings in drilling operations and low gas emissions. [3]

Considering various aspects like process optimization, process control, quality of the product and the safety of the process,

Keltech Energies Limited has implemented PLC based system for the production of Emulsion explosives

.

Implementation of PLC Based System in Emulsion Explosive Manufacture

The instrumentation required for the implementation of PLC based system is given in Table 1.

Instrument	Purpose
Flow Switches	Insuring flow
RTD	Sensing temperature
Proximity switch	Monitoring rpm (revolution per min.)
VFD	Speed variation
Limit Switch	Ensuring the closing and opening limits of Valves
Online pH & Density meter	Monitoring of online ph & Density
Level Switch	Ensuring the specific level
Pressure Transmitter	Pressure measurement
Load Cell	Measurement of quantity
PLC	Programming, software and logic control
Mass flow Meters	Ensuring the quantity of material
SCADA System	Controlling and Monitoring
HMI	Localised monitoring

Table 1 Instrumentation Required for Automation

Controls at Different Process using PLC based Automation

To control different processes required for manufacturing of Emulsion Explosives, a logical programme was developed indigenously using SCADA Software. The programme was designed in such a way that there is no manual interference in the process of emulsion manufacturing. The complete plant had been made automated. The automation was done at different stages in the emulsion Plant including: Feeding of Oxidiser and fuel blend to emulsifier, proportionate doping of solid ingredients in matrix and gassing of emulsion matrix before packing with a KP-Machine is been controlled by PLC.

All pumps are being controlled with help of PLC.

1. Oxidizer Blend (OB) & Fuel Blend (FB) Preparation

Preparation of oxidizer blend is controlled by PLC based automation system. The process parameters have been fed to software in such a way that if anything like pH, density and quantities of raw material added goes wrong, the system will give alarm. A steam inlet valve has been provided with solenoid three-way valves in such a way that if the temperature of tanks or pumps goes above the pre-set higher limits, heating will stop automatically. Supply of steam to tanks will start only if temperature goes below pre-set lower limits. Level switches are provided in preparation tanks to avoid overflow of material from tanks. Agitators and transferring pumps have been connected to the system. The complete process of making oxidizer blend will stop automatically, if any of above parameters exceeds set limits.

After preparation of OB & FB, material is transferred to respective holding tanks. Holding tanks have been provided with level switches which are been interlocked with the transferring pumps so as to avoid overflows. Pumps of holding tanks are provided with temperature and pressure switches which are connected to PLC in such a way that if temperature and pressure of pumps goes beyond or falls below set values, pumps will stop and complete emulsification process will stop automatically. To avoid ingress of foreign materials in explosive manufacturing process, filters have been provided. In inlet and out let of filters, pressure transmitters have been provided so as to monitor pressure and has been interlocked with PLC in such a way that the pump will stop automatically if pressure goes beyond the pre-set limits in software.

2. Emulsion Matrix Preparation

In making of emulsion matrix, all manual interferences have been eliminated by the installation of PLC based system. Programme has been designed in such a way that the complete process can be controlled from the PLC room.
In emulsion matrix manufacturing inline, a mass flow meter has been provided to monitor flow rate of OB & FB feed into the emulsifier. The mass flow meter is interlocked with SCADA logic in such a way that output given by mass flow meter will be same as feed in software. Software is designed in such a way that during production of emulsion matrix all the quantity feed to emulsifier will be varied proportionally as per requirement of process.
The feed rate of OB and FB is programmed in such a way that first feeding of FB will start to emulsifier, emulsifier will start automatically and after lag of few seconds OB feeding will start to emulsifier. Emulsifier is provided with temperature sensors which are interlocked with PLC programme in such a way that if temperature inside emulsifier goes above higher limit set in program emulsification process will stop automatically.

The quality of emulsion matrix coming out of emulsifier is consistent as the process is continuous and raw material feed is automatic without any manual interference. The properties of matrix coming out of emulsifier remain the same throughout the day. Variations in viscosity is only around 1% in intraday operation and variation in density of the matrix is around 0.5% which is very low when compared with the batch process in which variation in viscosity and density is more than 5%.

3. Doping of Emulsion Matrix

Doping of solid ingredient is also made automatic. Feeders are controlled by a programmed logical system which ensures continual and proportional mixing of doping material in emulsion matrix.
From doping mixer material is then transferred to product hopper from where it is feed to automatic cartridge packing machine after gassing.

4. Gassing

The product before feeding to the KP machine is gassed online with the help of gassing pumps which are controlled by programmed logic through PLC. The quantity of gassing which is injected to system is interlocked with product feed pumps. Gassing is mixed with matrix in Komex mixer and then feed to automatic cartridge packing machine.

5. Kartridge Pack (KP) Machine

KP machine is also controlled by PLC where the feed rate of material once set will continuously pack same weight and cut same length of cartridges. The properties and explosives characteristics also remain the same throughout the day. The product has been consistently excellent. The automation has also helped in reducing manpower in the plant and has also helped in reducing man and explosives contact to some extent. This is one of the benefits of using the PLC based system in process.

The flow sheets with various controls such as temperature, pressure and rupture disk are given in Figs 1-2. Some images of Instrumentation in Emulsion Plant and control systems are given in Figs 3-8 (see next page)

SUPPLEMENT - 3

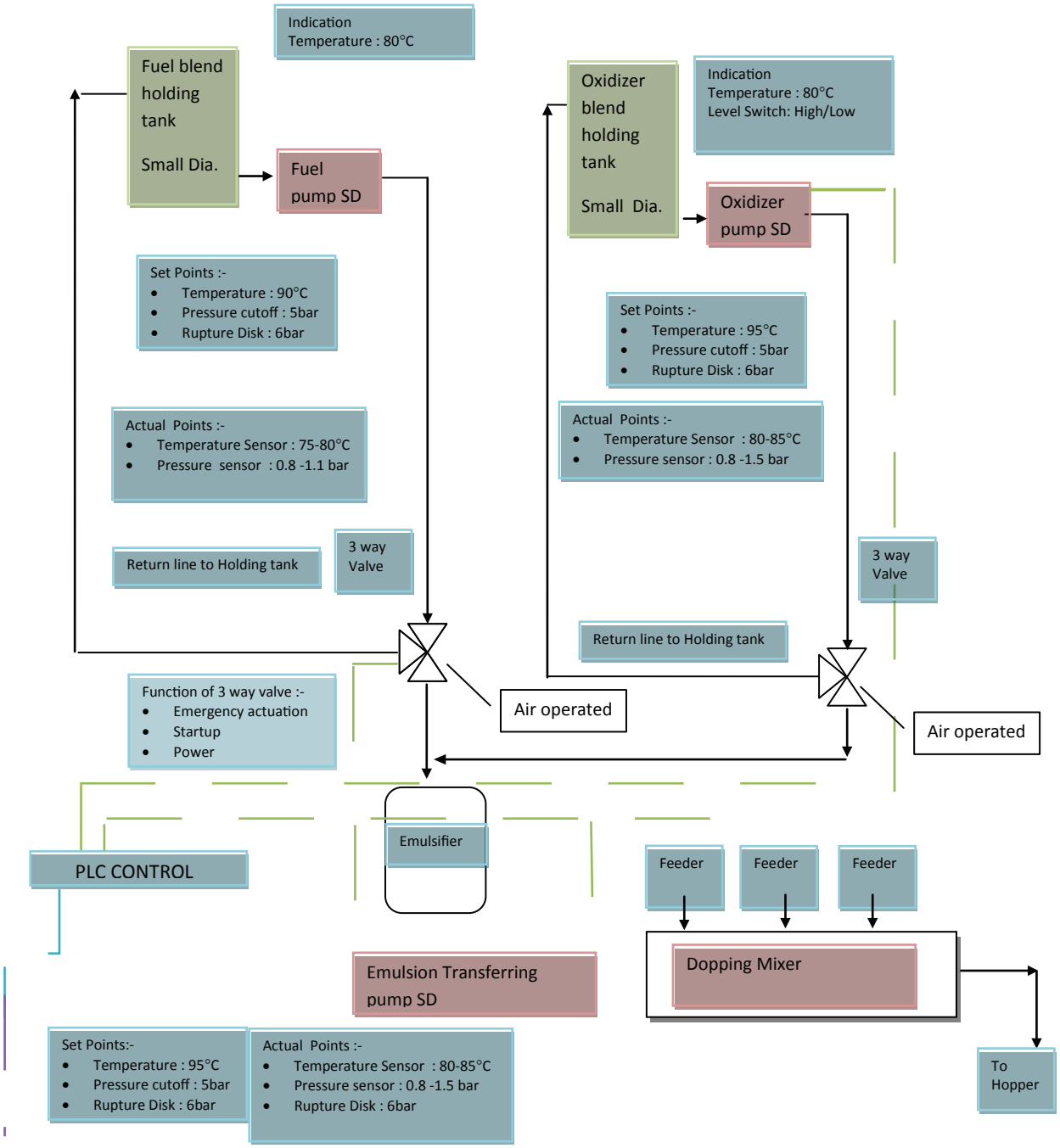


Fig.1 Flow Sheet for Manufacturing Area

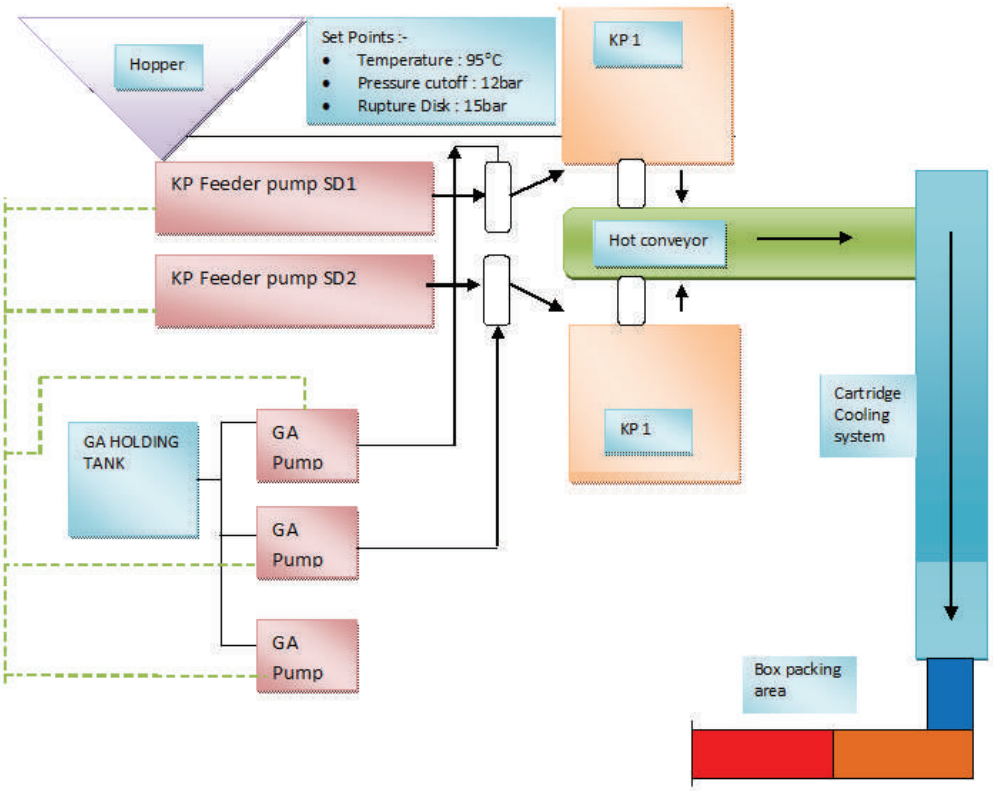


Fig. 2 Flow Sheet for Packing Area

Fig. 3 Typical View of PCP pumps with safety cutoff

Fig 4 Typical view of proportionate Doping arrangements

Fig. 5 Main screen

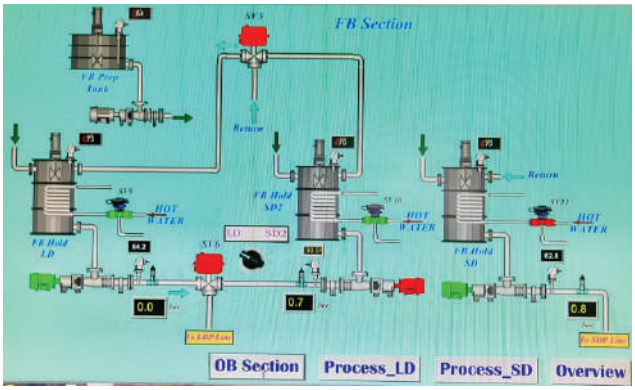


Fig. 6 Oxidiser and fuel Blend area control

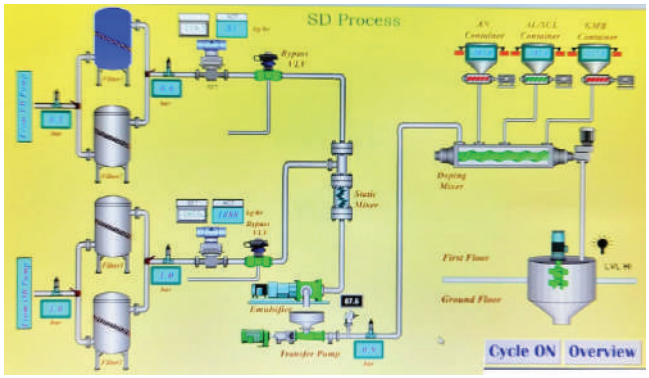


Fig.7 Emulsification Process control

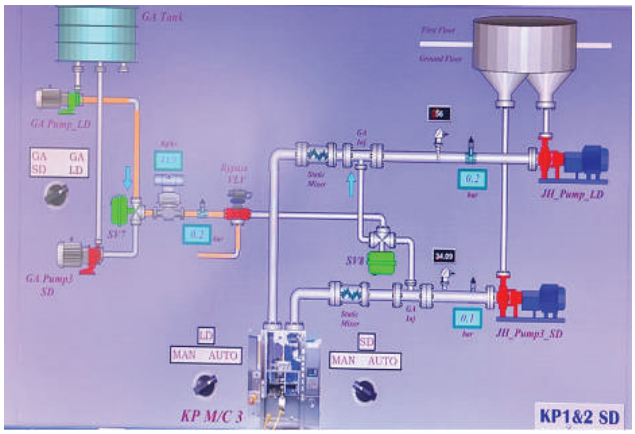


Fig.8 packing area control with gassing section

As can be seen from the flow charts and diagrams, an array of interlocks and logic can be used in the design of automation through PLC depending on the owner's requirement. The most critical aspect is no doubt use of human ingenuity to select proper and simple failsafe logic in the design of PLC.

The cost incurred for the installation of PLC based may be higher but in the long term of operation the overhead manpower cost will reduce effectively.

Conclusion

Implementation of the PLC based control system in the Emulsion Plant helped Keltech Energies Limited to increase productivity and to ensure consistent quality of products. It also helped in reducing the production cost. The other benefit to KEL was the reduction of manpower requirement by around 12 to 14 Nos. The interface of man and explosives has been reduced. Safety control systems are being monitored more strictly using PLC.

References

1. S. N. Sharma and Mr. A. P. Dwivedi, "Effect of Different Emulsifiers on the Stability and Performance of NPSD Emulsion Explosives", June 3-4, 2016 EXPLOSAFE-2016.
2. D.L. Liu, X.B. Zhu, K.L. Xu and D.M. Fang "Automation of Producing Explosives for Mining Industry", Applied Mechanics and Materials (Volumes 513-517), 2014.
3. S. N. Sharma, Mr. Atul P. Dwivedi and S. Sai Viswanathan, "A Review: Developments in Commercial Explosives over the Years", Technological Advancements and Emerging Mining Methods, CSIR-Central Institute of Mining and Fuel Research Dhanbad, India August 24-25, 2018.

" Recent Developments of PLC operated Bulk Mix Delivery Units (BMDUs) in India : A Brief Discussion "

By Sayanjeet Mitra , Spectra India , Hingna , Nagpur

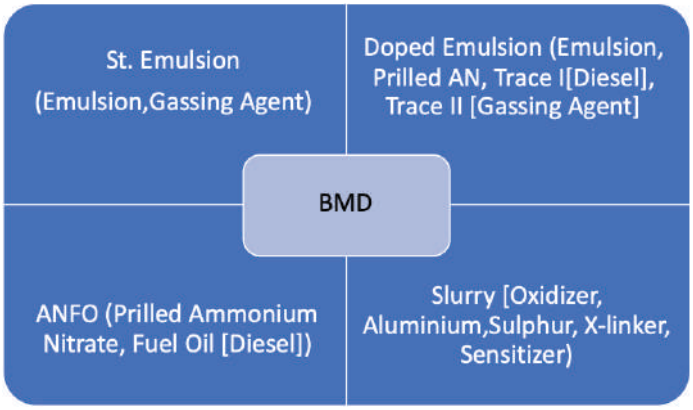
1. Advent of BMDUs

Before the advent of Bulk Mix Delivery Unit (BMDU), different explosive constituents were premixed at the plant itself and transported to the mines for charging purpose. The distance from the plant to mines was more than 50km, even 100km. This method had the following back draws:
- Pilferage/leakage on road.
- Fire/Blasting hazard due to increase in pressure in the carrying container/delivery unit.

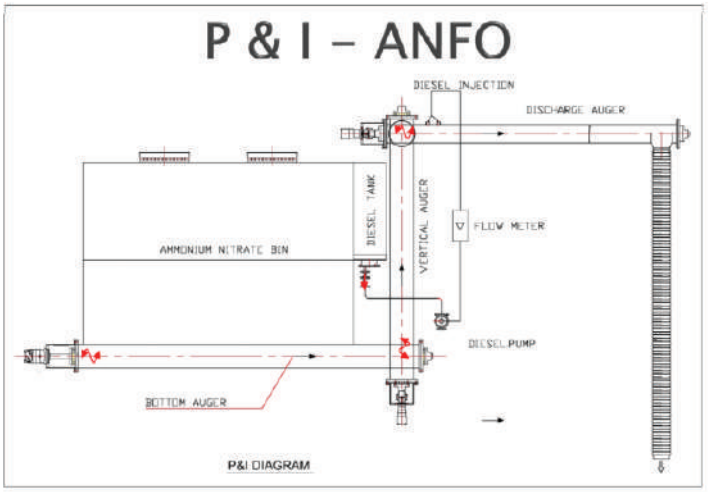
BMDU is a chassis mounted plant (processing module) which carries non-explosive ingredients from the base plant for the purpose of making explosives at site and directly discharge it into the bore hole using its own delivery system. BMDU was introduced in India around the late 80's and early 90's. Over the years it has gained tremendous popularity among explosive manufacturers. These units transport materials in non-explosive form from the plant to the mines where they are mixed in pre-defined proportions to form explosives while charging. The residual amount is carried back to the plant in non-explosive form.

During the initial phases, ANFO was the most preferred form of explosives among the explosive manufacturers. Subsequently, Heavy ANFO (Emulsion an ANFO blends) offering a wide range of sensitivity and energy density become the most preferred site mix blasting system. Presently, BMDUs supply around 75% of the explosive demand in the country.

2. Types of BMDUs in operation:



Site–Mix ANFO



Prilled Ammonium nitrate from the Ammonium nitrate bin is carried through the bottom auger, vertica/inclinedl and discharge auger at a calibrated rate. To avoid clogging, the bottom auger is made of half pitch, the vertical of 3/4th pitch and the discharge at full pitch. Also the rotational speed of the discharge auger is greater the vertical auger which in turn is greater than the bottom auger. A flow meter controls diesel injection at the discharge auger while conveying prilled ammonium nitrate. The top auger generally rotates 330-340 degrees during charging to reach the bore hole.

Typical ANFO BMD – Top Discharge

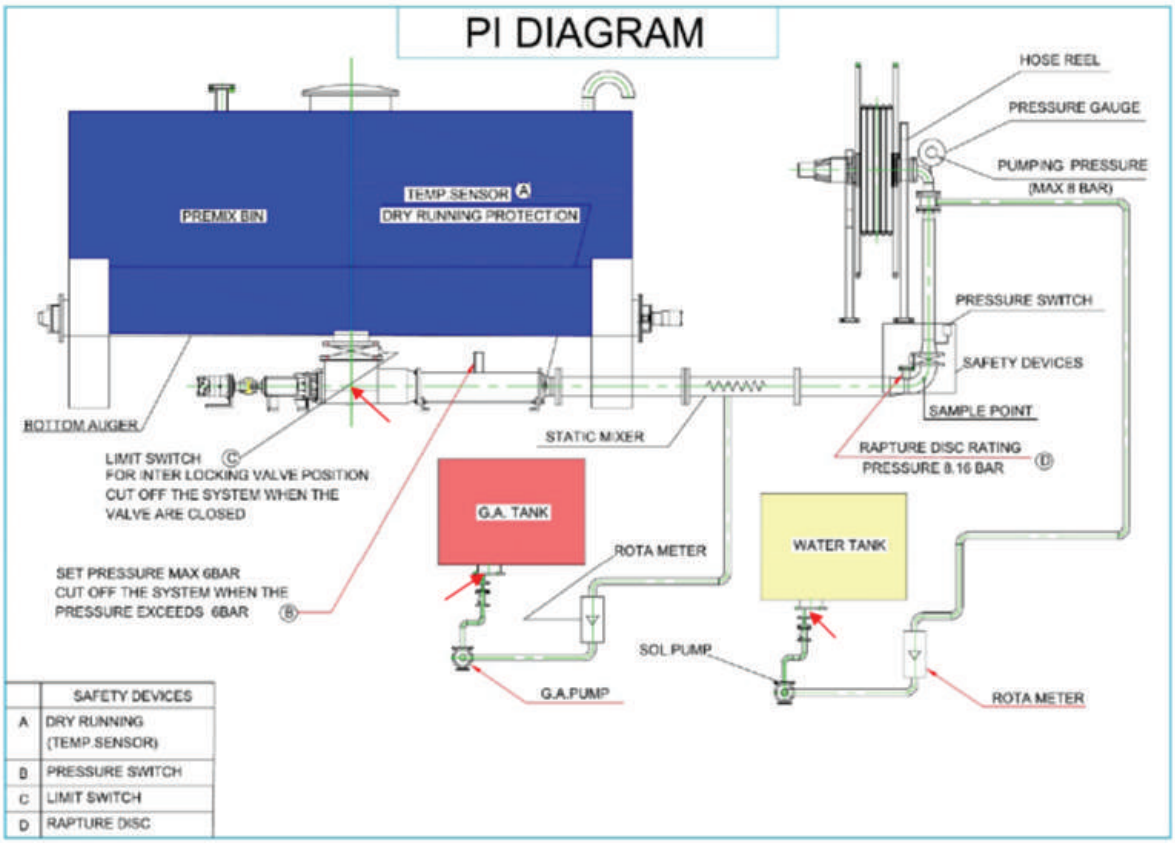
Typical ANFO BMD – Top Discharge

Typical ANFO BMD – Side Discharge

Straight Emulsions

The main constituents of straight emulsions are emulsion, gassing agent and water.

P & I – Repump



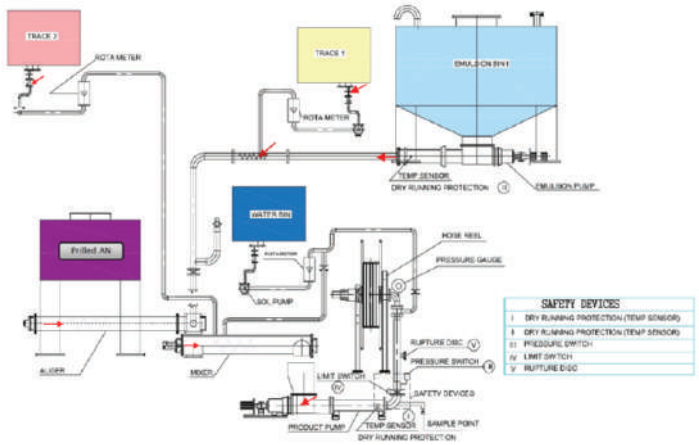
Emulsion & Gassing solution are mixed at a calibrated rate in the static mixer. Product is then pumped into borehole using product transfer pump & hose reel. Back pressure which arises during discharge is minimized by water lubrication.

Typical Re pump Unit (St. Emulsion)

Doped Emulsion/ Multi-Product BMD

The main constituents of multi-product bmd/doped emulsion type bmd are emulsion, prilled ammonium nitrate, gassing agent /trace-i, water and diesel (optional)/trace-ii.

PI DIAGRAM



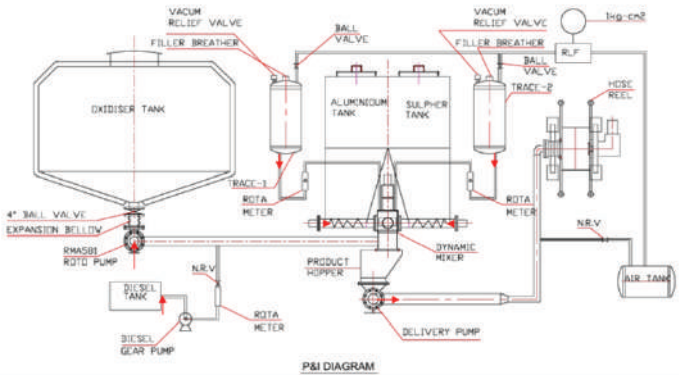
As seen in the diagram, Emulsion and Gassing solution (contained in Trace 1 bin) are mixed at a calibrated rate in the static mixer. Prilled AN is then mixed with Emulsion in the continuous mixture cum auger conveyer. The product is then delivered to the pump through the hopper and finally into borehole using transfer pump and hose reel.

Back pressure which arises during discharge is minimized by water lubrication (contained in solution bin). Diesel (contained in trace 2 bin) if required is mixed at a desired rate in the mechanical mixture.

Site Mix Slurry (SMS)

Site Mix Slurry Unit generally consists of oxidizer, fuel oil (diesel) , sulphur , aluminium, cross linker ,sensitizer and water. The functionality and features of SMS using the P&I diagram are given below:

P & I – SMS



P&I DIAGRAM

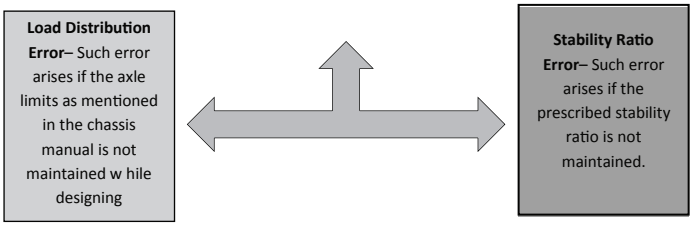
Oxidizer & Fuel are pumped into dynamic mixer at a calibrated rate. Sulphur and aluminium are also augured at a calibrated rate into dynamic mixer. Finally cross linker and sensitizer (contained in any/either trace 1 or trace 2 bins) are also injected at a calibrated rate into dynamic mixer. After mixing the gel-like product formed is dumped into the product hopper for loading into borehole using product delivery pump. By varying the flow rate, different composition can be loaded into bore holes as per strata condition.

3. Hazards in BMDUs

Hazards associated with BMD may be due to equipment failure, or instrument failure or human error or combination of these causes.

3.1 Equipment Failure- Equipment failure may occur due to the following causes.

Design Flaw – Error in the design of the processing module.



Oxidizer & Fuel are pumped into dynamic mixer at a calibrated rate. Sulphur and aluminium are also augured at a calibrated rate into dynamic mixer. Finally cross linker and sensitizer (contained in any/either trace 1 or trace 2 bins) are also injected at a calibrated rate into dynamic mixer. After mixing the gel-like product formed is dumped into the product hopper for loading into borehole using product delivery pump. By varying the flow rate, different composition can be loaded into bore holes as per strata condition.

Faulty Manufacture – Sometimes lack of penetration during welding may lead to weld stress which eventually leads to this type of error. The body of the vessel may get cracked resulting in spillage of hazardous materials

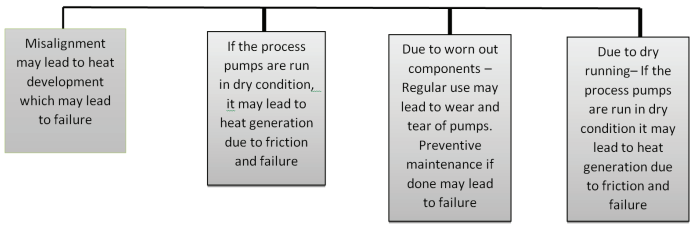
Wrong Material of Construction(MOC) – MOC should be chosen in such a way that it does not corrode or react chemically with the containing material

Overpressure - Sometimes during loading of material if vent in kept close then pressure inside the bin may arise which may lead to bulging and consequently lead to significant hazard.

Under loading – Under loading of bins may cause unusual turbulence during transporatation which may ultimately lead to structural error

3.2 Instrument failure- Instrument failure may occur due to the following causes.

Process Pump Failure – May arise due to the following causes



Control failure – The processing module is equipped with various control equipment viz. proximity sensor, rpm indicator etc. Error in the functionality of any may rise to significant hazard

Protective failure - Such error arises when any of the protective instruments guiding the processing module fails viz. high and low pressure trip in the discharge bin (eg: failure of high pressure trip may lead to spillage of final product which may lead to hazard)

Ailment – The processing module as a whole is a sort of a synchronised system where the proper functionality of each component is of utmost criticality. Failure of any small instrument may lead to hazard

3.3 Human Failure- Human failure may occur due to the following causes

Lack of knowledge – Proper knowledge and training is essential for smooth functioning and operation of the processing module. The operators should be given prior training failure of which may lead to significant hazard.

Safety distance not maintained – Proper safety distance has to be maintained while performing any activities like welding, grinding etc.

Stress, Long work-hours – Such factors may lead to loss in concentration which may ultimately lead to negligence/error.

Unwanted operational error – May lead to significant hazard

4. Recent development of Programmable Logic Controller (PLC) Operated BMDUs

4.1 PLC operated BMD was first introduced in India in 2012
The table below shows the advantage of PLC controlled BMD vis-a -vis Manual controlled BMD

Particulars	Manual System	PLC System
Product quality improvement	No formulation correction/check present. Totally operator dependent.	PID in PLC system not only controls but also checks for formulation while charging.
Safety enhancement	Depends on operator for pressure/temperature monitoring.	Operator is not required for monitoring pressure/temperature. If any increase in pressure/temperature from the set limit, system automatically trips.
Minimising human interference	Depends on operator skill and expertise.	All the prescribed parameters are already set. Operator only has to start and stop the system.
Component hazard prevention	In case of no material flow/dry run of pumps due to heat generated, pumps can be damaged.	The safety trips in the PLC system trips the total system in case material does not flow in any of the pumps.
Blasting analysis	No option available for analysis	Charging data for each hole stored in the memory.
Ease of operation	Change of formulation and discharge rate depends on operator's skill	Discharge rate and different formulations are already set. Operator only has to select them
Security	Operator can change the formulation.	Password protected

Product Quality Improvement (PDI):

A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID (proportional integral derivative) controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller. A PID controller regulates flow each of the constituents to maintain the required formulation.

Example
300 kg Straight Emulsion product is charged in a particular hole with a discharge rate of 150 kg/min.
Formulation = 94% Emulsion, 2% Gassing Agent, 4% Water
As soon as the system starts, PID controls each of Emulsion, GA & Water flow.

System at a discharge rate of 150 kg/min will require 2 mins to charge 300 kg in that particular hole. At every second material flow constitutes 2.35 kg of emulsion, 0.05 kg of gassing agent and 0.1 kg of water.

Safety Enhancement/Minimising Human Interference :

Safety enhancement of the overall BMD system is one of the prime reasons for using the PLC system. Safety interlocks programmed in the system ensures that all the system parameters i.e. pressure, temperature, flow are within the prescribed rage. In case of any deviation system will automatically stop flashing the cause of error and subsequently with an alarm.

1.Temperature: Temperature transmitter is connected in emulsion pump and product pump line. When temperature is below the set limit for 2 second system stops with low temperature trip. If temperature is above the set limit, the system stop immediately with high temperature trip alarm.

2. Pressure: Pressure transmitter is connected in emulsion pump and product pump line. When pressure is below 0.5 kg for 5 second, the system stops with low pressure trip. Low pressure trip will also useful to safe stator of ROTO pump, with this feature operator can avoid empty running of pump. If pressure is above the set limit, the system stops immediately with high pressure trip alarm.

3.Speed Variation: If there is variation in speed in pump above 5 percent system stops with speed variation alarm.

All these interlocks are provided to enhance the safety of the BMD system and to ensure minimum human interference so that human error hazards are minimised.
Component Hazard Prevention
The safety trips provided for protection of components are

- No Flow Emulsion
- No Flow Gassing Agent
- No Flow Water
- No Flow Diesel
- No Flow-Bottom Auger Ammonium Nitrate

In case there is any obstruction in the process pipe due to valve being closed or impurities in the pipeline material flow will be obstructed.
This will result in pressure being built up which may lead to hazard.
The no-flow sensor ensures that the system stops in case there is no flow in any of the pumps/augers.

SUPPLEMENT - 4

Blasting Analysis :

The date in the PLC system is stored in the following format

Hole Number	Emulsion	Gassing Agent	Water	Cumulative
1	141	3	6	150
2	235	5	10	250
5	258.5	5.5	11	275

The data can be stored for approximately 15 days of operation.
The data can be extracted wither via removable drive or wirelessly.
The data can be used to analyse the basting performance and subsequent analysis.
The data can also be used to cross-check how much each of the constituent has been used in a particular day for blasting and tallied from the loading data.
This will in addition prevent misuse of the constituents.

Ease of Operation :

The PLC system offers easy and convenient methods to change discharge rate and/or formulation. Different discharge rate as suggested by the client can be programmed in the PLC logic and can be selected via dropdown.
Also different formulations along with client formulation name can be programmed unto the PLC system.
The operator only has to select the formulation name and the formulation will be changed automatically.

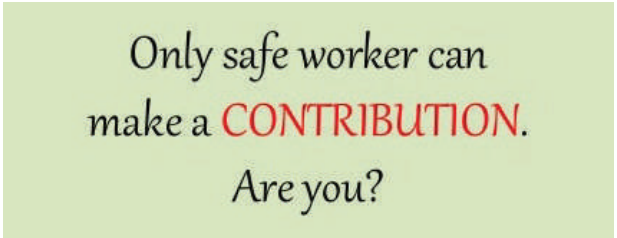
Security :

The formulations are password protected. In-case the operator selects a different formulation the log will be stored in the PLC memory.
Also the individual formulations are protected by admin password. Operator cannot enter the admin console without password and the formulation is therefore protected .

4.1 PLC system adoption rate in Bulk Mix Delivery Unit (2011-2019)

PLC operated BMD was first introduced in India in 2012. The progressive change over to PLC operated BMD from 2011 to 2019 is shown in Table below .

BMD Type	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
PLC Equipped	3	7	14	9	18	32	46	41	43
Manually Operated	25	32	9	19	8	5	8	3	0
Total No. of BMD's	28	39	23	28	26	37	54	44	43
Percentage	**10.7**	**17.9**	**60.9**	**32.1**	**69.2**	**86.5**	**85.2**	**93.2**	**100.0**



TECHNOLOGY ABSTRACTS

Selected Abstracts from The Procedings of INDOROCK-2019

8th Indian Rock Conference - organised by Indian Society for Rock Mechanics and Tunneling Technology (ISRMTT)

Rock Blasting and Sustainable Development

H.S. Venkatesh,
Director National Institute of Rock Mechanics, Bangalore

Blasting is the backbone of the mining, hydel and infrastructure industry. Over the period of time the blasting industry has evolved and India too has caught up with the rapid pace of the technological developments of the industry. The explosive and equipment industries geared up to meet the National supply demands. Indigenous technologies and global tie ups strived and Indian research too supplemented the excavation industries growth.

Table 1. Status of Indian practices vis-à-vis global practices

Activity	Global Status/ Operating Procedures	Indian Status/ Operating Procedures
Blast Design	Empirical formulae Regional design considerations and local database	Empirical formulae Regional design considerations and local database
Measurements	Digital cameras High speed camera Continuous VOD measurement Through commercial image processing tools Laser face profiling Signature hole analysis Bore hole pressure measurements Commercial Blast design softwares Numerical modeling/Simulation study – Auto Dyne/3DEC	Digital cameras High speed camera Continuous VOD measurement Through commercial image processing tools Laser face profiling Signature hole analysis Bore hole pressure measurements Commercial Blast design softwares Numerical modeling/Simulation study – Auto Dyne/3DEC
Ground Vibration & Air Over Pressure	Seismographs with AOP measurements Distance measurements with GPS/Conventional laser based survey Field measurements as per ISEE Standards differ country wise	Seismographs with AOP measurements Distance measurements with GPS/Conventional laser based survey Field measurements as per ISEE IS Code 14881:2001* and DGMS (Tech)(S&T) Circular No. 7 of 1997**
Rock Mass Damage studies in U/G Cavern & Tunnel	Conventional vibration monitoring Half cast factor Monitoring with High frequency geophone Bore hole camera Rock characterisation pre & post through seismic survey Strain measurements	Conventional vibration monitoring Half cast factor Monitoring with High frequency geophone Bore hole camera Rock characterisation pre & post through seismic survey Strain measurements
Over break control in U/G & Tunnels	Customised perimeter explosive used Bulk explosives for U/G applications Electronic detonators	Not readily available in India Just introduced in India Just introduced in surface mines. Still using conventional electric detonators and shock tubes.
Controlled blasting in urban environment	Rubber mats and Rope mats Shock tubes/electronic detonators	Rubber mats. Additionally we use link mesh, sand bags, Rubber tyres. Shock tubes

* Anon (2001) ** Anon (1997)

Characterisation of Excavation Damage Zone around an Underground Opening

By H.K. Verma and P.K. Singh
CSIR-Central Institute of Mining & Fuel Research CIMFR Regional Research Centre, CBRI Campus, Roorkee– 247667

ABSTRACT

In civil construction projects, blasting inevitably causes damage to the peripheralrock mass. However, the extent of the damage should be minimum and also should not pose threat to the safety and stability of the underground structures. Results of Schmidt hammer tests on rock core samples obtained from ten different locations reveal that the strength of rock mass in the tunnel periphery is significantly reduced. Reduction in strength upto 20% as compared to the undisturbed rock mass is observed when damaged zone is greater than 2.5 m. Field experiment have been carried out at head race tunnel (HRT) of Singoli-Bhatwari hydroelectric power (SBHEP) project site. Observations of ten experimental blasts were taken. Laboratory tests performed on the rock core samples provided insight into the change in strength and ultrasonic properties of rock in damaged zone. Geological logging of the rock core samples reveals that due to blast induced damage, the surrounding rock mass incurs significant damage and the rock mas quality index, Q is reduced by 10-15% in the immediate vicinity of openings. Analysis of variation of the rock mass properties in terms of RQD, Core recovery (CR) and maximum core length revealed that the blast induced damage significantly reduces RQD leading to deterioration in rock mass quality, particularly in the immediate vicinity of the underground openings. It has been observed that the deteriorating effect of the blasting has been enhanced in places where the Joint alternation number (Ja) is higher. The higher extent of damaged zone significantly reduces RQD and damage is exhibited by the large difference between RQD and Core recovery. Core recovery is not affected by the blast induced damage.

Tunnelling Overbreak Due to Blasting: Causes and Control

By M. Ramulu, P.B. Choudhury and P.K. Singh
CSIR-Central Institute of Mining & Fuel Research, Regional Centre, INDIA

ABSTRACT

Blast induced overbreak is a severe side effect in tunnelling projects, which areexcavated by drilling and blasting methods. The construction projects have to pay huge price for the excessive overbreak quantities through their nose. The over break also leads to increase the duration of project which has got huge indirect cost implication as the back filling by concrete is very costly and time consuming. Therefore, practice of proper controlled blasting techniques play a vital role in economic construction as well as timely completion of project. However, the general controlled blasting techniques need to be tuned to the site specific application to get maximum results in control of overbreak. CSIR-CIMFR carried out extensive investigation on control of overbreak and increase of pull in Himalayan rock formation for tunnels National Road Highway projects. One such project in ChenaniNashriTunnelway Limited (CNTL) at Udhampur-Srinagar Highway project, which is one of the longest roadway tunnels in India with 9 km length. The project consists of main tunnel and escape tunnel with 13m diameter and 6 m diameter respectively.

The effect of various parameters like rock, explosive and blast design were thoroughly investigated on extent of overbreak. Studies were conducted on the following governing parameters on extent of overbreak:
- Blast design of contour holes
- Delay numbering and sequence
- Joint orientation/foliation
- Type of Explosive
- Blast design of production holes
- Stemming practice
- Drilling Angle of contour holes

It was found that the foliation of joints with respect to tunnel axis, predominantly influence the extent of overbreak. It is generally considered that the blast design of contour holes play a significant role in control of overbreak. But from several trail blasts it was noticed that blast design of cut holes and helper holes is more important to control joint orientation based overbreak than the blast design contour holes. It was also found that the overbreak is inversely proportional to the area of cross section of tunnels for given geo-tunnelling conditions.

Application of in- hole delay blasting technique in cut holes smooth blast design of penultimate back holes reduced the overbreak by 40-90% in both main tunnel and escape tunnel. It was observed that good smooth blasting, in contrast to conventional blasting, resulted in saving of 21-39 % of overall cycle time of tunnelling.

RECENT PATENTS

RECENT PATENTS OF INTEREST (2019)

SYSTEMS FOR AUTOMATED LOADING OF BLASTHOLES AND

Inventor(s): Averett; Jeff; (Salt Lake City, UT) ; Giltner; Scott; (Salt Lake City, UT) ; O'Connor; Patrick; (Salt Lake City, UT)

Application(s): Dyno Nobel Inc

Abstract of US2018265426 (A1) - 20190234722 : Aug 1, 2019

ABSTRACT

Systems for automatedly delivering explosives with variable densities are disclosed herein. Methods of automatedly delivering explosives with variable densities are disclosed herein. Methods of determining an emulsion explosive density profile are disclosed herein.

LEAD-FREE INITIATING AGENTS OR INITIATING AGENT MIXTURES

Inventor(s): ZOELLNER; Helmut; (Meerbusch, DE) ; JOAS; Manuel; (Eitor, DE) ; SCHIRRA; Rainer; (Lohmar, DE) ; KAPLAN; Kemal; (Troisdorf, DE)

Application(s): DYNITEC GMBH

Abstract of RU2665582 (C1) - 20190256438:

ABSTRACT

Subject matter of the invention are lead-free initiating agents or initiating agent mixtures and initiating and igniting compositions which contain the lead-free initiating agents or initiating agent mixtures

---

LINHIBITED EMULSIONS FOR USE IN BLASTING IN REACTIVE GROUND

Inventor(s): Nelson; Casey L.; (Murray, UT) ; Gordon; David Lynn; (West Jordan, UT) ; Hunsaker; Dave; (Syracuse, UT) ; Halander; John B.; (Salt Lake City, UT)

Application(s): Dyno Nobel Inc

Abstract of RU2665582 (C1) - 20190257632: August 22, 2019

ABSTRACT

Methods of delivering inhibited emulsions are provided. The methods can include mixing an emulsion with a separate inhibitor solution to form the inhibited emulsion. Inhibitor solutions including water, an inhibitor, and a crystallization point modified are provided. Systems for delivering inhibited emulsions are also provided.

SPECIAL REPORT

IME
Institute of makers of explosives
The safety and security of the commercial explosives industry since 1913

ISSUE BRIEFS (2019)

We are presenting below a selected set of 'Issue Briefs' that were prepared by IME during 2019, to assist the Legislators and the Regulators in formulating policies and standards with regard to Safety and Security of commerce and use of explosive products in the USA. This forms a part of the continuing serial on IME Issue Briefs, started with the 10th edition of the Journal.

Editor

1.0 Ammonium Nitrate Detonability Question

Issue: Is ammonium nitrate (AN) prill a Class 1 explosive or not?

Background: Since the tragic 2013 incident at West, TX involving AN, some assert that AN has a TNT detonability equivalence of 0.72, a metric closely approaching the globally-accepted value of "ANFO" (ammonium nitrate fuel oil), a Division 1.5 explosive.1 Others assert that the technical grade of AN (TGAN) used in the explosives industry is inherently "explosive" while the fertilizer grade (FGAN) used in the agricultural industry is not.

Discussion: AN is a stable, noncombustible chemical compound. The chemical structure of TGAN and FGAN is the same, NH_4NO_3. The only difference is the density of the finished prill. TGAN is less dense than FGAN.
AN is not an explosive. It has been classified as an oxidizer by the U.S. Department of Transportation (DOT) and by the National Fire Protection Association (NFPA) based on prescribed tests.2

While AN prill is not an explosive, it can detonate under extreme conditions such as shock from an explosion or intense and sustained heat because it contains an ammonium molecule (NH3) which acts as an inefficient fuel – meaning that there is not enough fuel to consume all the oxygen supplied by the NO3 molecule. In a fire, AN can melt3 at 337 F° and decompose at 410 F°. This physical change increases the likelihood of a thermal explosion. Likewise, AN that is exposed to a shockwave from an explosion may be heated from the extreme compression to the point of decomposition and may detonate if the pressures are high enough and sustained long enough. When melted, there is no difference between FGAN and TGAN.

Determining a TNT equivalence based on this inefficiency has produced a range of results. The highest theoretical value in this range, based on the Thermodynamic Code "TDS", predicts a 0.42, not a 0.72, TNT equivalence. This means that the maximum amount of energy that could be expected from a detonation of AN would be no more than 42% of same amount of TNT.4 Other subject matter expert sources have predicted ratings as low as 0.25 TNT equivalence.5 The explosive inefficiency of AN also accounts for the fact that not all product will contribute to the detonation.

Recommendations: Additional studies and testing may validate or lead to reducing the TNT equivalence for AN. Until testing shows otherwise, AN prill, if managed properly, is an inert material which will not detonate. In the meantime, emergency responders should be trained not to attempt to fight that have engaged AN and to evacuate at-risk populations.

2.0 Taggants In Explosives

Issue: Should taggants be mandated in commercial explosives?

Discussion: Taggants can refer to two types of marking technologies. Detection taggants are used to detect explosives before detonation. Identification taggants are intended to be used to trace explosive materials to their source before and after detonation.
The Antiterrorism and Effective Death Penalty Act of 1996 (ATEDPA) requires detection agents for plastic bonded explosives (PBX). These agents enhance the detection of PBX which has historically been used by terrorists around the world. It is possible to add these detection agents to PBX without compromising their intended performance. IME supports the marking of PBX with detection agents. However, identification taggants present a different story.

From time to time, efforts are made to require identification taggants in explosives. The ATEDPA mandated a study of the feasibility of placing identification taggants in industrial explosives. The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) was tasked with this responsibility and The National Academy of Sciences (NAS) was contracted to conduct a third-party examination.

IME has worked closely with both the ATF and NAS to ensure that industry data was available to complete the study. The NAS report, completed and issued in March 1998, concluded:
"At today's level of threat, it is not appropriate to require commercial explosives to contain identification taggants … All of the taggant technologies currently available raise concerns about long-range environmental consequences, effectiveness in law enforcement, safety issues, and costs."

The ATF issued an Interim report in March 1998 and also concluded:
"At this stage of the Study it is clear that … there are remaining complexities surrounding the issue. Any effort which is to have a measurable impact on the prevention and investigation of bombing incidents must be an integrated one, involving the effective regulation of explosives and explosive materials, the effective enforcement of those regulations, and the effective application of cutting-edge technologies."

IME's position is consistent with these findings:
• Less than 1 percent of the bombings in the United States involve commercially manufactured high explosives.
• Identification taggants can dangerously increase friction sensitivity when added to the manufacture of high explosives, and their benefit to law enforcement is disputed as taggants may

complicate the investigation and prosecution of bombings.

• The substantial costs associated with placing taggants in commercially manufactured high explosives are not justified by the minimal benefits.

Recommendation: Any mandate for the addition of identification taggants must be based on sound science and a cost-benefit analysis. It is not in the best interest of the industry, public, the environment, or law enforcement to mandate identification taggants in commercial explosives at this time.

3.0 Drone (Unmanned Aircraft Systems/UAS) Safety & Security

Issue: What safety and security concerns about the operation of drones justify federal control and regulation?

Background: The use of drones and advances in UAS technology are on the rise as evidenced by their increased use across a growing number of industries. The explosives industry relies on drones to assess the safety of re-entering post- blast sites at mines and quarries. Critical infrastructure, including explosives manufacturing sites, benefit from the use of drones to inspect process pipes for leaks, examine flare stacks for maintenance issues, and even assess tanks when it would be too dangerous for a person to enter. Drone technology that would safely allow flight beyond the line of sight of operators and use at night are examples of technological advances that would greatly benefit industry.

Despite their potential beneficial uses, there have been numerous incidents of drones conducting unauthorized flights over critical infrastructure. Some fly-overs may be by unknowing hobbyists; however, drones can be used for surveillance or mapping of a critical infrastructure site. Drone video footage of our nation's critical infrastructure has been posted to websites such as YouTube without consent of the owner/operators of the facility. As such, bad actors could use this information for nefarious purposes, including to attack critical infrastructure. There are also real and present safety concerns with unauthorized drones flying over or making contact with a critical infrastructure facility. A drone that crashes, or if it is armed, could cause significant damage and injury.

State legislatures across the country have been actively moving UAS legislation forward. While state engagement is welcome, a patchwork of differing state laws and regulations will ultimately make compliance more difficult—for both UAS manufacturers and users.

Discussion: In response to these concerns and needs, Congress set the stage for a streamlined, national policy approach on the use of drones when it enacted P.L. 114-190, the FAA Extension, Safety, and Security Act of 2016. This legislation streamlines the processing of applications for commercial operation of UAS, sets up procedures for flying beyond line of sight, and a process to restrict airspace over critical infrastructure from unauthorized UAS flights. In the meantime, we are concerned that FAA is falling behind in its implementation of UAS provisions in the act, including how "critical infrastructure" is defined.

Recommendation: We support the safe use of drones and we do not want to limit this new innovative technology. However, as Congress considers drone legislation in the 116th Congress, we request these items:

• Encourage the development of a streamline process for critical infrastructure facility owners to register their property as a no-fly-zone;

• Ensure that there are appropriate penalties for those who violate restricted airspace above critical infrastructure with UAS overflights;

• Define under what circumstances the owners of critical infrastructure may legally disable rogue drones that are perceived to be a direct threat to the safety of employees or the public;

• Allow companies to use UAS beyond line of sight and at night to provide additional facility security; and,

• Preserve the language included in P.L. 114-190 Sec 2210(c)(2), to direct FAA to use DHS' definition of "critical infrastructure" rather than use scarce resources to invent another competing definition.

SPECIAL REPORT

Safex International

Safex Incident Notices: 2019

Summary			
	Activity		No. Of Incidents
*	Fixed Plant Manufacturing:		
		HE	2
		Explosive Accessories	11
			13
*	Mobile Manufacturing Unit (MMU):		-
*	Handling:	Within Plant Area	-
		Outside Plant Area	-
*	Storage:		-
*	Transportation:	Vans	1
		MMU	-
			1
*	Blasting Incidents		1
			TOTAL 15

1 IN2016-2018 Australia – High Potential Events – Elevated Temperature and Reactive Ground

DATE POSTED	**REFERENCE**	**SOURCE**
30 January 2019	IN19-01	Dyno Nobel

INCIDENT OUTLINE	
When did it happen?	Over the past three years from 2016 to 2018
Who experienced it?	Multiple metal / coal mines within Australia and Indonesia. The intent of this alert is to raise awareness of the hazards and risk involved with elevated temperature and reactive ground during blasting activities.
Where did it happen?	Multiple metal / coal mines within Australia and Indonesia.
What material was involved?	AN based bulk explosive
What happened?	Repeat High Potential Events (Multiple Fatality Potential) related to potential unplanned detonation due to elevated temperature and reactive ground. **Examples of repeat events:** • • Premature blast - one hole which has been identified as elevated temperature hole detonated approx. 45 minutes after loaded with 80kgs bulk product. No one injured. 16 people were on the shot. • • Personnel noticed that one hole was smoking and upon inspection it was realised that the Nonel® tube had started to melt. Shotfirer retreated and when he was approximately 10 meters away from the hole it detonated

SPECIAL REPORT

	• • Single hole Unplanned Detonation during night shift with no injuries or damage. • • Nonel® down hole lead was found to be melted and detached from the detonator and booster which remained at the bottom of the hole - half of the shot was fully loaded and stemmed. Blast Crew walking in the vicinity. **Reactive Ground Hazard Summary** Many mines have ground that contains pyrite or specific areas or bands that contain pyrite. Not all pyritic ground is necessarily reactive. There are a series of testing practices required to identify and properly characterise reactive ground along with industry codes that specify the sampling and testing practices required. Pyrite oxidises through a natural weathering processes producing sulfuric acid. Sulfuric acid reacts with ammonium nitrate to produce nitric and nitrous acid setting off a series of complicated reduction–oxidation reactions, some of which are exothermic (releasing heat) reactions.

2 11 March 2019: Peru-PETN Explosion

DATE POSTED	**REFERENCE**	**SOURCE**
15 March 2019	IN19-02	FAMESA

INCIDENT OUTLINE	
When did it happen?	Monday, March 11, 2019.
Who experienced it?	FAMESA EXPLOSIVOS SAC
Where did it happen?	Puente Piedra facility, Peru
What material was involved?	PETN
What happened?	A work accident occurred in one of the PETN stationary drying tunnels.
Why did it happen – theory?	The incident is presently under investigation and the exact cause is therefore unknown.
What was the impact?	One of the workers was injured, suffering an encephalic contusion, which later resulted in his death. The accident did not cause material damage to the facilities, nor did it affect the manufacturing process.

SPECIAL REPORT

3 5 February 2019: Unplanned Explosion At Burning Ground During Disposal Operation

DATE POSTED	REFERENCE	SOURCE
17 March 2019	IN19-03	Thales Australia

INCIDENT OUTLINE	
When did it happen?	05 Feb 2018; 13:30
Who experienced it?	Australian Munitions
Where did it happen?	Benalla, Victoria, Australia
What material was involved?	Waste Pyrotechnic Explosives
What happened?	Pyrotechnic powders mixed with flare canisters and general low explosives contaminated waste were loaded into two caged burning pits for disposal. On initiating the small igniter charge, an explosion occurred rather than the expected burn. The second loaded pit was then initiated by the operator resulting in a similar explosion.
Why did it happen – theory?	The pyrotechnic powder had not previously been disposed of at the facility. It was a dry fast burning composition which was not adequately dispersed and was loaded into the pits at too high a quantity.
What was the impact?	There were no injuries. However significant damage was sustained to the walls and cage of one of the pits.

4 11 Dec 2019: Grassfire Adjacent to Storage Magazines

DATE POSTED	REFERENCE	SOURCE
17 March 2019	IN19-04	Thales Australia

INCIDENT OUTLINE	
When did it happen?	11 Dec 2017; 13:30
Who experienced it?	Australian Munitions
Where did it happen?	Benalla, Victoria, Australia
What material was involved?	N/A
What happened?	A grassfire was initiated in the vicinity of the storage magazines during the routine slashing of dry grass. The fire burnt an area of approximately 10 acres before it was fully extinguished.
Why did it happen – theory?	The fire was most likely caused by sparks generated when the rotating slasher blade struck a small rock embedded in the surface soil.
What was the impact?	There were no injuries or damage sustained.

SPECIAL REPORT

5 27 March 2019: AEL South Africa – Fire in R&D pyrotechnic plant

8 April 2019	**REFERENCE** IN19-05	**SOURCE** AEL
INCIDENT OUTLINE		
When did it happen?	27 March 2019 at 15:05 pm	
Who experienced it?	AEL Intelligent Blasting	
Where did it happen?	AEL R&D pyrotechnic facility, Modderfontein, South Africa	
What material was involved?	A few kilograms of pyrotechnic powder manufactured for long period pyrotechnic delay detonators	
What happened?	During the drying process of pyrotechnic powders an ignition occurred which transferred through the plant. A few containers containing pyrotechnic powder was consumed by the fire. The plant is designed with a blow-out panel which worked as intended. There were no injuries.	
Why did it happen – theory?	The incident is presently under investigation and the exact cause is therefore unknown. The pyrotechnic composition involved in the fire is known to be sensitive to initiation stimulus such as impact, friction, electrostatic discharge and heat.	
What was the impact?	The plant sustained minor fire damage and safety mechanisms functioned as intended. There were no injuries.	

Photo showing damage to the pyrotechnic bucket gripper

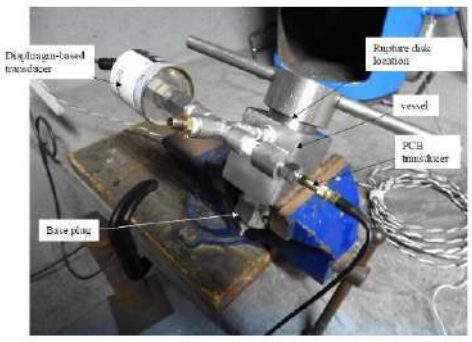
Photo showing inside of drying area vessel with combustion residue

SPECIAL REPORT

6 14 Jan 2019: Canada – Time/pressure accidental ignition

DATE POSTED	REFERENCE	SOURCE
10 April 2019	IN19-06	CERL

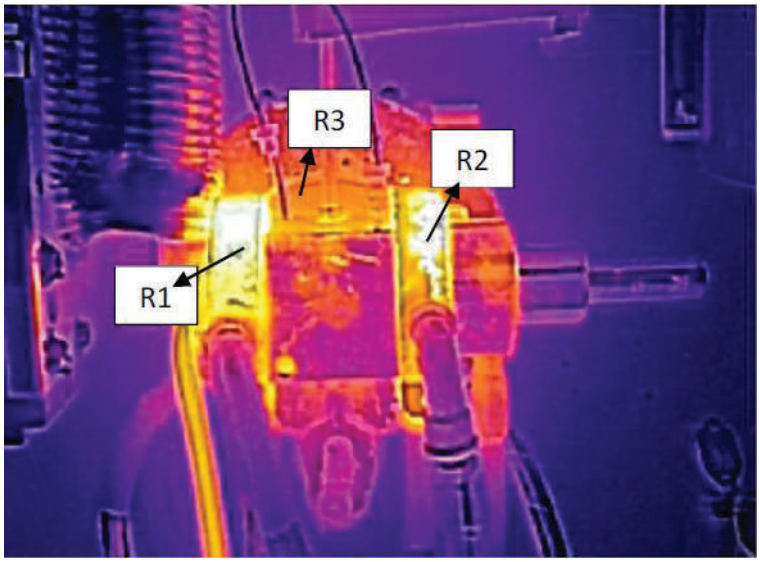
INCIDENT OUTLINE	
When did it happen?	Monday, January 14, 2019 between 13:00 and 14:30
Who experienced it?	Canadian Explosives Research Laboratory of the Department of Natural Resources Canada,
Where did it happen?	Bells Corners Canmet Complex, Ottawa, Ontario, Canada
What material was involved?	5 g of celluloid beads composed of commercial grade nitrocellulose plasticized with camphor.
What happened?	The celluloid was being tested according to UN Test 2(c)(i) Time/pressure for classification The apparatus consisted of a 16 mL pressure vessel fitted with an electric igniter, a burst disc and a pressure transducer. The sample was sealed in the vessel and was ready for firing-line connections to be made. When the operator connected the firing line to the vessel, the burst disk ruptured with a loud bang.
Why did it happen – theory?	The pressure transducer used in the setup was diaphragm-based and contained a 22-µF capacitor that was not specified in the transducer technical datasheet and installation instructions. The manufacturer of the pressure transducer was contacted following this incident and confirmed the presence of the capacitor which was intended to attenuate signal noise. Our investigation revealed that the capacitor had retained an electrical charge from the previous test conducted four days prior to the incident. Immediately before the event, the pressure transducer was connected to an oscilloscope and a power supply of which the output was off. When the operator connected the firing line to the vessel, the connection provided an electrical path from the capacitor through the electric igniter to ground causing the ignition the celluloid and the explosive rupture of the bust disk. Testing was suspended immediately until the cause of the incident was identified and engineering corrective measures were implemented.
What was the impact?	The operator suffered from tinnitus and inflammation of the ear canal that was resolved within three weeks with no residual effects.



7 Deflagration of PETN on Detonation Cord Extruder.

DATE POSTED	REFERENCE	SOURCE
14 May 2019	IN19-07	Austin Powder

INCIDENT OUTLINE	
When did it happen?	February 7, 2019
Who experienced it?	Austin Powder Argentina
Where did it happen?	La Florida plant
What material was involved?	PETN dust
What happened?	A small deflagration of PETN dust was noticed by the operator on top of the detonating cord extruder head.
Why did it happen – theory?	Due to a high diameter reading of the 60 g/m cord, the automatic cutting mechanism was actuated and the cord was retracted from the extruder. Because of the high cord load and the fast movement, PETN dust from the open end of the cord was spilled reaching the extrusion head. It was identified that the temperature on parts of the outside of the extruder head was higher than the melting and deflagration temperature of PETN.
What was the impact?	Nobody was injured during the incident. No significant material damage. Production was stopped until investigation had finished and identified issues had been resolved.



Temperatures above the deflagration point of PETN were found on the exterior of the extruder head.

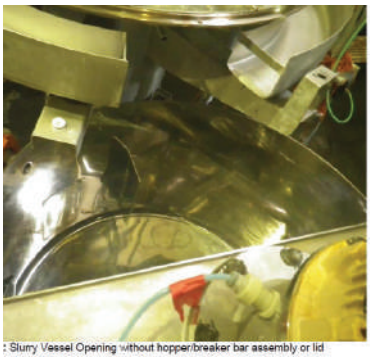
SPECIAL REPORT

8 Large piece of equipment dropped into PETN slurry vessel while in operation

DATE POSTED	REFERENCE	SOURCE
15 May 2019	IN19-08	Austin Powder

INCIDENT OUTLINE	
When did it happen?	August 27th, 2018
Who experienced it?	Austin Powder Company
Where did it happen?	Red Diamond plant, McArthur/OH USA
What material was involved?	Approximately 80 kg of PETN slurry
What happened?	During tidying up a PETN filter, an operator noticed that a polypropylene hopper with built-in stainless steel breaker bars/SS beaker (ca. 6 kg of total weight) was missing on top of the adjunctive slurry vessel. After stopping the operation and while investigating, the operator found it inside the vessel covered with PETN slurry and the vessel agitator running. The hopper assembly was located on the opposite site of the agitator. The assembly was removed from the vessel and the agitator was inspected for damage. No damage was observed.
Why did it happen – theory?	The hopper assembly dropped into the vessel when the adjacent lid was moved by the operator in charge. He was not aware due reduced vision from wearing a forced air helmet. It was discovered that the hopper assembly has an insecure mounting design, i.e. it was tight with the adjacent lid being closed, but could become lose when the lid was opened as the hopper had no additional securing conjunct to the vessel. It should be noted that the equipment had been purchased from a supplier with long-standing experience in designing and fabricating equipment for explosive manufacturing.
What was the impact?	No injuries and no equipment damage.

: Hopper/Breaker Bar Assembly in position without Slurry Vessel lid to hold it in place



: Slurry Vessel Opening without hopper/breaker bar assembly or lid

SPECIAL REPORT

9 Foreign body in Packaged emulsion Plant

DATE POSTED	REFERENCE	SOURCE
13 September 2019	IN19-09	Austin Powder

INCIDENT OUTLINE	
When did it happen?	March 29th, 2019
Who experienced it?	Austin Powder Company
Where did it happen?	Red Diamond plant, McArthur/OH USA
What material was involved?	Doped emulsion for packaged product
What happened?	A piece of metal (part of band clamp from the joint of the shaft of a PC pump) was found in the mandrel of a KP machine. When the pump was inspected, it was identified that the boot of the shaft joint was damaged. Emulsion had intruded into the joint and mixed with grease.
Why did it happen – theory?	The pump was stuck by lumps of AN prill. The operator tried to unblock manually by applying excessive force with a wrench tool and running the pump back and forth. This happened 2 weeks before the incident. The mechanical action damaged the band clamp that became lose and subsequently damaged the pump rotor and stator. Furthermore, the solidified AN in combination with excessive mechanical force damaged the shaft auger flights. After unusual noise was noticed, the pump was stopped but not inspected. As the noise disappeared, production was continued until the piece of the band clamp was found.
What was the impact?	No injuries, pump damage and loss of production for several days.

10 26 October 2018: Germany -Black Powder Incident

DATE POSTED	REFERENCE	SOURCE
2 November 2018	IN18-10	MAXAM

INCIDENT OUTLINE	
When did it happen?	Friday, October 26 ,2018 at 09:00 am (local time)
Who experienced it?	WANO Schwarzpulver GmbH
Where did it happen?	Kunigunde Black Powder Plant
What material was involved?	Black Powder
What happened?	An initiation took place in the roll crusher phase of the Black Powder manufacturing process during normal operation.
Why did it happen – theory?	The possible causes are still under investigation and we are collaborating with the authorities to learn about the causes. An investigation team of experts are working on the incident. More information will be gathered when the investigation is completed.
What was the impact?	One employee incurred severe burns and was immediately transferred to a special hospital, where he's receiving medical treatment.

SPECIAL REPORT

11 18 August 2019: AEL South Africa – Tyre fire on ANS road tanker

DATE POSTED	REFERENCE	SOURCE
25 September 2019	IN19-11	AEL Intelligent Blasting

INCIDENT OUTLINE	
When did it happen?	18 August 2019 at 03:30 am
Who experienced it?	AEL Intelligent Blasting
Where did it happen?	Public road approximately 10km from the border with Botswana
What material was involved?	Ammonium Nitrate Solution (ANS)
What happened?	A contracted transport company was carrying Ammonium Nitrate Solution (ANS) and whilst en-route to the end destination, the driver heard a tyre rupture. The driver immediately pulled over and brought the vehicle to a stop. As the driver dismounted from the vehicle, he noticed that the rear tyre area on the tanker was on fire. He unsuccessfully attempted to extinguish the fire, then disengaged the truck (horse) from the tanker and evacuated the area. The tyres on the trailer burnt out completely, without further incident.
Why did it happen – theory?	The fire was started due to a frictional tyre event.
What was the impact?	Fire damage to the tanker. The product was safely transferred and removed off-site. There were no injuries.

Photos showing damage to the tanker after the fire

Be careful, stay alert – don't get hurt

SPECIAL REPORT

12 Air Blower Explosion, Mexico

DATE POSTED	REFERENCE	SOURCE
7 December 2018	IN18-12	Austin Star Detonator

INCIDENT OUTLINE	
When did it happen?	Saturday, August 12, 2017
Who experienced it?	Austin Star Detonator
Where did it happen?	Lead azide drying building in Matamoros/Mexico
What material was involved?	Dust of lead azide
What happened?	Explosion of an air blower in the dust exhaust system of the lead azide drying building.
Why did it happen – theory?	In one of the bays of the lead azide drying building, a malfunctioning air blower had been replaced with a new blower that was inappropriate for this area (incorrect spare part). This blower was operating with a higher air flow compared to the others installed in the ventilation system and due to its design allowed lead azide dust to accumulate. The system had been cleaned sporadically, but not after a regular maintenance schedule. After the incident, additional filter gauzes were installed in the ducting. All relevant procedures were reviewed and updated.
What was the impact?	There were no injuries. The material damage was limited to the air blower and its mounting structure.

SPECIAL REPORT

13 Lead Azide Dust Explosion, Mexico

DATE POSTED	REFERENCE	SOURCE
7 December 2018	IN18-13	Austin Star Detonator

INCIDENT OUTLINE	
When did it happen?	January 24, 2018 at 1:00 pm
Who experienced it?	Austin Star Detonator
Where did it happen?	Detonator loading line, Matamoros/Mexico
What material was involved?	Lead azide dust
What happened?	After scheduled equipment maintenance on a detonator loading line, a maintenance operator identified that one of the door interlocks was not active. The door could not be closed due to a misalignment. After an unsuccessful attempt to close the door manually, the operator resorted to strike the door with the plastic handle of a set of hex-wrenches (explosive material had not been expected in this area). The second strike resulted in an explosion (small amount of lead azide dust) propelling the lower frame downward with sufficient force to cause a leg injury.
Why did it happen – theory?	The silicon sealing between the aluminium frame and the acrylic screen was inadequate and allowed dust to accumulate over time. Dust accumulating was intensified due to the dust control system allowing a dust containing airflow towards the door. The door became misaligned due to a broken rivet to tighten the frame parts.
What was the impact?	1 injured person (leg), limited material damage

14 Smokeless powder accident

DATE POSTED	REFERENCE	SOURCE
13 November 2019	IN19-14	Explosia a. s.

INCIDENT OUTLINE	
When did it happen?	November 1th, 2019. Time 07:20 AM.
Who experienced it?	Explosia a. s.
Where did it happen?	Semtín 107, Pardubice 2, Czech Republic
What material was involved?	Approximately 1,800 kg of NC smokeless tubular powder
What happened?	During the process of the carb dryers emptying into the manipulation cases, smokeless nitrocellulose tubular powder Lovex 030 ignited and burned. Injured workers were urgently treated.The fire was brought under control by Synthesia's fire brigade.
Why did it happen – theory?	The apparatus B 83 contains 10 pcs carb dryers each drying 200 kg of smokeless powder with hot air. After drying throughout the night supervisor stopped the drying process. Staff waited for the powder to cool to 40 degrees centigrade and then started emptying each carb into the manipulation case. After emptying the first carb the ignition took place. Approximately 1,800 kg of powder burned during accident.
What was the impact?	4 workers were severely burned. 1 worker died after two days in Prague Clinic (3. 11. 2019 08:00 AM)

SPECIAL REPORT

15 PETN Glove Fire

DATE POSTED	REFERENCE	SOURCE
14 November 2019	IN19-15	Austin Powder

INCIDENT OUTLINE	
When did it happen?	April 10th, 2017
Who experienced it?	Austin Powder Company
Where did it happen?	Red Diamond PETN plant, McArthur/OH USA
What material was involved?	Small fire from gloves in the nitration area of the PETN plant
What happened?	At 9:16 am a small fire was detected in the nitration are of the PETN plant. The top of a hazardous waste bin caught fire. Smouldering continued after the flames went out. An operator was in the nitration area working on a filter (scraping). After he finished his work, he removed his gloves and placed them onto the hazardous waste bin. Less than a minute later, after the operator had left the room, the gloves caught fire and spread to the hazardous waste bin. After the fire was detected, the operator pulled the fire alarm and the nitrator contents were drowned. The building was evacuated.
Why did it happen – theory?	Nitrile gloves were used in the specific area instead of the provided neoprene gloves. The gloves were not rinsed before disposal and put on top rather than into the waste bin. Longer scrapers had been replaced with scrapers with a shorter handle, so the gloves were more exposed to acid. The fire/smouldering was not detected immediately as control cameras are zoomed by default (less detail). The operator was not aware of the specific hazard/incompatibility of the glove material with the hazardous chemical (acid) and training had not specifically addressed this issue. The instructions for disposal of contaminated waste (here: gloves) were not clear (in the SOP).

Fire safety On – Fear gone

SPECIAL REPORT

Elimination of an incident: Sliding of Drill Machine -SMARTROC C50,from a Quarry Bench , due to collapse of a wall . By Joseph Ruska

A contribution from EFEE, courtesy Ing. Igor Kopal vide his following email addressed to Dr. A.K..Jha, Member of Editorial Board . We deeply appreciate the support of EFEE . The full article can be accessed @ https://efee.eu/wp-content/uploads/2018/09/2018-09-EFEE-Newsletter-3-.pdf - Editor

To
Dear Dr A.K. Jha

We have probably one article which could be interesting for you. This article describes elimination of an incident - "Sliding down" of a drilling machine from a quarry bench due to collapse of the wall. We have published this article in EFEE Newsletter in August 2018 (see link below).

I really do not know if this article meets your requirements but please consider it in your editing committee. I have an approval from author Mr. Josef Ruska to publish it in your newsletter. Please find attached 2 files (one containing the article and the second one containing the pictures). By the way this article will be published also in the latest SAFEX Newsletter #70.

Best regards.

Ing. Igor Kopál

Mobile: +421 904 904161
E-mail: igor.kopal@outlook.com
Sv. Vincenta 6
821 03 Bratislava
SLOVAKIA"

SELECTED ABSTRACT

Picture # 1 – Drilling machine after the slide

Picture # 2 – View on the drilling machine from the bench V

Picture # 3 – Fixing of the drilling machine to the crane

Picture # 4 – Forming of road cut

Picture # 7 – Finished road cut

Picture # 8 - Check of surrounding area

On 21st June, 2016 at 4.09 p.m. I was informed by a production foreman that an incident occurred in Vcelare Quarry – i. e. the sliding of a drilling machine from the bench IV (northern part of the western quarry wall, at workplace P7).

Facts: A bench had collapsed in the northern part of the quarry, approximately 6000 t of rock had slided down the from the edge of the bench (on the same place where drilling operations were carried out according to a drilling passport nr 086/16)

The drilling machine was approximately 5 meters below the level of the bench IV, on an inclined position, it leans on a rock and seems to be on a stabilized position.

The rock massive seemed to have stabilized, further sliding or rock material was not observed.

Finally a crane arrived on the site of the incident and we started to prepare to pull up the drilling machine. We contacted a company named ISOP Zvolen to obtain required information regarding the machine's anchoring system.

During the incident and the process of rescuing the drilling machine no personal injuries or damages to the property occurred.

Picture # 13 – Incident description

Picture # 14 – Drilling machine after the slide

SCIENTIFIC / TECHNICAL PAPER

DUMP SLOPE, HIGH WALL & BENCH MONITORING – A NEW APPROACH USING MOTION TRACKING ALGORITHM & PARTICLE IMAGE VELOCIMETRY

AJAY KUMAR JHA
President, BioID GmbH, Germany

ABSTRACT

Accurate measurement of movement/ deformation in dump slope, high wall or bench is fundamental to the success of disaster free mining operation. Motion tracking algorithm is very effective in geotechnical modelling domain. Particle Image Velocimetry (PIV) is a velocity-measuring technique in which image space i.e. patches of texture are tracked through an image sequence and converted to object space using a transformation matrix. Image processing algorithms have been written to apply the PIV principle to images of rock movement. This system allows measurement of enhanced deformation, associated velocity & acceleration to be measured to a precision greater than existing radar based systems.

1.0 INTRODUCTION

Motion tracking and analysis algorithm based on principle of particle image velocimetry (PIV) and close-range photogrammetry is useful to investigate the dump slope stability, high wall stability or bench stability. Using PIV, the movement of a fine mesh of soil/rock mass patches is measured to a high precision. Automatic tracking of unlimited number of objects without markers can provide a disaster management tool to predict early detection of failure in dump, high wall or any benches. Since PIV operates on the image texture, intrusive target markers need not be installed in the observed soil/rock mass. The resulting displacement vectors are converted from image space to object space using a photogrammetric transformation. This paper discusses a use case of use of motion tracking and analysis algorithm in a large surface mines using all weather NIR camera. Recently, many NIR camera manufactures across the globe comply the category I, II, IIIA & IIIC classification so that it can be used under rain, fog, mist or dust. The motion tracking algorithm for tracking the dump movement and bench slope movement utilizes patented algorithm using various technologies viz. Artificial Intelligence, deep learning, neural network, synergetic computing, advanced data analytics, machine learning, pattern recognition, discriminant analysis and classification techniques.

2.0 MOTION TRACKING AND ANALYSIS ALGORITHM

The algorithm takes video file(AVI, raw) as an input and undertakes 3D calibration. In order to track the moving objects automatically, the algorithm tracks object positions (so-called “trajectories”) covering following variables.

* x, y, z over t
* Angles and Distances
* First and second derivatives over time
* Angle Projections onto all planes
* Center of Mass
* Impulse
* Force
* Moment of Momentum
* Moment of Torsion

2.1 Key Characteristics of Motion Analysis Software

The tracking system allows the followings

- the necessary GUI to connect all inputs required and collect video streams from camera
- monitor the tracked objects features of movement in all directions
- necessary masking tool to define area of interest
- necessary communication to issue an alarm
- necessary licensing mechanism to protect the software
- trigger an alarm/alert as soon as an movement exceeds the threshold limit as set up by the mine management

2.2 Major Hardware Requirement

The list of major hardware details is enumerated below.

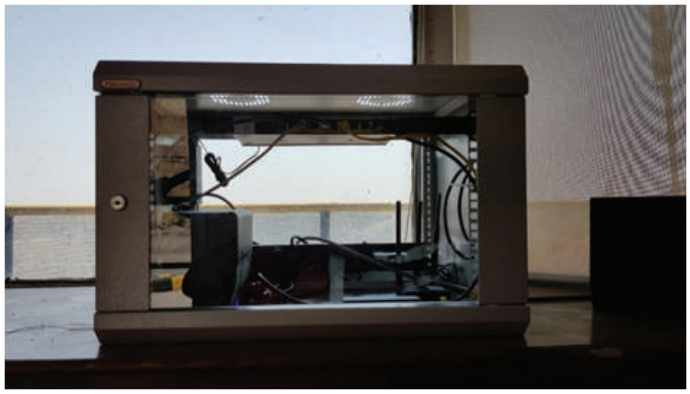
- Industrial Server with dual monitors:fan less, 25°C

~ 60°C, Intel Core i7, 32 GB, 1 TB SSD, 2TB HDD with RS 485

- Server rack: low with power supply
- WiFi radio with directional antenna(IP 67)
- Network switches with PoE
- Lightening surge protection
- Env. Box(IP 67)
- NIP camera with mounting accessories
- Alarm and notifications system with software
- Windows server with Presentation tool
- Power supply system

3.0 FIELD EXPERIMENTATION

The field study was carried in a large surface mine, where NIR camera was mounted on pole as shown in Figure 1 (a). The control system containing data storage and NAS is shown in Figure 1 (b). The camera was equipped with auto switch facility to activate night lense whenever the illumination fell to less than 10 lux i.e during evening and night. During day time, the colour lense was activated and all video streams were saved in internal memory of control system. The 6 MP camera was used during field experimentation with resolution of 3072x2048 pixels. At a distance of 500m, the camera had Field of View(FOV) of 575m (width) x 415m (height). The horizontal accuracy was configured as 18.72 cm/pixel and 20.26 cm/pixel as vertical accuracy.



A typical tracking picture showcasing the BioID framework in case of movement in dump is depicted in Figure 2(a), (b) & (c) where green color arrows are showing the movement of particles in dump picked up by BioID tracker software.

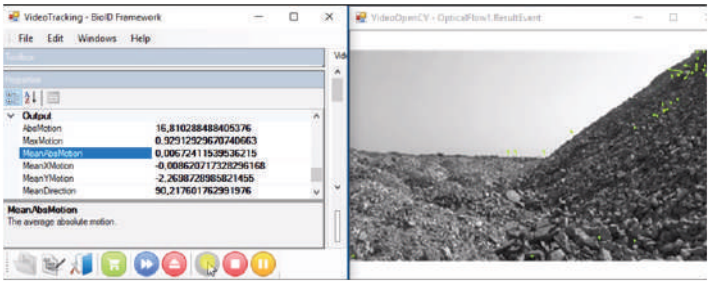


Figure 2(a) : Movement in dump captured by BioID Tracker

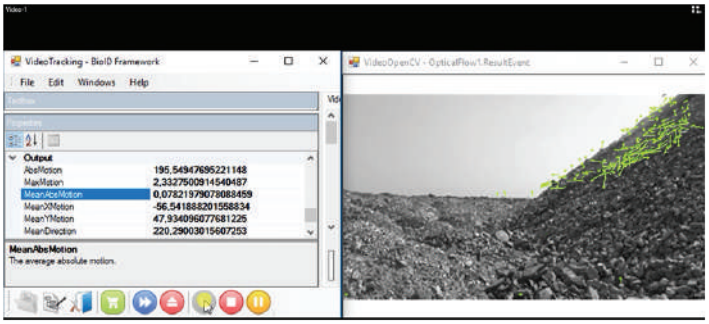


Figure 2(b) : Movement in dump captured by BioID Tracker

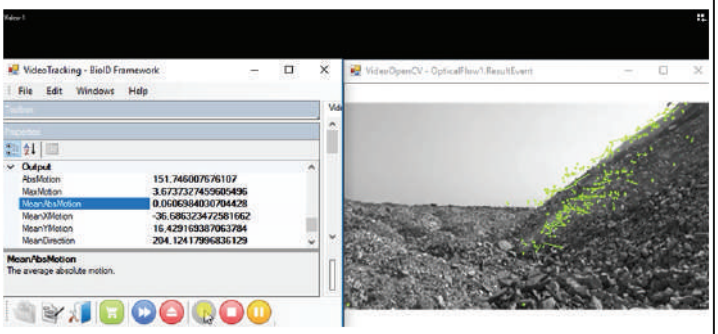


Figure 2(c) : Movement in dump captured by BioID Tracker

4.0 INTERPRETATION OF RESULTS

The analysed output derived from the motion tracking algorithm was compared with radar output by fixing identical field of view(FOV). The signature of average enhanced deformation average, minimum and maximum is shown in Figure 3(a), (b) & (c).

Figure 3(a) : Plot showing average enhanced deformation (mm) of moving particles

Figure 3(b) : Plot showing maximum enhanced deformation (mm) of moving particles

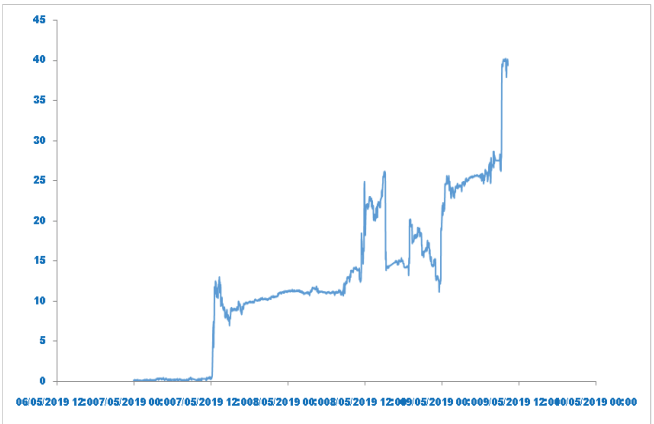


Figure 3(c) : Plot showing minimum enhanced deformation (mm) of moving particles

5.0 CONCLUSIONS

Motion tracking and analysis algorithm using NIR camera would be a cost effective and technically superior solution for investigating any movement . As camera system converts the image space to object space, all movement in real world scenario i.e. inward or outward of plane, vertical downward or sideways movement can be detected accurately and enhanced deformation trajectory can be obtained for detailed geo technical investigation. The camera system does not require any WPC license unlike radar system which requires WPC license. The camera system has no health hazard where as long exposure of radio waves can create health hazards viz. distress, insomnia, depression etc. In terms of tracking accuracy per pixel, camera system at a distance of 850 m from field of view would be 7.5 times more accurate than radar system as camera system can track at pixel size of 1mx1m with sub pixel accuracy where as radar based system has pixel tracking accuracy of 7.5mx 7.5 at a distance of 850 m from field of view and 15m x 15m at a distance of 1.7 km from field of view. The farther one proceeds, the tracking accuracy of camera system increases as compared to existing radar based systems. The camera system does not face any atmospheric refractivity like radar system which incorporates a fixed error during tracking movement.

It may be concluded that motion tracking algorithm along with PIV technique can be gainfully used to investigate the dump slope stability, high wall stability or bench stability.

6.0 REFERENCES

1. Adrian 1991. Particle imaging techniques for experimental fluid mechanics Annual review of fluid mechanics 23:261-304

2. Beasley D.H. 1973. Centrifugal testing of models of embankments on soft clay foundations CambridgeUniversity PhD thesis

3. Chen J., Robson S., Cooper M.A.R. & Taylor R.N. 1996. An evaluation of three different image capture methods for measurement and analysis of deformation within a geotechnical centrifuge International archives of photogrammetry and remote sensing vol. XXX1, part B5, 70-75, Vienna

4. Gerber E. 1929. Untersuchungen uber die Druckverteilung im Oertlick Belasteten Sand. Dissertation Technische Hochschule, Zurich

5. Grant R.J. 1998. Movements around a tunnel in twolayer ground City University, London, PhD thesis

6. James R.G. 1965. Stress and strain fields in sand. Cambridge University PhD thesis

7. Mair, R.J. 1993. Developments in geotechnical engineering research: applications to tunnels and deep excavations.Unwin MemorialLecture (1992), Proc. ICE, London, Vol 97 No.1, 27-41.

8. Taylor R.N., Grant R.J., Robson S. & Kuwano J. 1998. An image analysis system for determining plane and 3-D displacements in soil models Proceedings of Centrifuge '98, Balkema, Rotterdam 73-78

SCIENTIFIC / TECHNICAL PAPER

Preparation of Scientific and Technical Papers

Dr. G. R. Adhikari
Member, Editorial Board, Visfotak Journal

ABSTRACT

Scientific and technical papers have certain characteristics. Some characteristics are associated with the quality of the scientific or technical content while others are related to the quality of writing. The first part of this report presents these characteristics while the second part focuses on the structure and contents of papers in detail.

Part 1: Characteristics of Scientific and Technical Papers

The important characteristics of scientific and technical papers are originality, accuracy, conciseness, clarity, correctness, structure, comprehensiveness, consistency, and target readers.

1. Originality

Originality is the most important characteristic for publication of papers in scientific and technical journals. Editors and reviewers accept or reject a manuscript based on the presence or absence of its originality. The followings are acceptable definitions of originality [1]:

- Presenting a major piece of new research findings for the first time,
- Extending or elaborating on an existing piece of work,
- Developing a new product or improving an existing one,
- Reinterpreting an existing theory in a different context,
- Demonstrating originality by testing someone else's idea,
- Conducting empirical work that has not been done before,
- Examining the previous work from a new angle to produce new knowledge,
- Synthesising information in a new or different way to add to knowledge,
- Providing a new interpretation using existing /known information,
- Applying existing ideas/ a particular technique in a new area,
- Developing a new research tool or technique or algorithm,
- Conducting a study on a previously unresearched area or topic,
- Producing a critical analysis of something not previously exam ined.

Original work can be the outcome of basic or applied research. The purpose of basic research is to create new knowledge or understanding without considering the overall practical applicability whereas an applied research is concerned with practical applications of knowledge to solve problems.

The Office of Research Integrity, U.S. Department of Health and Human Services [2], has defined research misconduct which means of fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. Wikipedia has reported several cases of misconduct including 61 cases from biomedical sciences and 6-7 cases, each from chemistry, physics and social sciences [3].

2. Accuracy

Accuracy in technical writing refers to factual and correct information, free from bias or subjectivity. Researchers must be fair and honest in reporting facts without any distortion. The methods must be replicable to check the validity or verify results. It is important to always report the facts about a particular experiment, even if unexpected results were obtained. It is wrong and unethical to falsify information and data. An inaccurate writing does not command respect and confidence from the readers.

3. Structure

The basic structure of scientific papers is presented in Part-2 of this report.

4. Comprehensiveness

A comprehensive paper explores a topic thoroughly and presents the details in a proper structure so that the paper is complete and informative.

5. Clarity

The paper must be clear and straightforward so that it is easier for the target readers to understand. The author needs to adhere to the subject matter and to convey facts in clear terms. The following suggestions can improve clarity while writing and editing the manuscripts [4]:

Organise thoughts before writing. Clarity comes from clear thinking.
• Keep the subject and its verb in the sentences close to one another.

• Use active voice, which is clearer, more direct, and more engaging, e.g. "The manager decided to use emulsion explosives" instead of "A decision was made by the manager to use emulsion explosives."

• Use familiar, concrete words except for necessary technical terms.

• Use effective transitions between sections, paragraphs, sentences, and within sentences.

• Keep sentences short and focused on one idea per sentence and one theme per paragraph.

• Ensure coherence - logical bridge between words, sentences and paragraphs.

• Avoid misplaced phrases.

• Pay attention to punctuation marks such as full stops, commas, colons and semi-colons, and quotation marks.

• Ensure necessary articles, conjunctions, or prepositions in sentences.

• Replace the noun form of verbs e.g. "Fragmentation was assessed" instead of "Assessment of fragmentation was done"

• Ensure the pronoun that refers to a noun is explicitly clear e.g. "The air decking was applied in blasthole charging that consisted of …" instead of "The air decking was applied in blasthole charging. It consisted of …"

• Assign the adjectives correctly: bigger or larger for physical size; higher for height or position; greater for quantity or value; and longer for time or length. Be specific e.g. "Mochia mine conducted the India's largest underground blast with 145 tonnes of explosive" instead of "Mochia mine conducted the India's largest underground blast."

• Avoid sprawling sentences e.g. "The trial blast, which was postponed for Monday, was rescheduled for the following Friday so that seismographs could be available to monitor ground vibration" instead of "The trial blast was postponed for Monday, November 4, 2019 but seismographs were not available, so it was rescheduled for Friday, November 8, 2019 and then ground vibration could be monitored."

• Avoid faulty parallelism. Replace "Conducting a blast includes several steps such as bringing explosives, need to charge holes, stemming, connection of detonators devices, and firing" by "Conducting a blast includes several steps such as bringing explosives, charging holes, stemming, connecting detonators, and firing."

• Use defining and non-defining clauses correctly. The meaning of "The Manager, who supervised today's blast, is a mining graduate" is different from "The Manager that supervised yesterday's blast is a mining graduate."

6. Conciseness

Although words are necessary for effective communication, ideas should be expressed in few words. Writing concisely is different from writing briefly. Brief writing simply means short whereas a concise writing is short, and it covers all the essentials. Brevity versus conciseness is same as quantity versus quality of materials - volume versus concentration [5]. Brevity is desirable but is not always possible. A research paper cannot always be brief but it can always be concise. A good rule of thumb for concise writing is to eliminate redundancy and to delete or rewrite everything that does not add to clarity.

7. Correctness

Authors should check if the manuscript is contextually and grammatically correct, and readable. Editors and peer reviewers of journals reject manuscripts for English mistakes more than scientific mistakes or missing some scientific information [6]. If the manuscript is well-written, editors/reviewers concentrate on the technical merits. While preparing the first draft of papers, authors need to focus solely on writing without worrying about grammar and syntax which can be corrected at editing and proofreading stage. If authors are not confident in their English writing skills, it is a good idea to get their manuscripts corrected by someone who can understand the subject matter.

8. Consistency

Dates can be formatted in different ways: November 20, 2019; 20th November 2019 or 20/11/2019. All these variants mean the same thing but one variant is followed in one journal and other variant in another journal. This example explains the need for strictly adhering to target journal's format for references, font, font size, margin, line spacing, captions for figures and tables, units, abbreviations and symbols. Headings, subheadings, spellings (British or American English) must also be consistent throughout the manuscript. Inconsistency in writing indicates careless attitude of the author.

Technical writing discourages substituting key technical terms by their synonyms in the same paper so that the readers do not misunderstand the contents. For example, if term 'powder factor' is used at one point, it should not be replaced by 'specific charge' elsewhere in the same paper.

9. Target audience

The aim of scientific journals is to convey information about a technical subject to a specific audience. As an example, the readers of Visfotak journal are manufacturers and users of explosives or are from academic and research institutions. Papers dealing with research, review and case studies, related to safety and technology of explosives and applications of explosives in mining industries, are appropriate for these readers. Submissions of manuscripts, which do not fall within the aims and scope of the journals, are likely to be rejected [7].

Part-2: Structure and Content of Scientific and Technical Papers

The papers are aptly titled and structured in a standard format with the contents holistically organised into the following sections: abstract, keywords, introduction, materials and method, results, discussion, conclusion, acknowledgement and references. Introduction, method, results, and discussion are known by acronym as IMRaD. The main advantages of following the basic structure are:

• It helps the author to organise the contents of the paper in a uniform, logical and comprehensive way.
• It enhances ease of accessibility for the readers to locate specific information in a paper.

1. Title of the paper

The title of a paper should accurately reflect the content and the objective of the paper. It must be informative and attractive so that other researchers read and cite the paper. The title of a published paper “Empirical methods for the calculation of the specific charge for surface blast design” [8] states that the paper is relevant to those who are interested in surface blast design, particularly in calculating specific charge using empirical methods.

The title of a paper should contain minimum words that adequately describe the contents of the paper. A lengthy title [9] lacks conciseness and focus on key points. On analysis of 4,000 article titles from eight research areas, the average title length was 12.3 words [10]. To limit the title’s length to the recommended 10-12 words, unnecessary phrases such as “Studies on”, “A Study of”, “An Experimental Investigation of” can be deleted. However, abbreviations/acronyms should be avoided in titles unless there are well known to the target audience.

Paper writing can begin with a working title which can be modified during or after completing the paper.

2. Abstract

An abstract is a condensed version of the full paper that enables the reader to make a quick decision how the paper is relevant and important to their interests.

The abstract is the only part of a paper that is available on net, unless the paper is published in an open access journal. Therefore, it must be self-contained and representative of the paper.

An abstract can be structured or unstructured [4]. Most of the journals publish unstructured abstracts containing maximum 250 words in a single paragraph with a brief summary of main sections of the papers. Journals in medical sciences usually publish structured abstracts that also contain the same information as unstructured abstracts but abstracts are divided into short sections. The structured abstract reminds the authors to include information from all major sections. The structured abstract can be converted into an unstructured abstract simply by deleting the subheadings, combining all of the sentences into one paragraph, and editing/proofreading to increase readability and flow. An abstract should not contain undefined abbreviations or acronyms, citations or references, figures or tables, and anything that is not discussed in the paper.

Although ‘abstract’ is read after the title, it is always written at the end to recapitulate the entire paper.

3. Keywords

Keywords in a paper are the words or phrases that interested readers use while browsing on search engines such as Google Scholar, databases, or journal websites. Depending on the journals’ requirements, papers provide 3-5 keywords. Single word keywords are acceptable but a string of 2-3 words are better in retrieving the paper of interest. For example, a paper entitled “Influence of transducer-ground coupling on vibration measurements’ has provided three keywords, each containing 2-3 words [11]. These keywords are “Transducer-ground coupling”, “Transducer mounting”, and “Ground vibration monitoring”. When browsed on google scholar using these keywords, the first keyword displayed the title at the top of search results. The second keyword displayed the same information on the second page while the third keyword retrieved the information on the sixth page of search results. Therefore, it is important to choose the right keywords so that the paper is displayed at the top of search results.

4. Introduction

The purpose of an introduction is to capture the attention of the readers and to keep them interested on reading till the end of the paper. For writing a compelling introduction, authors follow an inverted triangle [12] or an inverted pyramid [13] or a funnel [14] model. The basic concept of these models is the same i.e. introduction begins from broad to narrow or from general to specific as indicated in the conceptual model of an introduction writing in Fig.1.

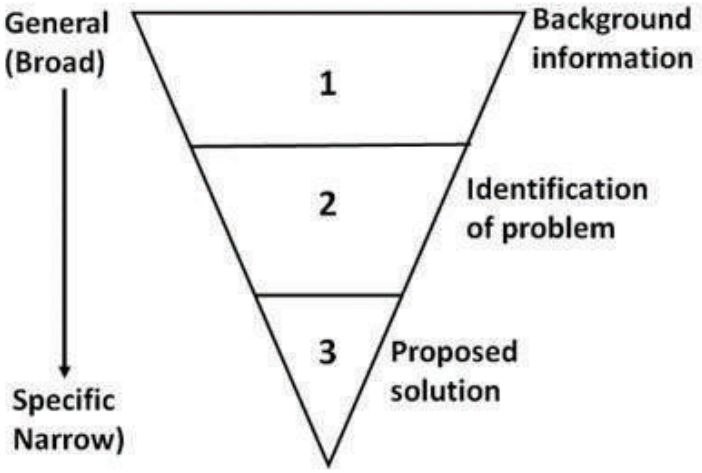


Fig. 1 Conceptual model of introduction writing

The conceptual model consists of three parts as described below:

1) Background information - The general or broad statements in the beginning of the papers are intended to give background information about the topic and the context in which the paper fits. It consists of information about what is known about the topic. Background information can summarise important and relevant studies and it can explain important concepts, theories and terms to help the readers in understanding the topic, the problem and its significance.
2) Identification of problem –The literature review of important and relevant studies reveals the knowledge gap that impedes understanding of a process or system. The knowledge gap refers to the unexplored areas, unanswered questions and unresolved issues of the topic. The gaps may also be identified from the conflicting research findings and limitations of previous studies. The importance of filling these knowledge gaps justifies the need for the proposed study on the identified problem.
3) Proposed solution - After identifying the knowledge gap and after underlining the need for filling this gap, the introduction should logically end by mentioning the specific objectives of the study.
Introduction may include the scope of work, assumptions made and limitations of the study. The scope of the study refers to the parameters or boundaries within which the study is conducted. It may include the extent/detail covered in the study, or a particular time period, or a specific geographical area. Scope should be designed to satisfy the needs of the objectives. The scope is controllable. For example, the researcher can identify a different problem and formulate different objectives for his research.

Assumptions are realistic statements that are believed to be true. The statements are based on logic or reasons but without any evidence or proof. For example, rock is assumed to be a homogeneous, elastic and isotropic medium in theoritcal and numerical analysis in rock mechanics. Assumptions can influence the inferences drawn from the study research.

Limitations are weaknesses or constraints imposed by time, budget and other resources. The limitations, which are out of the researchers' control, may influence the credibility of the research findings; hence, such limitations are to be mentioned.

The introduction should not [15]:
• Give unnecessary background information.
• Provide details of the previously conducted research.
• Provide extensive critique of the previous studies.
• Cite too many references.
• Describe results/conclusions of the study.

5. Materials and Methods

Materials refer to items or things such as samples, chemicals or instruments/equipment used in the study. The requirements of materials vary depending on the discipline and the research problem. In geological studies, materials include topographical map, GPS, geological hammer, Brunton compass, diluted hydrochloric acid bottle, sample bags, chisel, magnifying glass and camera. In blast studies, materials include seismographs, velocity of detonation recorder, laser profiler. It is necessary to mention the make, model of and calibration date of the instruments/equipment used.

Methods refer to the experimental procedures/techniques that describe how measurements were performed, how the data were collected and analysed [16]. It describes the rationale for the same or briefly justifies the experimental design. Methods include laboratory or field experiments, numerical modeling, neural network analysis, questionnaires, interviews and surveys, appropriate to the objectives of the study. The parameters measured and the measurements techniques are to be described and justified. It is necessary to mention analytical methods such statistical tests, computer software that are used to analyze the data.

If the study involves humans or animals, ethical permissions are required or if the study area falls in a protected zone, regulatory permissions are required.

This section should provide the right amount of detail so that other researchers can replicate the experiment and evaluate the validity of the results obtained. Too detailed description sounds like a laboratory manual. On the other hand, inadequate description does not allow to replicate the experiment [17].

If a known method is followed, it is sufficient to mention it and cite the original publication/standard that gives the details

If a procedure is modified by the investigators, it is sufficient to describe only the changes and cite the sources for the rest. If the authors employ a new process or technique, it should be described in detail [17]. Citations in this section are limited to data sources and references that describe procedures.

This section is often written in the beginning as experiments are performed. It is a relatively easy section to write because it does not require interpretation.

6. Results

This section presents the results obtained corresponding to materials and methods employed in the study [18]. Subheadings are often used to present the results of different experiments in a logical order. The content of the results section should include tables, figures but the same data should not be presented in both tabular and graphic forms. Tables are a concise and effective way to present large amounts of data. Figures can include photographs/maps that help readers visualize the information which are difficult to convey in words. Captions for figures and tables must be self-explanatory. Many readers may look at figures and tables without reading the main text of papers. This section should summarise the results without any bias and without ignoring negative/unexpected results.

The requirements of the target journal while preparing papers are to be checked as some journals combine results and discussion sections into a single section.

7. Discussion

The purpose of the discussion is to interpret and describe the significance of the findings in light of the research problem/research question, and to explain any new understanding or fresh insights about the problem based on the findings. The section can contain:

Meaning and importance of key findings
• Discuss the results from specific to general [18].
• Discuss the results in the order of most to least important [19].
• Relate the results to the objectives and discuss whether the results support the objectives.
• Evaluate the impacts, if any, due to assumptions and limitations of the study.
• Explain unexpected results and evaluating their significance. Consider alternative explanations of the results.

Interpretation of the results

• Identify correlations and patterns among the data.
• Evaluate the findings by comparing/contrasting with existing literature.
• Mention how the results contribute to knowledge.
• Discuss how the results might be generalized.
• Discuss likely causes (mechanisms) underlying the patterns.

Implications of findings

• Discuss the practical and/or theoretical implications of the results.

8. Conclusion

The conclusion section should
• Restate the topic and research objective to link introduction and conclusion to each other. The question that was raised in the introduction should be answered in the conclusion.
• Re-state the key findings from most important to least important mentioning the impact and significance of the findings.
• Suggest/ recommend for further research or practical applications.
• Avoid 'copy and paste' from the other sections of the paper; put them in different words.
• Avoid using the expressions like 'To conclude…,' 'In conclusion…,' etc.

9. Acknowledgments

The purpose of this section is to show appreciation to those who contributed in conducting research and writing the paper. Funding agencies, supervisors, and those who helped in completing the study are briefly acknowledged.

10. References

'References' is a list of the sources that the authors use in scientific writing. These sources may include books, journals, conference proceedings, theses, online sources, etc. Conventionally, authors cite the source and a reference gives the details about the source. Every source that is listed in the references needs to be cited in the body of the paper. Any source that is cited should be listed in the references.

The reasons for citations and referencing are to give credit to the original author, to use other's work without plagiarizing and to demonstrate that authors have read literature related to the topic. In scientific writing, authors should distinguish between their contribution and the work taken from other authors. It is necessary to cite whenever authors make specific reference to the source which has been relevant and important in the research. However, a well-known fact or common knowledge does not need citations and referencing.

Different citation styles have different rules for in-text citations and reference list entries. The way in which references are cited in the text and listed at the end of a paper must be in accordance with the "Guide for authors" of the journal/publisher. Referencing tools such as 'EndNote' can be used for proper citation and maintaining references [20].

References

[1]https://services.unimelb.edu.au/__data/assets/pdf_file/0009/471267/Developing_originality_Update_051112.pdf
[2] https://ori.hhs.gov/definition-misconduct
[3] https://en.wikipedia.org/wiki/List_of_scientific_misconduct_incidents
[4] Adrian Wallwork, English for Writing Research Papers, Springer, 2011. https://link.springer.com/content/pdf/bfm%3A978-1-4419-7922-3%2F1.pdf
[5] Reader's Digest, How to write and speak better? 1991.
[6] https://www.springer.com/gp/authors-editors/authorandreviewertutorials/submitting-to-a-journal- and-peer-review/what-is-open-access/10285582
[7] https://www.wiley.com/network/researchers/submission-and-navigating-peer-review/9-common-reasons-for-rejection
[8] G. R. Adhikari, Empirical methods for the calculation of the specific charge for surface blast design, Fragblast Journal, Int. Journal for Blasting and Fragmentation, Vol. 4, No. 1, 2000, pp. 19-33.
[9] A.K. Mishra, R.K. Chaudhary, P. Punetha, and I. Ahmed, Surge shaft excavation in adverse geological conditions: excavation methodology, support system, insitu treatment and monitoring of rockmass adopted for excavation of 13.5 m diameter and 152 m deep surge shaft of Mangdechhu Hydroelectric Project; Bhutan, ISRM (India) Journal, Vol. 9, No. 1 January 2020, pp. 3-10.
[10] D. H. Foster, "Long, short, efficient titles of research articles", September 4, 2018. https://blog.oup.com/2018/09/efficient-titles-research-articles/
[11] G. R. Adhikari, A. I. Theresraj and R. N. Gupta, "Influence of transducer-ground coupling on vibration measurements", Fragblast, Int. Journal for Blasting and Fragmentation, Vol. 9, No. 2, 2005, pp. 79-92; accessed on 19 December 2019.
[12] G. Morley, A Guide for Writing Introduction Paragraphs for Academic Essays.
https://www.ufv.ca/media/assets/academic-success-centre/handouts/How-to-write-an-introduction----Grant-Morley.pdf
[13] K. W. Plaxco, "The art of writing science", Protein Science, Vol. 19, 2010, pp. 2261-2266.
[14] A. Oshima and A. Hogue, Introduction to Academic Writing, 3rd Edition, The Longman Academic Writing Series, Pearson Education, Inc., 2007.
[15] S. B. Bavdekar, Writing introduction: Laying the foundations of a research paper, Journal of the Association of Physicians of India, Vol. 63, July 2015, pp. 44-48.
[16] R. H. Kallet, How to write the methods section of a research paper, Respiratory care, Vol. 49, No. 10, October 2004, pp. 1229-1232.
[17] J. R. Matthews and R. W. Matthews, Successful Scientific Writing: A step-by-step guide for the biological and medical sciences, 3rd edition, Cambridge University Press, 2008.
[18] C. A. Mack, How to Write a Good Scientific Paper, SPIE, 2018.
[19] https://www.springer.com/gp/authors-editors/authorandreviewertutorials/writing-a-journal-manuscript
[20] Referencing tools https://endnote.com/

ABOUT THE SOCIETY

Explosives Safety & Technology Society

Secretariate Address :
Maimoon Chambers
Gandhibagh, Nagpur - 440032

Email : visfotak@yahoo.com

Website : www.visfotak.org

History :

The idea of "Visfotak" as a Scientific Society took birth in 1998, on the eve of the National Seminar on Explosives Safety and Technology *(Visfotak - 98),* when for the first time the three major constituents of the industry, viz, the Government Regulatory Bodies, the Manufacturers, and the Users respectively, were formally brought together on one platform to deliberate on common Concerns and Issues. Arising from the deliberations, a proposal to establish a Scientific Society exclusively dealing with the Safety & Technological aspects of the Explosives industry was unanimously endorsed.

Consequently, the Explosives Safety & Technology Society (Visfotak) was registered vide Certificate No. 410/99 (Nagpur) dated June 17th, 1999.

Objectives :

(a) To promote and develop modern concepts relating to safety and technology in manufacture, handling, and usage of explosives.
(b) To assist the Government of India through its appointed departments and officials in recommending, formulating policies pertaining to explosives manufacture, handling and usage.
(c) To hold seminars, workshops, conferences to promote interaction between the three constituents, viz. the Government regulatory bodies, the manufacturers of explosives and the users of Explosives, in the interest of the growth and health of the explosives industry.
(d) To collaborate with academic and research institutions in promoting the objectives mentioned above.
(e) To promote and strengthen affiliation with other world bodies / societies dealing with explosives safety and technology for exchange of information.
(f) To institute awards, fellowships and scholarships for the excellence in the field of explosives.

Governance :

The activities of the Society are overseen by a Governing Council, comprising of eminent professionals and technocrats, including nominees from the two major Regulatory Bodies, viz, the Office of the Chief Controllers of Explosives, and the Directorate General of Mines Safety, respectively.

Institutional Association :

- **'Institute Associate Member' of Safex International, e.f. 30 May, 2008**
  (Safex International is a global organization founded by the manufacturers of explosives and pyrotechnics, currently having 110 members in as many as 46 countries. For more details on Safex, visit www.safex-international.org)
- **'Liaison Member' of the Institute of Makers of Explosives (IME), e.f. Oct 29, 2014**
  (IME is the safety and security institute of the commercial explosives industry in USA since 1923. For more details on IME, visit www.ime.org)

Membership of the Society :

The membership application form is enclosed. The application form can also be accessed and down loaded from the society's web-site.

Student Chapter :

This is an initiative launched by the society to promote the mission of the society amongst the students and academics who are, directley or indirectly associated with the science and technology of explosives. The application form for membership of the student chapter is enclosed; it can also be accessed and downloaded from the society's web-site.

Visfotak being a Scientific Society, shall totally refrain from partisan activities of any manner or kind and shall not entertain tasks which are biased with commercial interest of its individual members.

ABOUT THE SOCIETY

INVITATION TO MEMBERSHIP

In its quest for interaction towards improved Safety & Technology in Explosives, Visfotak cordially invites concerned people to enrol as members.
Membership Categories comprise :

CORPORATE OR INSTITUTIONAL

Entrance Fee	***Membership for 5 years***
Rs. 2000/-	*Rs. 3000/-*
US $ 200	*US $ 300 - For Foreign Nationals*

INDIVIDUAL

Entrance Fee	***Membership for 5 years***
Rs. 1000/-	*Rs. 1000/-*
US $ 100	*US $ 300 - For Foreign Nationals*

STUDENT

Entrance Fee	***Membership for 5 years***
Rs. 50/-	*Rs. 200/-*

Application forms are enclosed with this journal for necessary action.

- Secretary General Visfotak

ORDER FORM

For Advertisement in Visfotak

To,
Secretary General
Explosives Safety and Technology Society (Visfotak)
Maimoon Chambers, Gandhi Bagh, Nagpur - 440032

1. Name & Address of the Organization.
2. Advertisement enclosed : Hard copy/Soft copy/Both solicited with the tariff as follows :

Full Page (170 mm x 258 mm)

Colour	Outer back cover	Rs.	50,000/-
	Inside front cover	Rs.	40,000/-
	Inside back cover	Rs.	40,000/-
	Inside Page	Rs.	25,000/-
Half Page (170 mm x 120 mm)			
Black and White	Inside Page	Rs.	10,000/-
	Business Card	Rs.	5,000/-

Discount Offer : In case, advertisement is booked for four issues of the Journal at a time for one of the above categories, the concessional rates charged will be equal to three issues.

Payment is to be made through cheque / draft in the name of **"Visfotak", payable at Nagpur.**

SHARE YOUR ACHIEVEMENTS

Visfotak welcomes you to share highlights of your achievements and activities with other professionals through this journal.

Please send it to us through e-mail at : visfotak@yahoo.com
or write to
Secretary General
Visfotak : Explosives Safety and Technology Society, Maimoon Chambers, Gandhi Bagh, Nagpur - 440032, India

Tear along this line

Tear along this line

EXPLOSIVES SAFETY & TECHNOLOGY SOCIETY

REGISTERED UNDER SOCIETIES REGISTRATION ACT MAHARASHTRA NO. 410 / 99 NAGPUR (INDIA)

MEMBERSHIP APPLICATION FORM

(Registered members will be given a Certificate and they would be entitled to participate in all the events conducted by the Society, and receive the publications of the Society free of cost).

Category of Membership : (Please tick ✔) MEMBERSHIP FEE FOR FIVE YEARS ONLY

CORPORATE MEMBER ☐	INSTITUTIONAL MEMBER ☐	INDIVIDUAL MEMBER ☐
Entrance Fee Rs. 2,000/- (US $ 200)	Entrance Fee Rs. 2,000/- (US $ 200)	Entrance Fee Rs. 1,000/- (US $ 100)
Membership Fee Rs. 3,000/- (US $ 300)	Membership Fee Rs. 3,000/- (US $ 300)	Membership Fee Rs. 1,000/- (US $ 100)

Name of Corporate Body / Institution _____

Represented by (Head - Other) * _____

* NAME IN FULL _____
(First Name) (Middle Name) (Surname)

Date of Birth _____ Designation / Current Status _____

Mailing Address _____

City _____ Pin Code _____ Country _____ E-mail _____

Telephone (Office) _____ (Home) _____ (Mobile) _____ (Fax) _____

Qualifications Educational _____ Professional _____

Year of passing _____ Institute / University _____

Nature of Industry (Explosives, Mining, Hydel Power, Cement, Highways, Irrigation, Academic / Research / Technical Services, Defence, Statutory Bodies, Other) (Please specify) _____

_____

Membership of Professional Bodies, Awards, Recognitions _____

_____

_____

Professional Experience _____

_____

Areas of Specialization _____

Mode of Payment : Payments towards Membership fee may please be made by Cheque in favour of 'Visfotak' drawn on any Bank. Add Rs. 30/- for Outstation Cheques or send a Demand Draft payable on any bank in NAGPUR.

DD / Cheque No. _____ Date _____ For Rs. / US $ _____

Drawn on _____ Bank _____

Please forward the above application along with Cheque / Demand Draft to the following address :

The Secretary General, Visfotak - Explosives Safety & Technology Society
Maimoon Chambers, Gandhibagh, Nagpur - 440 032 (India)
Tel. : 2768631 / 32 ■ Fax : 0712 - 2768034 ■ E-mail : visfotak@yahoo.com

Place : _____ Date : _____ Signature _____

*** Please enclose a detailed BIO-DATA and a recent passport size PHOTOGRAPH.**
For Corporate and Institutional Members enclose Bio-data of the Head or Representative

Please send your detailed address, telephones / mobile numbers, fax and e-mail ID

admas

EXPLOSIVES SAFETY & TECHNOLOGY SOCIETY

REGISTERED UNDER SOCIETIES REGISTRATION ACT MAHARASHTRA NO. 410 / 99 NAGPUR (INDIA)

MEMBERSHIP APPLICATION FORM FOR STUDENT

(Registered members will be given a Certificate and they would be entitled to participate in all the events conducted by the Society, and receive the publications of the Society free of cost).

Membership Fee : (Please tick ✓) MEMBERSHIP FEE FOR FIVE YEARS ONLY

ENTRANCE FEE ☐ Rs. 50/-

MEMBERSHIP FEE FOR FIVE YEARS ☐ Rs. 200/-

Name of Corporate Body / Institution * _____

Represented by (Head - Other) _____

* NAME IN FULL _____
(First Name) (Middle Name) (Surname)

Date of Birth _____

Name of Institution _____

City _____ Pin Code _____ Country _____ E-mail _____

Telephone (Office) _____ (Home) _____ (Mobile) _____ (Fax) _____

Educational Qualification _____

Academic Course being persued : _____

Membership of Professional Bodies, Awards, Recognitions _____

_____

_____

Membership of Professional Bodies, Awards, Recognitions _____

_____

_____

Areas of Interest _____

Mode of Payment : Payments towards Membership fee may please be made by Cheque in favour of 'Visfotak' drawn on any Bank. Add Rs. 30/- for Outstation Cheques or send a Demand Draft payable on any bank in NAGPUR.

DD / Cheque No. _____ Date _____ For Rs. / US $ _____

Drawn on _____ Bank _____

Please forward the above application along with Cheque / Demand Draft to the following address :

Dr. N.R. Thote, Assistant Professor
(Hony. Secretary, Student Chapter
Explosives Safety & Technology Society (Visfotak)
Department of Mining Engineering
Visveswaraya National Institute of Technology, Nagpur - 440 011

Place : _____ Date : _____ Signature _____

*** Please enclose a detailed BIO-DATA and a recent passport size PHOTOGRAPH.**

Please send your detailed address, telephones / mobile numbers, fax and e-mail ID

admas

Tear along this line

Tear along this line

VISFOTAK JOURNAL IS NOW ONLINE

Access Volume 13 by clicking on link
www.visfotak.org