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SAFEX NEWSLETTER NO.73

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SAFEX CONGRESS XX



SALZBURG

5 till 10 September 2021

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From the Desk of the SG

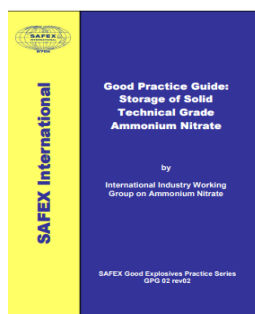
Since the last Newsletter Covid-19 ruled our lives (and the world) and we all went through extremely strict lockdown protocols. Since then we realised that life as we knew it has been irrevocably changed. I hope the effect on you and your families and companies was manageable and all are moving forward. Due to the uncertainties around the Covid-19 situation for 2021 the Board has decided to move the SAFEX Congress XX to 5-10 September 2021. Arrangements for this change is well under-way and registration will commence early in 2021.

DATE	ACTIVITY	CONCURRENT ACTIVITY
Sunday, 5 September	Registration - Training	
Monday, 6 September	Registration - Training Training Session	
Tuesday, 7 September	Training Session Registration – Workgroups	
Wednesday, 8 September	Registration - Workgroups Workgroup Sessions Registration - Congress Welcome Reception	
Thursday, 9 September	Registration - Congress Plenary Sessions – First Day Ordinary General Meeting	Spouses' Programme
Friday, 10 September	Plenary Sessions – Second Day Board Meeting Gala Dinner	Spouses' Programme
Saturday, 11 September	Congress Excursion	

This change necessitated the Board to look at an intermediate event/s and a survey was conducted amongst SAFEX members. There was overwhelming support to conduct an interim webinar in the first quarter of 2021. A first 2-hour webinar on Explosives Incidents is under preparation. More details will follow soon.

SAFEX is evaluating establishing a presence on LinkedIn to provide members a continuous forum for sharing thoughts and ideas relating to safety, health, and environmental issues. Any thoughts on this move would be appreciated.

The tragic disaster in Beirut also brought home the necessity of risk assessments and following the correct protocols with ammonium nitrate. I hope that all companies dealing with this product have reviewed their position and ensured that all the safety rules and measures are in place. A reminder that the SAFEX GPG **“Storage of solid Technical Grade Ammonium Nitrate”** contains excellent guidelines to assist members in ensuring they have the correct protocols in place.



The first paper in this Newsletter **“Ammonium Nitrate – An overview for its safe storage and handling”** is specifically authored to relay topical safety information to you. This article should be read together with **“How to assess the probability of the risk of explosion in AN storage?”** published in Newsletter 72. There are also articles dealing with AN sensitivity, Truck fires and methods of prevention.

SAFEX welcomes four new Governors on the Board of directors:

- Dan Reinke -Chemring
- Neil Franklin-AECI
- Joao Roorda- ENAEX
- Lance Tinney- Dyno Nobel

These appointments are in line with SAFEX articles of Association and will be formalized at the Ordinary General Meeting in September 2021

SAFEX also wants to take this opportunity to welcome SUA Explosives and Accessories Ltd as new members from India .I know they will find that their interaction and involvement with members, and our safety initiatives ,will add another pillar to their making their business safer.

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Ammonium Nitrate – An overview for its safe storage and handling

By

Francois le Doux and Noel Hsu

Ammonium nitrate (AN) is a naturally occurring chemical compound that was extracted from the earth in the past. It was successfully synthesized in the lab by Glauber in 1659 and not until the first industrial scale manufacture of ammonia in 1913 was its industrial synthesis enabled. Today the chemical is industrially manufactured and used primarily in agriculture (~75-80%) as a source of nitrogen and industrially for the manufacture of commercial-grade explosives (~15-20%); the remaining 2-5% is used in specialized technical applications, such as the generation of nitrous oxide gas. Globally approximately 85 million te AN are produced with more than half of it sold as pure or nearly pure (+90%) AN in the product.

This article is about the safety related to ammonium nitrate in handling and storage, focusing on technical grade ammonium nitrate (TGAN), which in this context is any ammonium nitrate not used in agriculture. The SAFEX Good Practice Guide (GPG) on technical grade ammonium nitrate storage details the necessary steps and controls for the safe storage of this product.

Manufacture

AN is manufactured by the neutralization of nitric acid with ammonia. AN plants typically have their own nitric acid plants. The principal raw material is ammonia, which is either produced locally or imported. Ammonia is commonly produced out of natural gas, air and water. Ammonia is commonly produced out of natural gas (coal and naphtha are also used in some countries), air and water. AN is made by the neutralization of nitric acid and ammonia, with nitric acid itself being produced out of ammonia and air. The neutralized solution containing AN and water is concentrated before being converted into solids through a prilling tower or granulation process. The solid AN is further processed, depending on the plant and the intended grade, through different steps such as drying, screening, cooling, coating. TGAN (technical grade AN) is normally a prilled product, and FGAN (fertilizer grade AN) is normally either prilled (1 to 4mm diameter) or granulated, granules being slightly larger (2 to 5mm diameter).

AN is produced in large plants or industrial sites, typically 100 to 2,000 tonnes/day for TGAN, and typically 500 to 5,000 tonnes/day for FGAN and require warehouses in accordance with these scales. FGAN storages are typically larger than TGAN because of the scale of production and the seasonal demand of agriculture.

Properties

Pure AN is a stable compound with a melting point of 170°C. It is classified as an oxidizer, Division 5.1 substance, for transport provided it meets the requirements of the testing regime of the UN Manual of Tests and Criteria. Although it does not burn it will readily support combustion. It is a hygroscopic compound. The solid has five crystalline phases (Figure 1.) that are temperature dependent (Keleti). These crystalline phases pose unique challenges to the storage of AN. At 32°C, a temperature reached in many parts of the globe, the AN that transitions through this temperature undergoes a 3.7% volume change, and on cycling through this temperature results in degradation of the structure of this prill.

Temperature cycling coupled with the hygroscopic nature of AN results in caking of the product when stored over extended periods. Hence on storage, even prolonged storage, the AN remains unchanged chemically, but its physical form may be altered depending on the temperature and humidity conditions.

1. There are several projects to manufacture "green ammonia" where hydrogen is obtained via hydrolysis of water and the hydrocarbons' reforming is not required. In such a process, especially if electricity used comes from renewable energy, ammonia synthesis does not emit any CO₂.

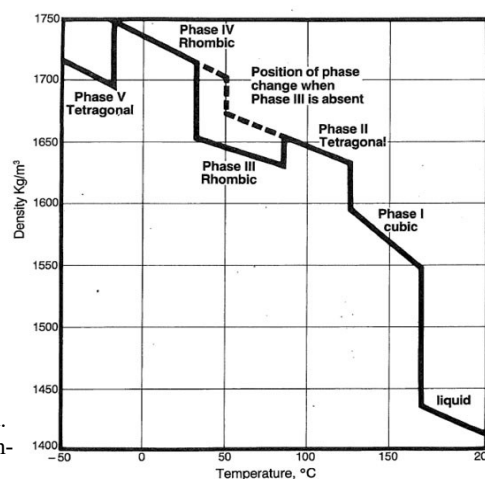


Fig. 1 Density changes in phase transitions of ammonium nitrate.

Figure 1

Manufacturers use various internal additives and coating agents, at levels of ten to hundred parts per million, to mitigate these deleterious effects and, combined with good storage practices preserve the physical quality of the product.

Hazards

AN is a stable compound under normal storage and handling conditions. However, if involved in a fire, large amounts of toxic gases will be generated, and the fire will be enhanced by the AN because it is an oxidizer. Ultimately explosion is its worst-case hazard. AN is a dangerous good and the controls for its safe storage must be strictly in place.

Contaminated AN or off-spec AN cannot be considered as AN and must be handled specifically, as their inherent risks can be disproportionately high compared to pure AN. For example, AN spillage on the ground soiled with fuel traces can become a Class 1 substance – an explosive – which highlights the importance of proper handling and good housekeeping standards.

The most common threat is fire and its uncontrolled consequences, in particular if AN is co-stored with incompatible goods such as flammable or combustible materials. Exposed to fire, solid AN will melt at 170°C and support combustion even in the absence of atmospheric oxygen. Contamination with incompatible material such as chlorine compounds, acids or some metal salts may lower the decomposition temperature of molten AN significantly and support a potential run-away reaction. On prolonged exposure to fire AN will start decomposing becoming a shock-sensitive mixture. The decomposing melt can also progress to a thermal explosion if confined; or form explosives mixtures with incompatible materials in proximity, such as fuels, organics, metal powder, molten aluminum, etc.

AN is classified as a dangerous good, specifically a Division 5.1 substance i.e. an oxidizer. In normal storage, transport, handling and use AN is very stable: it is insensitive to friction, impact, and static discharges. When exposed to major insults and under very abnormal conditions such as shock, heat, and contamination it can however explode and hence the institution of controls, as specified in the GPG will prevent such an event from occurring.

Since AN can be shock-initiated, it needs be included in estimating the Net Explosives Quantity when it is stored next to Class 1 products. Due to its relative low sensitivity, some competent authorities require it is included as an acceptor only.

Manufacturers must ensure sound product stewardship is in place to prevent people forgetting the hazards of AN throughout its lifecycle: from manufacture, storage, transport, use, and where necessary disposal, and to develop and maintain safe practices.

The industrial accidents described below highlight the effect of these threats on AN.

1.Oppau (Shock initiation)

One of the most cited industrial accidents involving AN is that at the BASF plant in Oppau, Germany in 1921 (Wikipedia, 2020). The practice of breaking up masses of caked fertilizers using dynamite was common, and prior to the mass explosion on September 21 was estimated to have taken place approximately 20,000 times. The product manufactured was a mixture of ammonium sulphate and ammonium nitrate, nominally a 50:50 mix. It is possible that the composition was not uniform and that some areas in the pile were more concentrated in AN (Medard, 1987). The initiation was clearly by shock. The explosion destroyed the plant, with a fatality count of 500-600 people with about 2,000 more injured. The use of explosives to disaggregate caked fertilizers and AN was strictly forbidden although a similar event occurred in 1942 in Tessenderloo where disaggregation with explosives resulted in an explosion that killed 189 people (Wikipedia, 2020).

2.Toulouse (Chemical contamination)

The only known industrial accident where chemical contamination was a root cause took place at the AZF fertilizer plant in Toulouse France on September 21, 2001(Wikipedia, 2020). The explosion occurred in a warehouse which was used as a temporary storage for off-spec AN. These materials were intended to be recycled in AN-based binary or ternary fertilizer processes (Nicolas Dechy, 2004). The mass involved was approximately 400 tons. INERIS estimated that the TNT equivalent of the explosion was in the range 20 to 40 tons. There were 30 fatalities and over 2,000 people injured. While the original cause of the accident is not agreed between the investigators and the parties involved, it was judged that the most likely cause was identified as a reaction between AN and sodium dichloroisocyanurate or AN and trichloroisocyanurate acid, both compounds which are incompatible with AN and on reaction release trichloramine (NCl₃), a sensitive and explosible compound.

3.Tianjin (Fire)

A large fire was reported at a warehouse in the Tianjin port area in the evening (about 22:50 local time) on August 12, 2015.

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The fire was in the area where dangerous goods were stored. First responders and firefighters were on the scene but unable to contain the fire. Around 23:30 a first explosion occurred that was equivalent to 2.9 tonnes TNT equivalent based on the seismic waves generated (2015 Tianjin explosions, 2020). After 30 seconds, a subsequent more powerful explosion occurred equivalent to 21.9 tonnes TNT. There were 173 fatalities and 797 people injured. Of the fatalities 93 were firefighters. The cause of the explosions was not immediately known, but an investigation concluded in February 2016 that an overheated container of dry nitrocellulose was the cause of the initial explosion.

4.Beirut (Fire and possibly Shock)

On August 04, 2020 there was an explosion involving AN at the Beirut port. The mass involved was significantly higher – 2,750 tonnes, and the explosion resulted in over 190 fatalities, injuring 6,000 and causing billions of dollars in damage. There was a preliminary explosion that was followed about 30 seconds later with the larger explosion that involved the AN stored in the port. According to the news and the official statements of the Lebanese authorities soon after the explosions, these 2750 tons of ammonium nitrate had been stored for six years in that warehouse.

The Lebanese authorities are leading the investigation and are being supported with foreign experts including the FBI and French experts. From the information released to date, the most likely cause of ignition of the fire that preceded the first explosion was welding that was carried out that day (New York Times, 2020). The article also stated that in the same warehouse there were 15 tons of fireworks, five miles of fuse on wooden spools, jugs of oil and kerosene, and hydrochloric acid.

Maritime transport and storage at Ports

Ammonium nitrate is internationally traded, and volumes moved by sea are in million tonnes per year. TGAN sea vessels will typically transport ~1,000 to ~10,000 tonnes while FGAN are commonly transported 20,000 tonnes in a vessel.

Over the decades this mode of transport has been carried out safely by following strict controls. Nevertheless, during its transport or intransient storage, if the controls are not in place the product may be exposed to threats that can result in a catastrophic event.

Published information on the explosions at the Tianjin and Beirut ports indicate that there were failures of controls for the safe storage of AN. In both events there were flammable, combustible, or pyrotechnic substances in proximity to the AN. These substances did accidentally ignite leading to a thermal insult to the AN. Since there were fireworks (New York Times, 2020), which are classified as Class 1 goods, co-located with the AN in the warehouse at the Beirut port, there may have been a shock insult as well.

Reminders and Lessons from the Recent Events

Ammonium nitrate manufacture and use has a long history, and as mentioned in a previous SAFEX newsletter, certain well-known accidents had practices from the past that are not comparable to those of today. Learnings and knowledge were gained and practices improved. The AN manufactured post-WW I or shortly after WW II is not the same product as today. Many of these products would be classified as explosives under today's UN safety regulations.

The following are reminders from the Beirut Port event:

1.Prohibition on the Co-storage of Flammable/Combustible, Explosible and Incompatible Materials

One of the principal controls when storing AN is that there should not be any flammable/combustible, explosible or incompatible materials in proximity to it. This becomes even more important when the product is entrusted to the carrier or stored under the jurisdiction of a third party, as was the case in the Beirut port.

2.Clear accountability and ownership

The Beirut event highlights the responsibility of care of all stakeholders: the supplier (AN manufacturers, who are aware of the product and its hazards), the buyer (explosive manufacturer, also aware of the product and its hazards) and the authorities. The supply chain actors will normally be less knowledgeable on the product, but they should not be less aware of the product and its safe handling. The supply chain must not be overlooked as it is of utmost importance with respect to transferring hazards knowledge to all stakeholders.

3.Compliance Checks

Auditing of operations against the SAFEX GPG or internal standards should be carried out to ensure strict compliance with segregation, safeguards, etc. This should also include assurance that the risk controls on the whole product lifecycle, product ownership and/or stewardship are in place.

In summary, when storage conditions are neglected and AN characteristics are forgotten the AN storage can become unsafe. The subsequent probability of an event can be orders of magnitude higher and the TNT equivalent can be higher as well since the product may be degraded, contaminated, incorrectly co-stored, etc. In the case of the Beirut Port explosion, the news-feeds indicate that hot work may have initiated the fireworks and other combustible materials stored in the same warehouse as AN.

When storage conditions are in conformance to either the GPG or appropriate internal standards, AN storage is safe.

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The meaning of Thermal Stability in Ammonium nitrate

by

Ron Peddie, Peddie Engineering Pty Ltd

All of us who work with Ammonium Nitrate know it normally just looks and behaves as say table salt – but we also know there is a devil in there, a demon waiting to escape, we know it can explode.

When discussion or investigations into explosion involving ammonium nitrate the concept of thermal stability is raised. This idea can be difficult to follow once lots of detail is presented but in essence it is a simple concept.

The purpose of this paper is not to examine in great technical detail of these events but to give an overview, a safety primer, on what can happen.

Part of the difficulty is the way that ammonium nitrate looks and behaves under normal circumstances.

Ammonium nitrate looks like common salt and in most circumstances that is the way it stays.

This is different to many other hazardous chemicals which are normally fuels or have some warning about their hazardous nature.

Why does Ammonium Nitrate explode?

Ammonium Nitrate can start to generate more heat than can be released, this is not the case for common salts.

If this happens the conditions for an explosive event have been created.

There must be an external heat source for this to happen. The external heat source supplies the heat to raise the temperature of the ammonium nitrate until the ammonium nitrate itself is unstable.

This is not a straightforward process, the amounts of heat required are large and the heat needs to be continually applied.

Ammonium nitrate is not susceptible to short term application of heat like a spark or even a small fire, it does not burn. In many instances it will not support a fire, if there is not a mixture of fuel to AN which is favourable the endothermic (heat absorbing) heating and melting of the AN will extinguish fires.

But if a large external fire develops and envelops the AN then the situation becomes serious.

There are several instances of large fires where virtually the only thing left is the AN

In the vast majority of incidents there are two sources of heat

1. An uncontrolled and large external fire in storage and transport
2. In process plant the application of heat to the process at too high a temperature. This is typically elevated temperature steam

What causes a thermal event?

For a thermal explosion to proceed there needs to be internal self-generation of heat

In all cases there is a critical temperature for ammonium nitrate where it starts to generate more heat than it can absorb without increasing the rate of decomposition. This tipping point temperature is what determines whether ammonium nitrate is stable or unstable. Therefore, we use the phrase "thermal stability", Below this temperature the situation is stable – beyond this point it is unstable. Once unstable the situation deteriorates with incredible speed – therefore called a thermal explosion. Only in certain circumstances.

Reaction Runaway & Thermal Stability Heat Production vs Heat Loss as function of Temperature

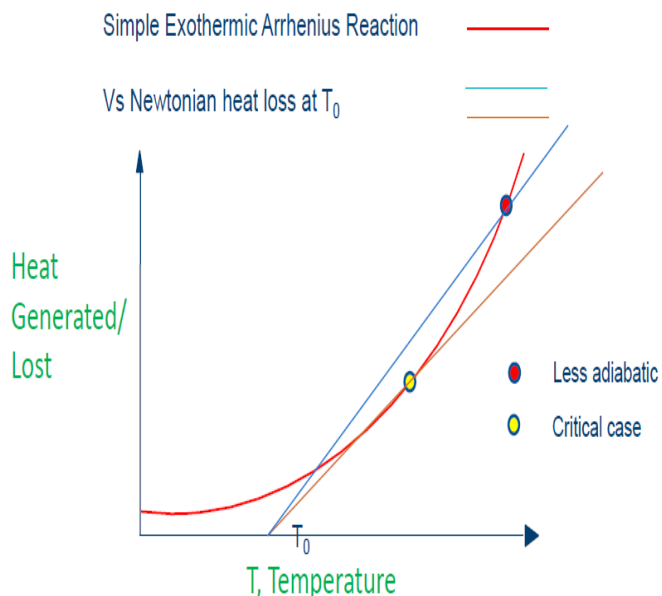


Figure 1 Description of critical temperature[1] Not a very good illustration.

Methods of testing for thermal stability

Safety research and investigation for Ammonium Nitrate is based on determining the highest stable temperature. Generally, this is compared to the value obtained for pure Ammonium Nitrate to see if some factors have made the samples being tested less stable

When investigating additives or contaminants to ammonium nitrate or in the investigation of incidents a sample of the AN is tested to determine this temperature.

A difficulty with testing for this highest temperature is that real systems are adiabatic (have little ability of lose heat) While testing methods on a laboratory scale do have the ability to lose heat.

To go back to 1st year engineering for those that have forgotten the definition of adiabatic

"relating to or denoting a process or condition in which heat does not enter or leave the system concerned."

This means that the test results may be non-conservative (give a higher temperature than the highest temperature that could be allowable in the real-world situation) . This implies that results must be treated with conservatism – so a margin of safety

needs to be applied. An extra safety margin of 20-30 °C is recommended. [3]

Examples of methods of testing AN for thermal stability

A question that could be asked is why we not test AN at full scale therefore avoid any inaccuracy in the result.

The problem is that it would be expensive dangerous and slow

Obviously if you take a large sample and run it to instability you would have to be incredibly careful about what happen. It would also only be possible to do a small number of tests and the expense and time would be large.

I sometime look at the tests that were done in the old days and think – there is no way we would be able to do that in these days – but we are very grateful we have the results.

The tests we would use are:

- Differential Scanning Calorimetry (DSC)
- Accelerating Rate Calorimetry (ARC)
- Adiabatic Dewar Calorimetry (ADC)
- DSC a quick method of screening. It is not recommended as a definitive test but is useful as a screening method as many tests can be made quickly.
- ARC a more comprehensive test but more complex – the best that can be done on a laboratory scale. It

does require a specialised laboratory with the proper technique of handling AN.

- A Dewar test where the scale is larger now requires a test range or blasting tank

I will not go into detail on these tests they are described fully in two excellent ANNA presentations [1][3]

Practical outcomes

After all this what are the things we need to do:

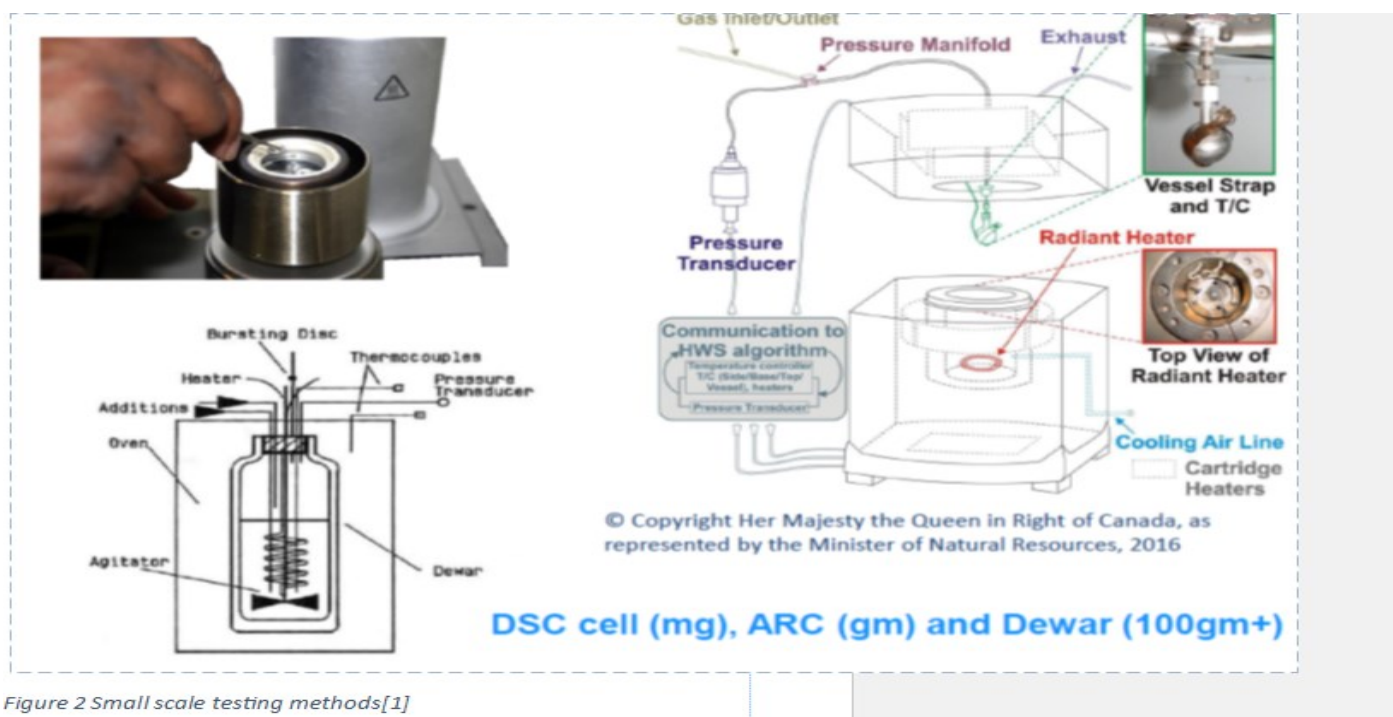
For storage of solid product, the outcome is to make sure there are no external fire sources. If there are none solid storage is entirely safe. Very simplistic view. Internal fire/decomposition is often the issue.

For the operation of manufacturing plants.

The best option is to only run with the temperatures needed so keep general heating steam at a low pressure so high temperature areas cannot develop.

If higher temperatures are needed, such as in the prilling of fertiliser grade again the temperatures are tightly controlled but also the equipment design draining, and residence times are also closely engineered

Nothing should be added to AN without knowledge of its effect on stability. If additive materials are being used the manufacturers should have an obligation not to make any changes to the formulation without consulting with their customers.



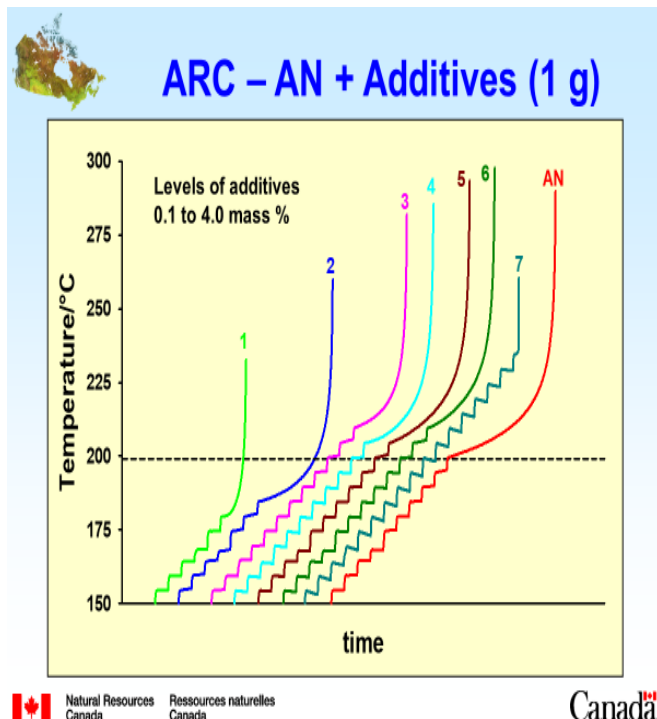


Figure 3 Example to testing on additive effect on thermal stability of ammonium nitrate [3] needs more detail – additive, quantity.

Accidents involving AN

As described any incident involving an AN explosion is a thermal event. A bit misleading – we have seen shock initiation. Need to clarify. Maybe he is just talking about AN plants?

For solid AN this means a large external fire so if the source of fire is eliminated the risk is eliminated entirely. Elimination is possible for storage by building a dedicated store built with non-combustible materials such as concrete and steel, avoiding wood and perhaps aluminium.

On process plant contamination may make an incident more likely but it will still require heat input. This typically come from high temperature steam often being supplied above the necessary temperature for operation.

If the steam temperature on process plants is controlled the probability of an incident is similarly extremely low. In the hazard assessment process checks should be made that in unusual circumstances the temperature of the steam cannot rise due to equipment failure or a transient control problem.

Almost all explosion incidents on AN process plant involve a component of overheating.

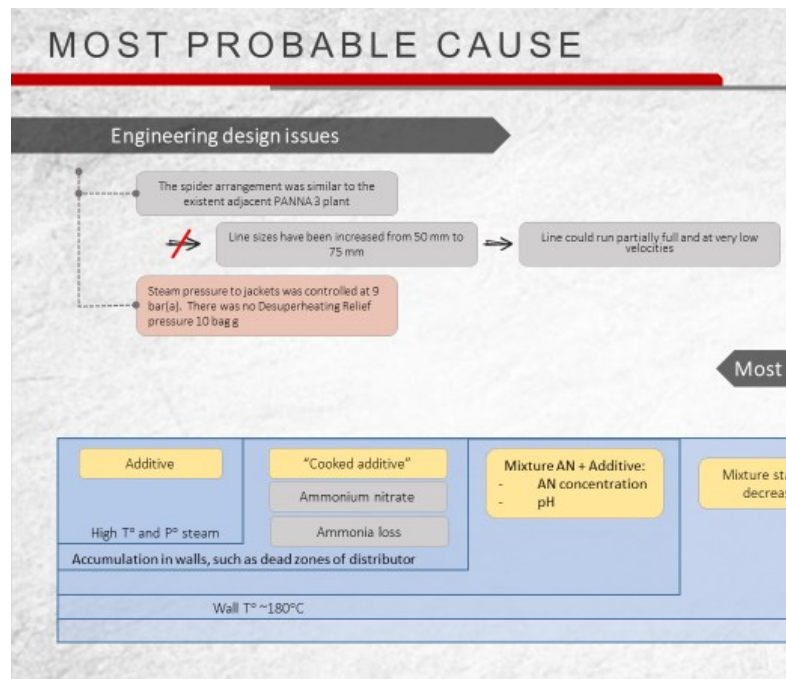


Image courtesy ENAEX

.Figure 4 Use of thermal testing in an accident investigation[2]

Conclusion

If you were writing the story of Ammonium Nitrate from scratch, you probably could not make it up. A chemical that is both an invaluable and irreplaceable fertiliser and powers the entire world economy in its use a safe explosive able to be used in vast quantities – who would believe this for one chemical.

We all depend on the production of food and raw materials – so we could say we are stuck with Ammonium Nitrate, but a better way would be to say we are lucky we have such a material.

The history of ammonium nitrate in explosives is a story of improved safety and lower costs and increased standard of living for the entire world.

The first explosives used were black powder. Nobel's invention of dynamites which are a mixture of the Nitro-glycerine and AN greatly improved the safety and usability of explosives. They were still dangerous by modern standards.

The development of Mixtures of AN prill and fuel oil in the US in the fifties and the subsequent development of slurry and emulsion explosives, which the majority component of

which is AN introduced the era of high volume low cost and very safe explosives.

We have good houses and cars eat well have all the modern technology at a price everyone not just kings can afford due the availability of low-cost materials which is predicated by low cost AN based explosive.

And this has been achieved with a huge advance in safety, Explosive production is now among the top tier of statistically safe chemical manufacturing activities.

Application of knowledge and attention to working temperatures will allow the safe manufacture and distribution of ammonium nitrate. Again a very focussed view.

I need to recognize my collaborators (or co- conspirators) over the years Richard Turcotte and Martin Braithwaite

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Truck Fire Prevention

by

Brian Devaraj – Dev Global Logistics Services, Australia

One of the main risks in an incident with a truck transporting Explosives or Ammonium Nitrate is a fire. A truck fire can completely engulf and destroy a truck within 5 to 10 minutes and may cause an explosion under certain circumstances.



The fire can be generated in a number of ways including engine or turbo fires from super-heated oils spilling onto other hot areas and igniting; electrical fires caused by sparking or short circuits; brake or wheel hub fires caused by friction; or chemical fires from contaminated or improperly stored products. There are preventive measures that must be taken before the truck is utilised, and mitigating actions that must be taken after the accident happens. This article focuses on the prevention of vehicle fires to reduce the risk to yourself and the other road users.

To reduce the risk of fire a truck driver should:

- not smoke in or within 10 metres of the vehicle at any time.
- not cook in, under or within 10 metres of the vehicle.
- keep the truck and trailer clean and free from spills, rags and other rubbish.
- drive at a safe speed to reduce the chance of an incident.
- ensure the truck is well maintained, particularly wheels, axles, bearings and any other source of friction or heat in the vehicle.
- be aware of hazards while refuelling including talking on your mobile phone.
- regularly check temperature of wheels and hubs every time you pull the truck over for a rest or service stop.
- conduct regular checks in the rear vision mirror for signs of smoke from tyres, tarps or bearings.
- drive defensively, especially around hazards, bends or areas of high traffic or population.
- ensure your load is well secured. Check it over every time you stop.
- be aware of fires in areas you may need to drive through. If you can – avoid the area. Smoke may obscure your vision and cinders blowing off the fire can quickly start fires on your truck.

QUITFIRE IN AUSTRALIA

By

Ken Price

Truck Fires

Those of you with experience in the road transport industry involving explosives or dangerous goods will be aware of the risks from truck fires and how matters progress.

They usually start after a brake drum or bearing has

overheated and the vehicle has stopped for a routine check or the driver has noticed smoke.

This is the most likely time for a fire to occur due to intense heat. The driver then runs for the fire extinguisher and empties that onto the fire. (Limited volume).

They then run back for the next extinguisher and empty that on the fire that has restarted because of the high residual heat in the fire area.

Then if time permits, they uncouple the prime mover and drive off while the load goes up in smoke. Or worse.

The regulatory authorities in Australia have recognised this and have introduced provisions in the Australian Dangerous Goods Code to allow an effective suppression medium to be carried on trucks that has been shown in practice to be more effective than conventional hand held fire extinguishers. And if the system is fitted, it may replace the prescribed portable extinguishers that must be carried in the load area.

Quitfire in Australia.

Quitfire is a proprietary product developed in the Kalgoorlie goldfields in Western Australia. It has been used on some of the roughest roads in Australia for the past 12 years and not one system has failed to work in 12 years of service.

For a video of how it works: <http://quitfire.com/>

Very simply, Quitfire is a pressurized tank of water and foaming agent with a length of hose and a foam induction nozzle. It works off the truck compressed air pressure (750 kPa) so there is ample residual pressure if the truck engine stops. It holds 60 L or 80 L of extinguishant and is good to go down to -10°C. Installation is very simple. Bolt the cabinet onto support brackets anywhere on a trailer/truck and a run a 12 mm nylon brake air line run from an auxiliary air tank (99% of trucks have these) to a push-in fitting on the tank of extinguishant. It is ready to go once filled

To actuate it, the user flips open the cabinet, opens two quick acting valves, grabs the hose and takes off to fight the fire. The foaming agent sticks to the tyre thereby cooling it. If the fire restarts there is plenty of foam and water to kill it again. (3 to 4 minutes run time)

There are currently more than 200 Quitfire systems on trucks in Australia. At least two major carriers use these systems, one being a very strong supporter of this equipment (all of their explosives vehicles are now fitted with this system) and another (who transport much ammonium nitrate in the state) is now embracing the system.

It is claimed that it has been used many times with great success but information regarding this has been

hard to obtain; many incidents go unreported due to the paperwork. However, in one documented incident the driver had a fire on one axle of his truck. What the report didn't explicitly state was that though the fire was on one axle, it was two tyres, one on each side. Both fires were extinguished.

Quitfire has been gaining acceptance from industry slowly but the restraining factor was that they were not scientifically rated, are not built to a prescribed Australian Standard and were not given any concessions with respect to the legal fire extinguisher requirements. Hence if installed the vehicle still had to carry the required fire extinguishers. This is slowly changing with the new edition of Australian Dangerous Goods Code making allowance for these types of systems.

One Australian explosives company now includes a requirement that Quitfire be on all trucks carrying their products.

They last much longer than a portable extinguisher and you can use it in short bursts which makes them really effective.

These types of systems will be beneficial for all types of DG vehicles especially those that transport DG with a fire or explosion risk.

Australian Dangerous Goods Code (ADG7.7)

Attached is an extract from the ADG Code which gives dispensation from a fire extinguisher if the vehicle is fitted with this type of system. National Transport Commission plan to conduct a full review of fire protection for DG vehicles but that will require a Regulatory Impact Study and hence a new version of the ADG Code.

The key clause is Note 4. *A foam or water firefighting system using compressed air, electric pumps or other means, may be used in place of portable fire extinguishers in the load area. The firefighting system must be operational even when the engine of the vehicle is turned off and must be suitable for the types of fire scenarios likely to be encountered with the aim of preventing the spread of fire to the load.*

PART 12: SAFETY EQUIPMENT FOR ROAD VEHICLES

Table 12.1: Minimum Fire Extinguisher Requirements for Road Vehicles Transporting a Placard Load of Dangerous Goods

Load: All types of dangerous goods packed in: <ul style="list-style-type: none"> • packages, drums, overpacks, segregation devices • intermediate bulk containers (IBCs) containing non-flammables – any quantity • IBCs containing flammables with up to (and including) 10,000 L total capacity or containing up to (and including) 10,000 kg in total
Required extinguishers: 1 x 30B dry powder that is to be placed in the cabin (see 12.1.2.5.5), or at the front of any trailer transporting a placard load

Load: Non-flammable goods packed in: pressure drums, tubes, multiple element gas containers (MEGCs), tanks, bulk containers (solids)
Required extinguishers: 1 x 80B dry powder, or 2 x 30B dry powder, in the load area 1 x 10B dry powder in the cabin (see 12.1.2.5.5)

Load: Flammable goods packed in: <ul style="list-style-type: none"> • pressure drums, tubes, MEGCs, tanks, bulk containers (solids) • IBCs > 10,000 L total capacity or containing >10,000 kg. in total
Required extinguishers: 2 x 80B dry powder, or 1x 80B dry powder and 1 x 20B foam, in the load area 1 x 10B dry powder in the cabin (see 12.1.2.5.5)

NOTE 1: In this table "flammable goods" means dangerous goods of Division 2.1, Class 3 or Class 4, or having a subsidiary hazard of 2.1, 3 or 4.

NOTE 2: In cases of combination vehicles, these directions apply to every separate trailer transporting a placard load.

NOTE 3: If more than one dry powder fire extinguisher is required in the load area, one may be replaced with a foam or water fire extinguisher of at least 9L capacity. If a foam or water fire extinguisher is used it must be suitable for the types of fire scenarios likely to be encountered and selected with the aim of preventing the spread of fire to the load.

NOTE 4: A foam or water firefighting system using compressed air, electric pumps or other means, may be used in place of portable fire extinguishers in the load area. The firefighting system must be operational even when the engine of the vehicle is turned off and must be suitable for the types of fire scenarios likely to be encountered with the aim of preventing the spread of fire to the load.

Extract from ADG Code 7.7, 2020



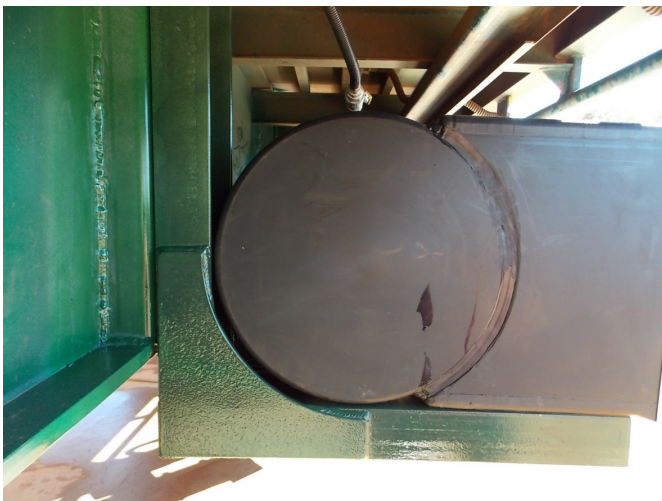
Mounted on a truck.



Showing mounting brackets.



Open, ready for deployment.



Mounting brackets and tank



Packaged for dispatch



Teaching explosives students in the time of Covid-19: Insights for life-long learning in the South African explosives industry

By

Petrus Cloete, Andreas De Beer, Heinz Schenk

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Introduction

The COVID-19 pandemic has and still is causing higher education institutions globally to devise and implement rapid strategic shifts and changes to deal with the disruptions and displacement inflicted to the full breadth of institutional endeavour of universities. As evidenced in all industries, the fault line of Covid-19 has torn apart every aspect of normal business and operational continuity and forced management of institutions towards quick and decisive action in virtually every area of activity. The list for teaching institutions included dealing with campus closures, digitization of teaching programmes and rapidly moving them online, finding new ways of communicating, supporting and meeting, devising and implementing alternative formative and summative assessments that would remain rigorous and academically

sound, empowering faculty and students to study and work from home, collaborating and sharing available scarce resources, and systemically searching for and creating solutions for what is well likely to become a new norm in future curriculum delivery.

In this article we wish to share a brief look at what such challenges meant for the students and faculty in a long-established explosives management programme serving the explosives industry on the African continent.

Background

In 2005 the University of South Africa (UNISA) introduced a new programme in explosives and ammunition sciences for supervisors and middle managers to support their competence towards maintaining and expanding South African's vast mining, explosives and well-established armaments industry. This new UNISA programme combines explosives sciences and management principles. The focus is on exit-level outcomes of graduates who will be able to manage teams and enterprise resources to ensure that the work gets done effectively, efficiently and safely. The purpose of this programme is to provide the explosives sector in South Africa and the African continent with qualified students who have sufficient technological and management knowledge to take safe technical and sound managerial decisions in an explosives-related work environment.

Explosives operations managers contribute to society by safeguarding lives and property. The occupations, jobs or areas of activity in which the qualifying learners will operate are predominantly in the commercial sector (dealing with the manufacture, quality assurance and application of commercial explosives for the mining and explosive industry).

This qualification model heralded a shift from a supplier-led approach (in which qualifications and programmes are designed by education service providers) to a more demand-led collaborative approach to programme design, development and delivery, carried out as agreed upon by an industry stakeholder consortium comprising industry representatives, regulatory bodies, training institutions and industry bodies. These resulting tertiary Diploma and Advanced Diploma qualifica-

tions are based on the principles of lifelong and lifewide learning and career paths for its learners and workforce in the explosives sector.

Lifelong learning is a form of self-initiated education that is focused on personal development, that is not restricted to a certain period of one's life but can happen anytime and anywhere. It is a continuous process initiated by teachers or workplace supervisors but directed by the learners. The acquisition of knowledge and skills in these powerful learning environments should happen through social interaction between its members. This results in a life-wide process which involves a combination or blend of events such as coaching by a line manager, engagement in work teams and panel discussions, participating in online chat groups, accessing knowledge management databases, having breakfast with colleagues, work shadowing, using job aids or performance tools, observing role models or studying independently at home.

From the inception of the explosives management programmes, the pedagogical model was grounded in a distance education model. The following pedagogical elements define the current model of delivery at Unisa:

- Admission is only open to students certified by employers to be relevantly employed in the explosives industry;
- Collaborative selection of teaching staff from industry-recognised subject field experts
- Flexibility in formative and summative assessment practices aimed at employer needs of limiting absence from work and loss of productivity.
- An essentially blended learning approach combining face-to-face tuition with open distance learning and e-learning activities.
- Student support includes the use of workplace mentors, decentralised video con-

ferencing support and e-learning tools on the my Unisa student portal.

Such pedagogical elements are found to be aligned to the principles of flexibility of support and understanding of the student body and its unique workplace demands as a conceptual framework for conducive lifelong learning environments.

Prior to the onset of the pandemic and the institution of a national lockdown in March 2020, the curriculum delivery could rely on the national footprint of Unisa with the use and access to video conferencing facilities at the closest convenient Unisa satellite campus for faculty to present from and students to attend the interactive broadcasts. Technical support in the production and recording of presentations was available to faculty, and extensive courier services ensured the logistical flow of assignments and examinations between faculty, administrators, moderators and employer training coordinators who all could be geographically dispersed over a 1000km radius from the Unisa main campus.

As a dedicated open distance-learning institution Unisa with its national and international footprint, was geared far better than many traditional residential universities to respond to the sudden imperatives to embark on digitally driven wide-scale emergency remote teaching and learning to salvage the 2020 academic year. On the other hand, however, as a mega-university serving around 400 000 students and attracting a third of all higher education students in South Africa, the pandemic-induced challenges were magnified inordinately due to the sheer size of Unisa's operations. Conditions for emergency responsiveness such as sourcing and providing work-from-home infrastructure to staff suddenly deprived of all office and campus-based resources and connectivity, delivery of learning devices and data access for students, many of which are residing in totally unconnected localities, and geographically determined logistical support co-ordination, exacerbate the constraints of Covid-19 lockdown conditions.

Specific impact on and responsiveness by the Explosives programmes

Within the academic teaching fraternity and administrative support team of the explosives programmes, emergency responses and coping strategies largely focussed on the accelerated acquisition of new digital technology skill sets in teaching and communication through MS Teams and ZOOM platforms, creating 'band-width sensitive' PowerPoint presentations, webinars and VPNs without the usual assistance of ICT support experts; the acquisition of new pedagogical skill sets geared to new assessment strategies suitable for non-venue based and non-invigilated assessment formats and, thirdly and importantly new skill sets dealing with the vagaries of social distancing, confrontations with own vulnerabilities, trial and error disappointments, emotional perseverance, and sustained commitment to student learning and success. (And sometimes the lockdown regulations enforced abstinence from alcoholic libations and tobacco-based pleasures 😊)

Happy outcomes on the teaching activities include that every Lecturer now conducts live and interactive broadcasts from their home offices, MS Teams platforms are utilised with great effect and increasing virtuosity, and lectures and webinars are recorded and students can access and revisit them at their own convenience on the myUnisa portal. Anecdotal evidence of higher levels of student engagement and active participation during lectures on the Chat facility has been recorded and student feedback on the new learning experience is generally positive.

Regarding changed assessment practices, stronger emphasis towards theory application, case study and scenario utilisation, and MCQ mixes of factual, situation-based, and analysis-based questions dominate the formative assessments.

Given the forced demise of the invigilated venue-based format of examinations due to social distancing imperatives, some alternative assessment methods that were considered, included:

- Timed online assessments - limited to a specific time frame such as three hours within which par-

ticipants should download, complete and upload the assessment online.

- Portfolios - where evidence of specific activities related to mastery of the course outcomes throughout the course is collected and then submitted as a portfolio at the end of the programme.
- Take-home assessments - where learners have a specific period to complete a range of assessment activities offline and submit the completed assessment online using a learning management system.

For the short term the timed online assessment option was adopted, with a continuous assessment model being the longer-term solution to be adopted by the university.

To meet the student needs all sorts of potential technological challenges that students could experience during the online assessments were anticipated and mitigation strategies implemented, without compromising non-negotiable integrity standards. One such contingency was the possibility of students not being able to re-submit completed assessments via the relevant channels (in the case of the explosives courses, a dedicated special e-mail address) in the prescribed time frame, due to personal or technical obstacles. Mitigating strategies included the allocation of additional time to compensate for variations in student's typing skills, compensatory uploading times, and continuous monitoring of outgoing and incoming assessment documents to and from students participating in the assessment.

Preliminary analysis of examination results for the first semester compare favourably with results achieved by previous cohorts and more in-depth institutional research will focus on the analysis of the efficacy and sustainability of the alternative assessment options. The reliance on electronic systems in the conducting and administration logistics of all examination processes and the elimination of the handling of physical scripts and their couriering to examiners and moderators has also significantly reduced the turnaround

time for the full completion of the examination cycle to the Senate approval and publishing of final results.

Conclusion

With the explosives management students representing but a tiny fraction of the entire Unisa student body, the responsiveness and robustness of solutions developed through the resourcefulness and partnering of dedicated teaching and support staff is illustrated by the unique technical feat of the success of the single largest session of 27 000 Law students having written the same examination paper online at the same time. In this period of pandemic responses there will be countless examples of human ingenuity, resilience and grit triumphing in the face of adversity and prevailing through trial and error in uncharted waters to overcome many vulnerabilities. Reflecting on such continued vulnerabilities, Unisa's prof Paul Prinsloo mused "Covid-19 vulnerabilities are not limited to students, faculty and administrative staff, but also include systems, processes, capacity, and policies". There were many examples of how the challenges faculty faced in teaching from home impacted on students who waited longer for feedback or did not get someone to respond to their queries. We saw how vulnerabilities collided and increased as our ICT systems could not handle the number of uploads, students could not get hold of faculty and faculty could not get hold of ICT. Student vulnerability is linked to, and entangled in the vulnerabilities of the lecturer, the department and institution's policies and processes, ICT and data infrastructures, and the responsiveness of systems."

How true is this in the context of your own organisation?



Did you know that - - - ? -

by Wen Yu

Did you know that explosives can behave differently to impact, friction, electrostatic hazards? Even the same explosive behaves differently when it is in different crystalline structure, particle size and shape or when it is mixed with other explosives.

2,4,6-Trinitrotoluene (TNT) is one of the most widely used molecular secondary explosives. It is valued because of its insensitivity to shock and friction, which reduces the risk of accidental detonation. However, TNT behaves differently when it is in different crystal orientations or mixed with other explosives. For example, the sublimed TNT, accumulated on the inside walls of the ventilation pipes, is in very fine needle shape crystals. It has higher sensitivity to impact, friction and electrostatic than the crystalline TNT or the flake TNT. This feature is clearly very important when undertaking maintenance work on ventilation systems in TNT or booster processing buildings.

Lead azide is another commonly used explosive that exhibits different levels of sensitivity depending on crystal type.

The mixtures of TNT with other explosives, such as PETN, have lower thermal stability than either the TNT or PETN itself under the same conditions.

It is important to understand the explosives and their properties before they are handled and take appropriate controls to eliminate the risks.

DETONATION TRAP STUDIES

By

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ABSTRACT

Methods were evaluated to stop detonation propagation in liquid and slurry energetic materials in process. Numerous concepts were evaluated and tested to prevent propagation of detonation. Numerous methods were found to stop detonation but growth-to- detonation downstream could still be possible. Criteria was also established to prevent growth to detonation.

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INTRODUCTION

In numerous processes dealing with manufacturing chemical processing and transportation of liquids or slurries, the fluids may be capable of propagating detonation. The fluid ability to detonate depends on how energetic it is when initiated, size of piping or processing equipment, temperature, pressure and velocity of flow. From the safety standpoint, prevention of detonation is the first line of defense. The second consideration is that of minimizing the potential explosion damage. This normally is done by utilizing continuous process (versus batch) methods. It becomes very critical that a detonation once initiated will not propagate throughout the process. In this paper, methods to prevent detonation propagation (normally called detonation traps) are reviewed.

METHODS

Numerous methods can be utilized to stop detonation propagation should an initiation occur in a liquid/slurry flow process. Typically, they can be divided into the following categories:

- Dilution
- Reduction of Dimensions
- Disruption of Flow Pattern
- Energy Absorption
- Flow Disruption
- Stoppage of Flow

In the following paragraphs, these will be described in more detail. They will be evaluated regarding function ability, performance, safety and reliability later.

DILUTION

By diluting the detonable fluid with other media, detonation can no longer occur. This can be done by the following means:

DILUTANT	METHOD TO REMOVE DILUTANT
Solvent	<ul style="list-style-type: none"> • Wiped film evaporators • Distillation
Water	Same as above
Other Liquids Immiscible in Detonable Fluid	<ul style="list-style-type: none"> • Centrifuge • Dropout Pots
Solid Particles	<ul style="list-style-type: none"> • Centrifuge • Dropout Pots • Screens • Filter Media

Solvent diluent will be effective for process fluids which will not be altered by them. A typical example is the use of solvents for gun propellant manufacturing. Centrifugal separation and drying of formed grains remove the solvents. Solvent extrusion processes are also used on nitramine propellant manufacturing.

Water dilution has been used for years to ship highly sensitive detonable explosives. For materials such as lead styphnate, the water barrier mostly prevents initiation of detonation, but may do nothing to prevent shock initiation and propagation. This is also true for fine grain RDX and HMX. Water separation is normally facilitated by adding water soluble solvents (e.g., acetone, etc.) which aid separations.

An example of dilution detonation trap is shown in Figure 1.

Other liquid immiscibles can be introduced and mixed with detonable fluid. The effectiveness to stop detonation will be a function of uniformity of mix (no settling out). Once reaching its destination, the mixture is passed through a centrifuge or dropout tank for separation of immiscible liquid.

Solids can be introduced into the fluid line to prevent propagation. The solids effectiveness will depend on the concentrations in fluid, size of solids, mixture of solids, solids mixing and material type.

The solids can be separated in the following ways:

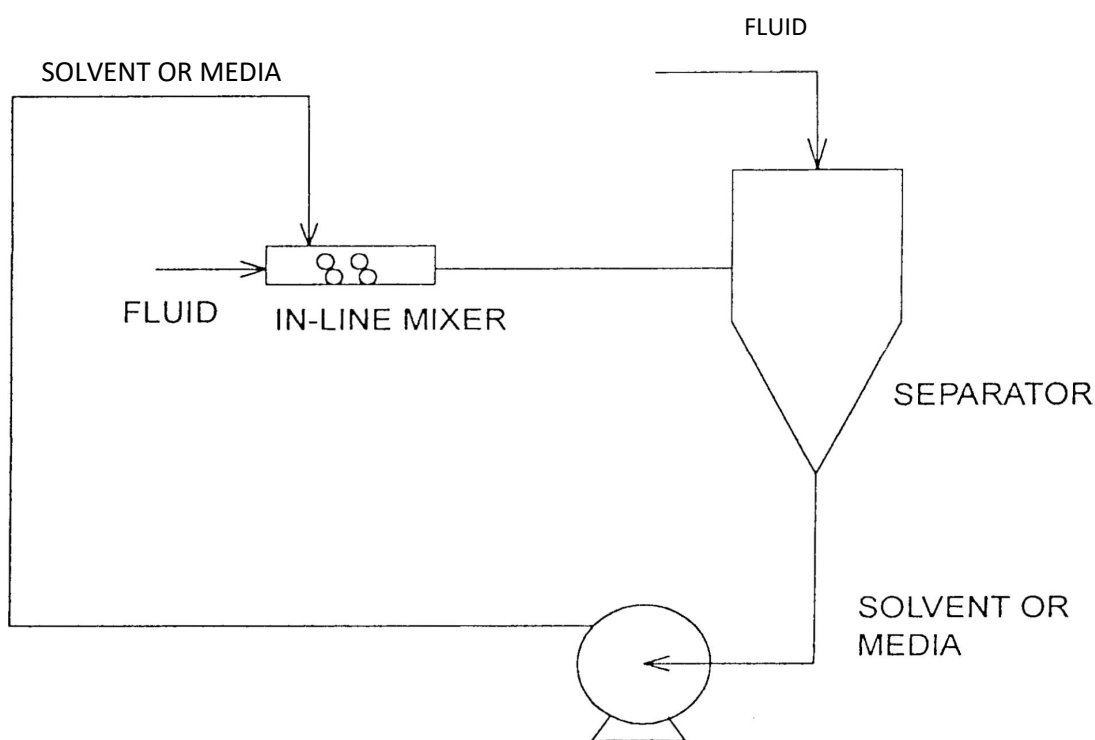


Figure 1. Dilution detonation traps

- Centrifuge
- Screen/Filter
- Rota Clove
- Settling Tank

The solids would then be reintroduced upstream in the detonable fluid.

REDUCTION OF DIMENSIONS

In previous technology, detonation traps consisted of flow being split into a series of smaller diameter sample tubes. These tube's inside diameter was so small that detonation would die out because they were smaller than critical diameter (dimension) of the explosive. See Figure 2 for an example. The length of tube bundles, wall thickness of tubes, tube material type are variables effecting the ability to stop detonation. If deflagration to detonation (DDT) transition distance is very short, it is possible, that growth-to-detonation can occur downstream of detonation trap.

DISRUPTION OF FLOW PATTERN

One way to stop detonation is that of providing ways to disrupt the detonation wave and reaction front. A few methods which will knock down a detonation front are as follows:

- Fine Mesh Screens
- Filter Media
- Packed Columns
- In-Line Mixers

See Figure 3 for examples of disruptors.

Fine mesh screens will break up the detonation wave if screen openings are way below the propagation dimensions. If the screens occupy a short travel distance in flow (~ 1 length = 1 critical diameter), the deflagration-to-detonation transfer can occur and defeat the method.

Filter media sized for the detonable flow rates can act as very effective detonation stoppers depending on the media and porosity. They may be prohibitive if process flow pressures are very low (i.e., pressure drop too great to maintain flow).

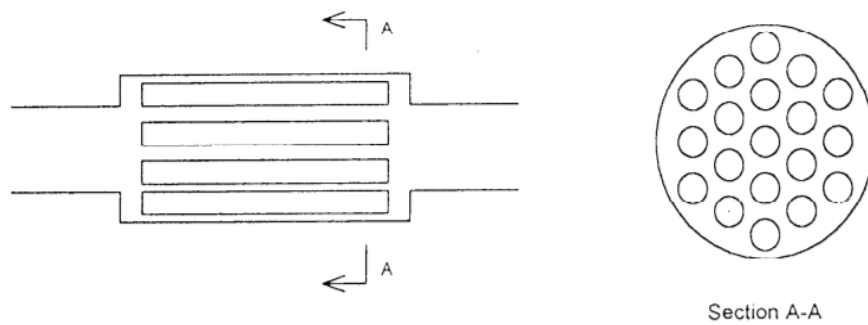


Figure 2. Reduction of dimensions detonation trap

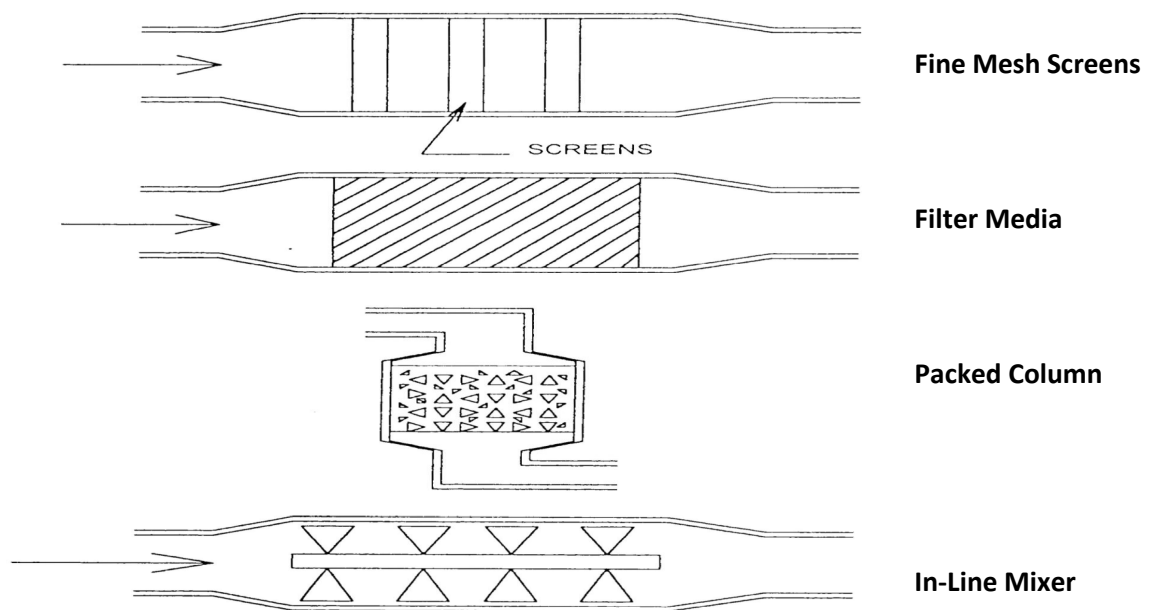


Figure 3. Flow disruption detonation tubes

Packed columns can be used to stop detonation also. The size, type, shape and material of packing will govern detonation, stoppage effectiveness. Changes in flow directions into the packed column will also aid in stopping detonation. Total liquid flooding is required in the packed column to prevent adiabatic compression initiation of fluid in the column.

In-Line Static Mixers can be used to break up detonation waves due to groove changes in fin directions (to mix flow).

ENERGY ABSORPTION

Several methods can be incorporated to absorb detonation and reaction energy to stop reactions. The following ways to absorb energy can be used:

- Fins to Transfer Heat Away
- Meltable Media
- Encapsulated Liquid Pouches

See Figure 4 for examples.

Finned sections in flow such as used to stop vapor detonations can be utilized to absorb detonation and reaction energy. The length, gap distance and material of fins will govern their effectiveness.

Meltable media can be used in trap sections, in filters or in packed columns so that when detonation hits the media, energy will be absorbed due to media heat-of-fusion loss. The meltable media could also be used for flow dilution.

Encapsulated liquid pouches could be used in-line so that when a detonation encounters the media, the liquid breaks free to stop reaction propagation. Usually, encapsulated liquid particle diameters are very small, thus, containment of the media may be very difficult.

FLOW DISRUPTION

If the detonating fluid flow is not continuous but pulsed, a detonation wave will be stopped from propagating. Typical examples are as follows:

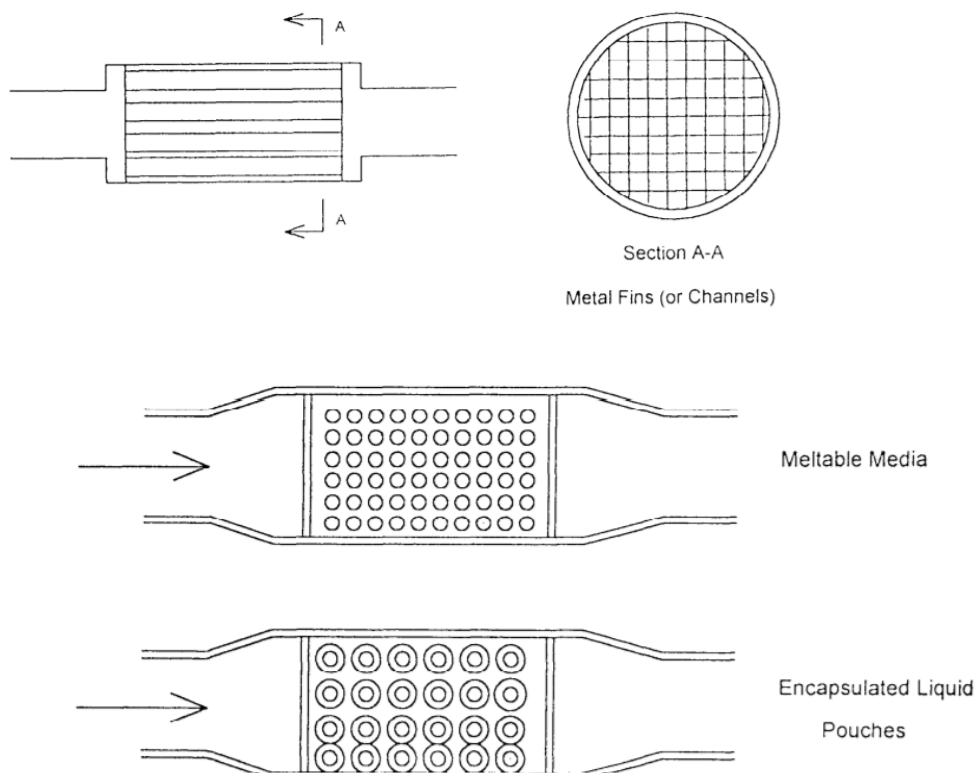


Figure 4. Energy absorption detonation traps

- Pulse Feeder
- Star Valve Feeding
- Peristaltic Pump Feed
- Diaphragm Feed

See Figure 5 for examples.

All the above methods utilize flow stoppage and separation. Certainly, potential for DDT downstream of the devices is possible. The effectiveness will be a function of pulse length and diameters.

FLOW STOPPAGE

In the past, an extensive study was conducted to develop detonation trap valves that once a detonation was sensed on a melted castable liquid explosive, an upstream detonation valve has activated stopping flow completely. See Figure 6 for illustration.

Detonation loops in pipe were evaluated for some liquid explosives which are designed to cause rupture of upstream piping prior to arrival of the detonation front. Refer to Figure 7.

SELECTION CRITERIA

Methods to prevent detonation propagation will depend on the following detonable fluid parameters:

- Fluid Critical Dimensions for Propagation
- Fluid Detonation Reaction Zone Thickness
- Heat-of-Detonation and Reaction
- Fluid and Materials of Construction Sound Propagation Velocity and Density
- Density
- Fluid Vapor Pressure, Specific Heat and Thermal Conductivity
- Fluid DDT Characteristic
- Chemical reactivity of fluid (Acid/Base)

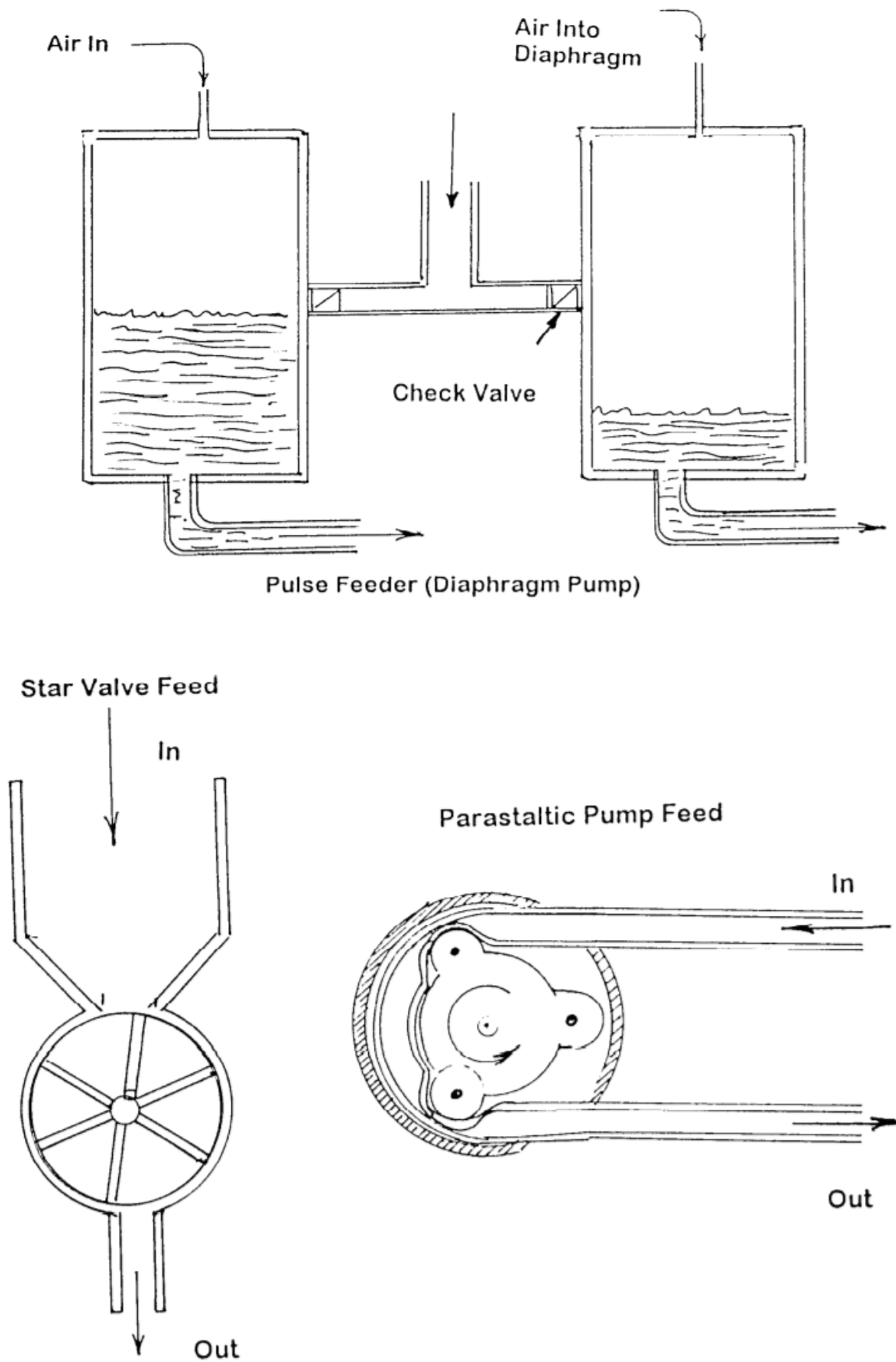


Figure 5. Flow disruption detonation traps

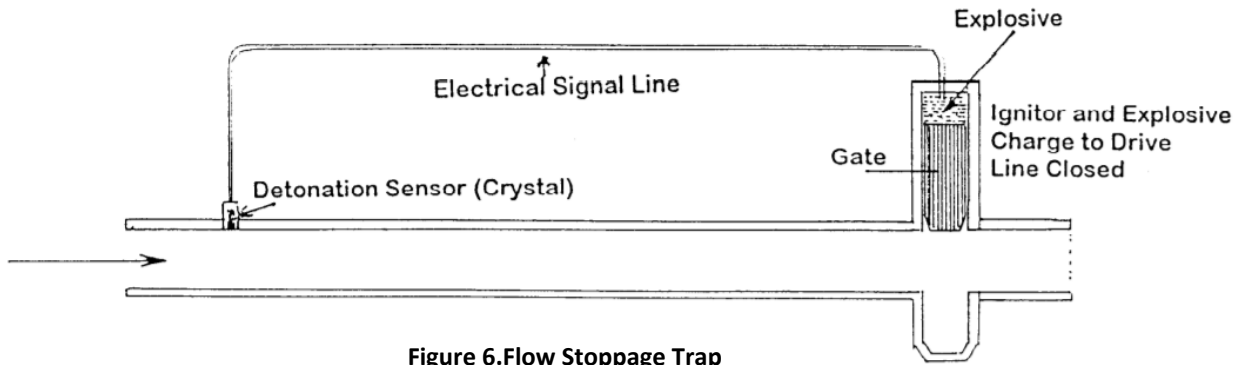


Figure 6. Flow Stoppage Trap

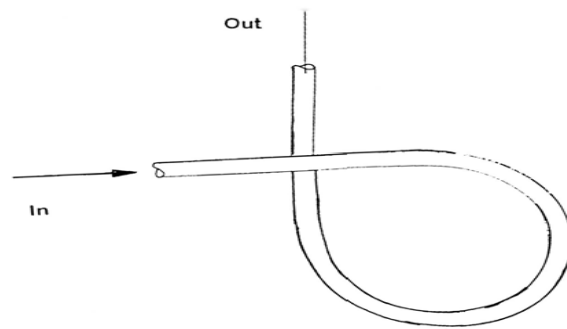


Figure 7. Detonation Loop

To optimize method selection, the following items must be evaluated and traded off:

- Simplicity
- Compatibility with Fluids
- Reliability
- Maintainability
- Safety
- Costs
- Structural Integrity
- Performance/Effectiveness

For detonable fluids that are very chemically reactive (strong acids or strong bases), materials of construction, energy absorbers and diluents must be selected which will not react or adversely affect fluid quality.

The DDT characteristics of the fluid really depend on reaction zone thickness, heat-of-detonation/reaction, sound velocity, and thermal characteristics (e.g., specific heat, thermal conductivity).

The cost, reliability and maintainability are all greatly affected by the simplicity of the design.

Detonation trap performance (i.e., stop detonation) may be satisfactory but if the reaction can build back up again, transition to detonation will occur downstream of the trap.

The fluid property characteristics will greatly influence selection of the optimum detonation trap method. Applicability of the trap method based on fluid properties is shown in Table 1.

METHOD OPTIMIZATION

Each method is then evaluated relative to the system parameters mentioned above. Ranking levels are made for each method so that the overall ranking can be made. Ranking values from 1 to 6 (1 being the best) were assigned as shown in Table 2. For one example, an overall rank was made by adding up all the ranking values for each method and finding the lowest value. For example, flow pattern disruption was found to be the best. The flow pattern disrupter also will stop reaction.

CONCLUSIONS AND RECOMMENDATIONS

Various detonation trap methods were reviewed. Criteria for selection was identified based on detonable fluid properties and system considerations. An example of method optimization was also presented. Numerous methods to stop detonation were identified. Potential for growth-to-detonation downstream exists for many of them. Thus, extreme care must be utilized to select traps that will stop both detonation and reactions. Fluids with very low critical dimensions for propagation are especially difficult to stop reaction growth (DDT) to detonation.

TABLE 1

POTENTIAL DETONATION TRAP METHODS

FLUID PROPERTY	DILUTION	DIMENSION REDUCTION	FLOW PATTERN DISRUPTION	ENERGY ABSORPTION	FLOW DISRUPTION	FLOW STOPPAGE
I. Critical Dimension						
- Small (< 5 mm)	X		X	X	X	X
- Large (> 20 mm)		X	X			
- Average (=5-20 mm)	X		X	X	X	X
II. HEAT-OF-DETONATION						
HIGH	X				X	X
LOW		X	X	X		
MEDIUM	X	X	X	X	X	
III. HEAT-OF-REACTION						
HIGH	X					X
LOW	X			X		
MEDIUM	X			X		
IV. DDT CHARACTERISTIC						
SHORT	X				X	X
LONG		X	X	X	X	
MEDIUM		X	X	X	X	X

TABLE 2

DETONATION TRAP OPTIMIZATION EXAMPLE FOR A LIQUID DETONABLE MATERIAL

FLUID PROPERTY

- Critical Dimension = 2.5 mm
- Acid Based Fluid
- Heat-of-Detonation - High
- Heat-of-Reaction - High
- Heat Transfer Ability - Low
- DDT Characteristics - Short

Ranking from 1 to 6
One being best

Optimization Item	Dilution	Dimension Reduction	Flow Pattern Disruption	Energy Absorption	Flow Disruption	Flow Stoppage
Simplicity	5	1	2	3	4	6
Compatibility with Fluids	6	1	2	4	3	5
Reliability	2	6	5	4	3	1
Maintainability	5	1	2	3	4	6
Safety	2	6	3	5	4	1
Cost	5	1	2	3	4	6
Structural Integrity	1	4	2	3	5	6
Detonation Trap Performance/ Effectiveness	1	6	2	3	4	5
Reaction Stoppage Effectiveness	2	6	4	5	3	1
TOTALS	32	32	24	33	34	37

BASIC SAFETY PRINCIPLES, FACTS AND MYTHS

IN THE EXPLOSIVES MANUFACTURING INDUSTRY THESE ARE OFTEN FORGOTTEN AND NOT PASSED ON

By

Mervyn Traut

IN THE EXPLOSIVES MANUFACTURING INDUSTRY, THESE ARE OFTEN FORGOTTEN AND NOT PASSED ON BY THE “OLD” TO THE NEW CHAPS ON THE EXPLOSIVES BLOCK.

**In the article below, quotes and facts are often drawn from articles/books written by the late Trevor Kletz.*

Dr Trevor Asher Kletz OBE, FEng, FRSC, FICHEME (1922–31 October 2013) was a prolific British author on the topic of chemical engineering is credited with introducing the concept of Inherent Safety and was a major promoter of HAZOP. Dr. Kletz, started out his career as a research chemist in the United Kingdom and quickly established a career in chemical process safety. Considered by many as the father of inherently safer technology and processes, his approach to accident investigations triggered radical changes in modern safety management thinking.

(See books written by Kletz in Addendum below. Anyone of these is a good read!!)

In the explosives industry, there has been a general move away from the use of the traditional “difficult and challenging” explosives compounds (NG-based explosives), to the more user friendly “safer” explosive’s (emulsions).

Together with this change to the safer side of production, comes the very strong impression and conviction that the standards applicable to the old fashioned explosives are no longer applicable for the Safer Modern Explosives.

This is a myth and is erroneous thinking!!

In the Bible, *Ecclesiastes 1:9*, in approximately 935BC, the wise king Solomon wrote;

“What has happened before will happen again.

What has been done before will be done again. There is nothing new in the whole world.”

In his book “Lessons from Disaster”, Trevor Kletz states that “organisations have no memory and accidents recur”. It is suggested that not only accidents but indeed errors in judgment also recur.

To illustrate the above quotations, it is safe (pardon the pun) to predict that within the next month or two or three:

- A trip will fail to operate or will be disabled by an operator.
- A seal will fail on a pump probably because it was put in incorrectly or the “new” seal was faulty.
- An operator will open the wrong valve.
- A contaminant or poor quality raw material will result in product failure.
- A plant modification will not work the way it was intended to work.
- A Certificate of Conformance for a raw material in use will not be seen or verified for the entire year.
- A cleaning procedure will be by-passed or not carried out according to the written procedure.
- Misuse of machinery by personnel and or the use of incorrect work tools etc. will take place
- Failure of personnel to detect faulty components during checking/testing operations will take place
- Failure of personnel to respond correctly to an alarm
- Rule flouting and or the breaking of rules or legislation violation by personnel and others will occur
- Vandalism, attempted burglary and even sabotage will take place

Quietly the reader in his/her mind thinks; “I’ve been there, seen it and done it”. The above very short list merely illustrates that history does indeed repeat itself in the production world and explosive’s production is no

exception and despite this we continue to make errors in judgment.

So what can be done to stop all of us and those in our Safety care, from making the same old mistakes?

Answer: recognise and assume that it is a fact that at some or other stage of your operations, these events WILL take place. Therefore IMPORTANTLY, cater wherever you can, for the fact that these will and can happen.

When we employ new persons to work on the explosive’s block, it is by and large a block that has been gone around a number of times by many people (and then we can say that there are many that have not made it all the way round the block yet!!).

This suggests that we should be able to teach these guys many lessons already learnt and not subject them to, or allow them to, make the same mistakes made by us and others who preceded them.

So how can we do this?

♦ PUT A SAFETY MANAGEMENT SYSTEMS (SMS) IN PLACE.

Myth. The most common mistake seen with SMS is that companies often develop extensive safety procedures that the workers are not aware of, care about, or use. In fact what quite often happens is that the procedures are placed on/in the Manager’s bookcase or a computer program and are rarely referred to.

Fact: TO BE EFFECTIVE AN SMS MUST BE IMPLEMENTED, ENFORCED AND KEPT AVAILABLE AND RELEVANT AT ALL TIMES. This needs to be implemented in tandem with “THE INHERENT SAFETY CONCEPT”

As explained in the Trevor Kletz book “*Process Plants: A Handbook for Inherently Safer Design*” The four main principles of inherent safety, are:

- **Intensification:** Use small amounts of hazardous materials (i.e. a smaller inventory) so that the consequences of accidents arising from the escape of materials are much reduced.
- **Substitution:** Use a less hazardous material – less flammable or less toxic.
- **Attenuation:** If a hazardous material must be used, use it:
 - under less hazardous conditions or
 - in the least hazardous form.

- **Limitation of effects:** Limit the effects of failures by changing the design or conditions of use rather than by adding protective equipment that may fail or be neglected.

The above is as relevant to explosives as it is to other chemical products.

Kletz notes in the book that most plant designers are confident in their ability to control hazards but had not given much thought to minimising inventories.

That confidence evaporated in the aftermath of Bhopal – the notorious explosion of a Union Carbide pesticides plant in 1984, which killed 2,000 people. There were safety systems in place - **but they failed.**

Despite the fact that the Kletz ideas had been discussed for almost ten years already, Kletz says that he doubts if those concerned at Union Carbide had ever heard of the phrase *“what you don’t have can’t leak”*, or the concept of inherently safer plants, which springs from it. It took this devastating catastrophe to show that reliance on safety systems **is not the safest way.**

◇ TRAIN ALL YOUR PERSONNEL

Myth: There is a misconception that our training material has been written in such a way that everybody understands it and that the training system instils discipline. A further misconception is that we then believe that this will ensure so that everyone will follow the procedures and know how to operate safely.

Fact: Training is often only carried out on the shop floor by word of mouth (i.e. by an “experienced” operator who only teaches what he remembers and what he believes is important). Training manuals are non-existent or out of date or do NOT reflect the written safe operating procedures.

We do NOT always give “new” personnel the necessary technical skills BEFORE we expect them to work on our plants?

Not all trainees are necessarily at the same intellectual level or have the same command of the language medium in which the training is given.

Discipline is seldom mentioned in training BUT INSTEAD we demand and expect it from every level of personnel.

Therefore: Training should be carried out by fully qualified trainers who are fully conversant with the requirements of the tasks for which the training is being given. This training is carried out according to up to date and accurate training manuals. These manuals are necessary to ensure that there is uniformity and consistency when

training or retraining ALL personnel. I.e. all trainees must receive exactly the same relevant information.

It is necessary that all trainees for a particular task have acquired not only the practical but also the technical skills required by that task before or during the training process.

It should be ensured that, trainees, before being appointed to a particular job/task, indeed have the communication skills necessary for the job/task.

In the process of doing this, below are just a few of those skills that need to be refined:

◇ EXERCISE DISCIPLINE

Discipline is an acquired attribute and dare one say an art and often comes with maturity. Over many years Rules, Regulations and procedures have been honed to a high degree of perfection and without fail these have been instituted for extremely valid reasons. It is mandatory that these are clear, unambiguous, documented and enforced.

Therefore it is necessary, indeed imperative before they are written or changed, to know and or research the basis for which they exist in the first place and then to challenge their validity or reasons for any change. Often, discipline in the workplace, is seen as punishment but in the workplace it is not intended to be in most cases punitive. Discipline in the workplace should follow two general guidelines i.e. discipline must be progressive and also be corrective.

Progressive Discipline:

The intent of progressive discipline is to allow an employee who displays improper or undesired behaviour, an opportunity to improve. This is normally done by first giving a verbal warning, followed by a written warning and then advanced discipline if the improper behaviour continues. Advanced discipline may be a suspension or termination.

Corrective, not Punitive:

Workplace discipline is intended to be corrective rather than punitive. Thus, verbal and written warnings should clearly state the misconduct or undesired behaviour, followed by what is needed to improve and to meet expectations. If the issue is substandard performance, employers must identify clear performance standards that must be met and additional training or support if needed.

One of the only punitive measures and employer has is termination of employment. Termination, however,

should be the last resort when progressive discipline fails.

Employees dislike disciplinary action even more than Managers do. So if everyone dislikes disciplinary action so intensely, why then have disciplinary procedures found a home in most organisations today?

What can be done to mitigate this? We need to strive towards creating, in the work environment, a culture and supervisory interactions that encourage ALL employees to develop and practice self-discipline.

Contrary to common belief, self-discipline does not mean being harsh toward oneself, but it is indeed the ability to ensure that one does things one knows you should do,

- **even when you do not want to,**
- **when it might be inconvenient at the time or**
- **only do when you are being watched.**

Self-discipline requires self-control and the ability to resist distractions and religiously follow the prescribed Rules, Regulations and Procedures no matter what.

◇ IMPROVE EMPLOYEES' UNDERSTANDING

Understanding is defined as: "The way in which someone judges or interprets the meaning of something or a subject and thus gains knowledge of the subject"

Two factors that significantly influence understanding are:

- the degree of literacy
- technical knowledge of the person being tutored and how they can adapt to and use the local jargon

Literacy:

Literacy skills are all the skills needed for reading and writing. They do include such elements such as awareness of the sounds of a language, awareness of print and the relationship between letters and sounds. Other literacy skills include vocabulary, spelling and importantly comprehension.

Normally literacy levels for the full spectrum of personnel in an organisation differ vastly and yet everyone is expected to understand the language of choice chosen for communication purposes.

As an example in South Africa, English is the first language of only 9% of the South African population with 43% speaking it as a second language. Yet most of the common language used in training and operating instructions in South Africa is English.

Is this language issue applicable in other countries? It is important that, for each situation, we are always mindful of the levels of literacy of our workforce and that training programmes and work instructions are presented in a manner that is fully understandable by the target audience.

Technical knowledge and jargon:

Not all personnel and yet alone the new employee have the same degree of Technical knowledge. When one enters a new organisation there is a plethora of technical jargon which confuses the new employee even more. Also as a "newbie" one does not have the hands on experience.

Experience in the technical field and the jargon that go with it, can be passed on via mentoring programmes and or by using Operating Instructions/ Procedures. These need to specify and qualify reasons for carrying out certain operations i.e. why things are done in a particular way or sequence and also to clarify the meanings of the commonly used acronyms.

For any of the above, the "old hands" must be involved intimately and when there are changes made, they too must be involved.

Do you remember when you acquired your driver's licence? It is most likely that you only became a really "competent" driver after some years of experience. Having Technical qualifications is most often only an entry pass and further development and training in your chosen field of endeavour is essential.

◇ **THE RITES OF PASSAGE TO RUN AN EXPLOSIVES PLANT.**

Definition: "Rites of passage usually involve ritual activities and teachings designed to strip individuals of their original roles and prepare them for new roles"

In the explosives environment, one can think of these Rites as a passage followed where the incumbents once they have accepted that they;

- do not know it all
- willingly learn from those who have been round the block,
- walk the block themselves and build up their own experience
- learn the necessary technical skills

- learn to walk the talk
- become competent in exercising discipline in the workplace and
- learn to exercise self-discipline:

they are given “permission” to actively be a part of the explosives fraternity.

Remember always that you have to **earn** the right of admission and not gain it **only** by way of your qualifications or your status.

Quote from G S Biasutti in his book “History of Accidents in the Explosives Industry”

“All accidents (sic mistakes) can be avoided by preventing their occurrence. This presupposes that the persons who are responsible for design, construction or operation of the plant must not only have **the knowledge of the potential hazards (sic pitfalls) and the way to prevent them, but also the power, the ability and the authority to enforce the rules by demanding discipline and sense of responsibility from everyone concerned.**”

◇ Some more myths and facts

MYTH

Restructuring of resources always results in a more effective and efficient operational system i.e. Layoffs Improve Bottom Lines

FACT

Layoffs should be better known as “liquidating human assets” in other words, we are trading skills, experience, future capability and competitive advantage for short-term cash and long term disaster

MYTH

Operating instructions are carried out in exactly the same way on night shift as on day shift

FACT

There are not too many managers that can hand on heart say this.

If you as managers believe they are indeed the same, then ask yourselves the question; how do you know and when last did you check?

MYTH

Investigators often identify people as the problem of

many incidents and human error as the root cause

FACT

Well, sometimes they are, probably, because people make mistakes. One can choose to stop there. For organizations, it's often a solution to a problem. A very cynical solution, but it's a reality one should be aware of.

For many organizations, a solution to an accident is to apportion blame and figuratively speaking, throw somebody under the bus and then move on.

Things to change or improve upon

- Investigations that are carried out by inexperienced personnel.
- Accident investigations that have identified only a single cause
- Accident investigations that are superficial
- Human error is the cause and someone is to blame
- Recommendations in reports that are difficult to implement or impossible to eliminate.
- Recommendations for changing procedures instead of designs.
- Reports that have been written to “save the company image” (so we cannot learn from the true mistakes made).
- Forgetting the lessons learnt resulting in the accidents happening again.

MYTH

Instead of battling with a safety issue, you can pass on the process to an outside contractor so the problem is no longer yours.

FACT

Subcontracting your risk does not make it go away.

In fact the control of the problem is lost but the liability still remains in your court (pun intended).

QUESTIONS FOR THE READERS TO ANSWER FOR THEMSELVES.

1. Do we spend enough effort in ensuring that everyone understands the questions and knows the answers asked regarding our specific operations?

2. Do we inculcate discipline and demand and expect it from every level of personnel?
3. Do we ensure that we give “new” personnel the necessary technical skills before we expect them to work on our plants?
4. As a supervisor do you wear a different standard of clothing from your workers when you visit the plant?
5. Have you turned a blind eye or walked past an operator or colleague doing the wrong thing?
6. Do you give instructions verbally and generally in your home language?
7. Do you consider small deviations from procedure in a less serious light than large deviations from procedures?
8. Do you as an experienced person walk into an operating house and sense that something is amiss and then leave before identifying it?

Each operating procedures defines the Basis of Safety for that operation?

ALL decontamination (not desensitisation!) procedures are fully documented and enforced?

How do you handle temporary repairs? Is the change proposal system followed?

Do you have temporary repairs on your plant that have become “permanent”? Remember Flixborough!

Do you include in the change proposal system, changes to operating procedures, operational changes from 1 shift to two or three and positional changes to key personnel?

Do you adjust your scheduled maintenance frequencies when making operational changes from 1 shift to two or three?

How many of these could you answer “YES” to and how many of these issues are at least worth a second thought and review?

AND NOW

Why do you think these have been put in place and how are they being monitored/controlled?”

- Loose article lists
- Operational licences
- Licence circles (Safety Distances)
- Personnel Licences
- Operating procedures (How are changes to

these controlled?)

- Clothing and cleaning equipment standards
- PPE standards and the use thereof
- Maintenance and Engineering standards (How are these controlled and do they meet statutory requirements?)
- Modification/change proposal procedures
- Hazard studies and Risk assessments

How many of these did you not know the answer to?

LEST WE FORGET

BELOW ARE BUT 3 INCIDENTS TO JOG YOUR MEMORY

SIERRA BOOSTER PLANT NEVADA USA 1998 4 KILLED 6 INJURED



SOME OF THE FINDINGS

- Process hazard analysis (PHA) conducted by the facility was inadequate.
- Training programs for facility personnel were inadequate.
- Written operating procedures were inadequate.
- The facility was built with insufficient separation distances between operations and the design/construction of buildings was poor

PIPER ALPHA OIL RIG 1976 (167 DEATHS)



Just 2 of many findings:

Permit to work and isolation for maintenance

The permit to work system on Piper Alpha relied heavily on informal communication.

The Cullen inquiry asked four questions of the permit to work system:

1. Was the procedure adequate?
2. Was the procedure complied with?
3. Was there adequate training?
4. Was the procedure monitored?

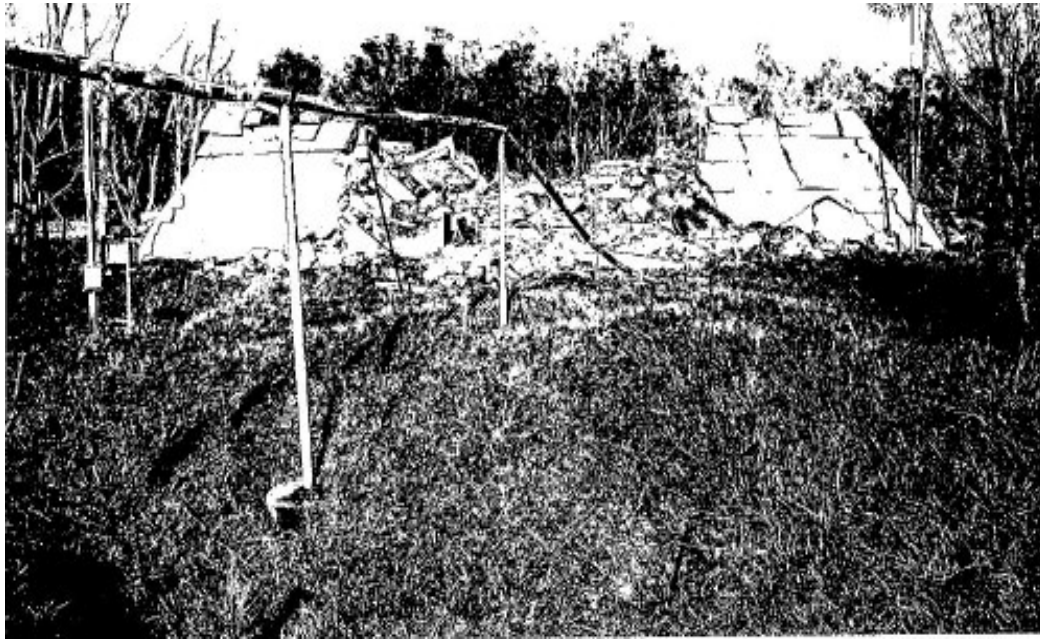
Safety culture (complacent — everything's fine)

The Cullen enquiry recognised that:

- the primary responsibility for safety lies with those who create the risks and those who work with them, in other words with the management and operators of an installation;
- safety management systems should be developed by the management and operators of the installation themselves, in order that they identify with the system and make it work;

critical safety procedures must be checked to see how they work in practice: auditing must include what is actually done and not just what is meant to be done or said to be done.

01-06-1962 A SERIES OF EXPLOSIONS OCCURRED AT THE NG PLANT AT THE AECI SOM-ERSET WEST FACTORY



SOME OF THE FINDINGS

- The golden rule broken. Poor stock control/unable to account for workers
- Basis of Safety (BoS) principles were not adhered to.
- Control of loose articles was poor.
- There was a poor choice of materials of construction for machinery and buildings using rails and for mound supports, S/S for the cock, bricked walls for mounding, and glass bottles in the explosives buildings.
- Cleaning procedures were inappropriate
- Undue splashing and spilling of NG
- Clearance to work procedures violated
- Emergency exits were locked.
- Maintenance and engineering practices were poor.
- Changes had been made to plant and equipment without the necessary authorisation and or due diligence.

LAST BUT NOT LEAST

BEWARE!!!!

**SOMETIMES WE GRADUALLY ACCEPT A LOWER
STANDARD OF PERFORMANCE UNTIL THAT LOWER
STANDARD BECOMES THE NORM!!**

ADDENDUM

Books by Trevor Kletz (sole author)

- *Cheaper, safer plants, or wealth and safety at work: notes on inherently safer and simpler plants* (1984) IChemE [ISBN 0-85295-167-1](#)
- *Improving Chemical Engineering Practices: A New Look at Old Myths of the Chemical Industry* (1989) Taylor & Francis, [ISBN 0-89116-929-6](#);
- *Critical Aspects of Safety and Loss Prevention* (1990) Butterworths [ISBN 978-0-408-04429-5](#);
- *Plant Design for Safety – a user-friendly approach* (1991) Taylor & Francis [ISBN 978-1-56032-068-5](#);
- *Lessons from Disaster – How Organisations Have No Memory and Accidents Recur* (1993) IChemE [ISBN 0-85295-307-0](#);
- *Learning from Accidents* (1994/2001) Butterworth-Heinemann [ISBN 0-7506-4883-X](#);
- *Dispelling Chemical Engineering Myths* (1996) Taylor & Francis, [ISBN 1-56032-438-4](#);
- *Process Plants – a handbook for inherently safer design* (1998) Taylor & Francis [ISBN 978-1-56032-619-9](#);
- *What Went Wrong? Case Histories of Process Plant Disasters* (1998) Gulf, [ISBN 0-88415-920-5](#);
- *Hazop and Hazan* 4th ed (1999) Taylor & Francis, [ISBN 0-85295-421-2](#);
- *By Accident... a Life Preventing them in industry* (2000) PFV, [ISBN 0-9538440-0-5](#);
- *An Engineer's View of Human Error* 3rd ed (2001) IChemE, [ISBN 0-85295-430-1](#);
- *Still Going Wrong: Case Histories of Process Plant Disasters and How They Could Have Been Avoided* (2003) Gulf, [ISBN 0-7506-7709-0](#)
- *What Went Wrong?: Case Histories of Process Plant Disasters and How They Could Have Been Avoided* 5th ed (2009) Butterworth-Heinemann/IChemE [ISBN 1-85617-531-6](#);

Books by Trevor Kletz (joint author)

- Trevor Kletz, Paul Chung, Eamon Broomfield and Chaim Shen-Orr (1995) *Computer Control and Human Error* IChemE, [ISBN 0-85295-362-3](#);
- Trevor Kletz, Paul Amyotte (2010) *Process Plants: A Handbook for Inherently Safer Design* 2nd ed, CRC Press [ISBN 1-4398-0455-9](#);

The Executive and Safety management

Or

“What can I do to make our company safe”?

By

Andy Begg

“Safety is our top priority”

“Nothing is so important that it cannot be done safely”

“The most important thing is that we all return home, safely, every day.”

These are typical statements that companies make when asked about their values. They will often be found on company web pages in bold type. They might be used on company documentation and correspondence. These statements are quite simple and very clear. They all say that Safety is important or particularly important, very, very important even.

They are all very easy to say. But this does not mean that the achievement of “Safety” is easy.

The top Executive in a company will often sign the Safety Policy for the company or group of companies. When asked they will say “Yes, Safety is very important to me and our company. I want our people to be safe”. They will be genuine; they will not want their employees to be injured. But does that person really understand how the goals or targets of that policy will be achieved or do they leave it to “the others” to deal with it?

Safety performance is in many ways no different to any other measure of performance in a company. In finance there could be targets for fixed costs, sales value, margins, maintenance costs, project costs and so on. In sales and marketing there will be targets for market share, prices, sales values, and volumes etc. Similarly, in Operations or Production there would be relevant performance measures.

The Executive would not rely on the financial performance of their company just to “happen”. They would know what the budget was. They would know what actions were underpinning the achievement of that budget. They would be reviewing performance on a regular basis and ensuring that those with responsibility were taking any necessary corrective actions. They would require their managers to tell them promptly of any events that were going to affect the attainment of the budget – or any sudden opportunities to improve on the budget. They would ensure the resources were there to make things happen. There would often be rewards or consequences based on actual performance.

The same should apply to Safety.

However, where Safety differs is that if a goal is not met, a person in the company may suffer an injury or even death. This is not just a statistic or a blip on a graph. It could be a livelihood ended or a family shattered forever. There will be impact on the company also - but nothing to compare with the impact on the person and their family. Safety is not just important – it is a right for every employee.

So, what can the Executive do?

Follow up. That is it. The Executive just must follow up. Simply signing the Safety Policy is not enough; they must follow up on what it means and on how it is to be implemented. Just as in understanding the financial performance where they will be part of the budgeting process, approving the goals and actions and routinely following up, they just need to do the same for Safety.

So, the Executive has to **follow up** and here are some suggestions:

Behaviour

They will demonstrate the importance of Safety Management and performance as key components of the overall business success. They will do this by being aware of significant Safety issues and actively following up on them on a regular basis. They will agree and monitor key Safety objectives of their Executives in support of the overall business goals and require them to be able to confirm that they also have similar monitoring and action systems in place and being implemented.

Here is a Safety self-audit for Executives. Why not try it? Ask your managers to participate also.

Executive Checklist for Safety Commitment

- Do I view our successful implementation of our company Safety procedures and achievement of Safety performance targets as a personal requirement?
- Are full implementation of Company Safety procedures and continuous improvement in Safety performance key components in our business strategic plan?
- Do we have timetables for the full implementation of Company Safety systems? Do I regularly evaluate progress with my managers and take any necessary action?
- Do I routinely factor Safety management requirements into the business planning process?
- Do I behave in a manner consistent with the importance that I state Safety to have in my business?
 - ◆ Do I regularly visit work locations and informally discuss Safety with employees?
 - ◆ Am I able to identify unsafe conditions and do I take positive action?
- Am I aware of our business Safety performance and how it compares to our targets and to our industry peer group? Do I require prompt remedial action to be taken to address shortfalls in monitored Safety performance and do I openly recognize good performance?
- Do I regularly discuss our business commitment to continuous performance improvement both internally with employees and externally with key stakeholders including government officials, educators and plant community representatives?
- Do my managers understand our Company Safety management systems and their implications to their business? Do they require regular progress reports from their departments?
- Do my managers discuss Safety internally and externally? Am I satisfied with their feedback?
- Am I responsive to requests for personnel and other resources to meet requirements?
- Do I ensure that we will not compromise Safety performance or standards for business improvement? Are my managers supporting this?
- Have employees agreed Safety performance targets and are they evaluated against these targets?
- Do I recognise achievement in relation to actual performance? Are there consequences of failing to reach targets?
- Are management systems established to support the goal of full implementation of Safety systems? Are they regularly monitored and updated to reflect changes in our operations and organisation? How do we verify these systems?
- Do I participate in or support any industry Safety forums?
- Are Safety messages regularly communicated to employees, stakeholders and other external audiences?
- Do I publicly proclaim our commitment to 'Earn stakeholders' Trust' through continuous improvement in Safety Performance?
- **Do I follow up?**

Reflections on 15 years as an Independent Explosives Consultant

By

Michael du Plessis

Major Hazard Facility Safety Case report writing

I have worked in the commercial explosives industry since 1982 when I joined AEL in their research Department in Johannesburg South Africa. After a very enjoyable and fulfilling career working in various R&D and technical management roles in ICI and Orica, I left the security of corporate life and commenced working as an independent explosives consultant in 2006. My decision to move on from Orica in Sydney was by mutual agreement and I am forever grateful to Orica on how well my departure was managed.

This was a leap into the great unknown. As a technical specialist in a niche industry sector, it wasn't clear to me whether there would be a need for my services. I have since learnt that it is better to be a specialist rather than a generalist. One advantage in having specialist skills, consulting in a niche sector like commercial explosives is that there will be less competition from other consultants!

You may ask why would anyone want to become a consultant? It is a much maligned profession. It seems, the larger the consulting firm and the larger its reputation, the greater our distrust. This is where the opportunity for an independent consultant lies, by placing service to the client as your single-minded purpose. It's not about corporate reputation, branding or office politics. Your aim is to help people and solve problems. In doing so you can contribute to the world, make friends, and gain a great deal of personal satisfaction.

Over the last 15 years, most of my consulting work in Australia has been for small or medium-sized explosives manufacturers, blasting service providers and transport companies. Most of these firms are privately owned. The business owners are entrepreneurial and survive in the market by being flexible and responding rapidly to customer needs. Their small size often limits their ability to employ technical specialists and this is where consultants can help, providing specialist technical and safety related expertise. The consulting assignments I work on typically cover the following broad areas:

- Explosives awareness, best practices and basis of safety (BOS)
- Explosives licencing and regulatory compliance
- Hazard studies and risk assessments
- Safety and operational audits
- Safety management system development, documentation and procedures

I am a chemist, not an engineer, so I avoid providing advice on process engineering or plant design. I have picked up a broad understanding of these aspects of explosives technology and manufacturing however, if advice is required in these areas, I refer the client to a specialist with explosives engineering knowledge and experience. I also use other specialists for more specialised aspects of risk assessment and engineering including quantitative risk assessment (QRA) using tools like IMESA FR.

So, what have I learnt as an independent explosives consultant over the last 15 years?

Personal relationships are everything.

I have maintained personal relationships with friends and colleagues across the global explosive industry. These are people that I have worked with over the years and others that I have met through my consulting work.

There is an old saying: *"it's not what you know, it's who you know"*. You can't know everything and a strong network of colleagues that I can call on for advice and information is vital. In consulting, knowing things is less important than knowing where to find things and whom to ask. I continue to work proactively on these relationships by keeping in touch with colleagues and sharing useful information with them.

It has been enormously beneficial being a member of the SAFEX Expert Panel. This has given me access to SAFEX Good Practice Guides, publications, and the broader network of SAFEX members and expert panel members. SAFEX incident reports and the incident database have also allowed me to provide useful safety information to my clients. The ability to access this rich trove of information is invaluable to small and medium-sized explosives companies that may not meet the SAFEX membership criteria or cannot afford the membership fees. SAFEX members may not be aware of benefits of allowing health and safety information to be shared with the broader industry in this way.

One of the most satisfying parts for my consulting work has been the relationships and friendships that I have built up with my clients. I have got to know many of them on a personal basis, met their families and stayed in their homes while travelling on assignments. These friendships have endured long after assignments have been completed and business owners have moved on to new endeavours or retired.

Be generous with your time – don't think like a lawyer

Don't think like a lawyer and charge the client for every minute of time. Don't charge for every phone call, email or

letter. Be generous with your time. Its lonely being an owner or manager of a small to medium-sized business. Clients really appreciate the opportunity to use you as a sounding board without the worry that the clock is ticking during the call or meeting and that the bill will soon follow.

I also make time for other consultants that want to chat about issues or problems. I have learnt that if I am generous with my time, they will be there to help me if I have a problem or need advice.

Leave the corporate mindset behind

Having worked for a long time in large corporations I had to change my thinking when working with small and medium sized firms. Owners of small and medium sized firms are not interested in corporate jargon, complex systems and long-winded policies and procedures. The business owners I work with are practical down-to-earth people that come out of the manufacturing, mining, quarrying and transport sectors. They are hands-on, “no-nonsense” people that want advice and solutions that are practical and fit for purpose. Keep it simple.

Avoid conflicts of interest – stay away from the commercial side of the business

There are a relatively small numbers of firms in the commercial explosives sector. To be a successful consultant you will need to work with firms that compete vigorously with each other in the market. For this reason, I have been careful to confine my services to explosives safety advice which is not commercially sensitive. This is also been helped because the culture of the explosives industry is to share safety management methods, best practices, and information. It is inevitable that you will learn about the client's customers, cost base and profitability. Business owners may want to discuss these aspects with you, particularly if they are under financial pressure. I am always happy to listen but don't give advice on commercial matters. I never share confidential information or sensitive commercial information with my other clients. I am also upfront with clients and let them know when I am working with any of their competitors. Clients appreciate this openness and transparency and I have seldom found this an impediment to winning work.

Make complicated things simple

A large part of my consulting involves assisting clients to obtain operating, storage and transport licences from regulators. Traditionally explosives regulators have come from mining, the explosives industry, or the military. However, in recent years many experienced regulators have retired and there has been a loss of knowledge of the commercial explosives industry.

New people have been hired from diverse industry backgrounds including petrochemicals, oil and gas and chemicals. It is now more important than ever that submissions to regulators are presented in a way that avoids explosive industry jargon and provides clear and simple descriptions of processes, control measures and safety systems. I have found that some risk assessments or hazard studies written by engineering consultants are difficult to understand unless you are specialist in the field. This is where the consultant can help to interpret information and recommendations and present them in a way such that the regulator can easily understand it and approve the licence application.

There is another benefit of keeping things simple. It makes communication to employees and other stakeholders much easier. This is a requirement of many Australian licensing schemes including Major Hazard Facility (MHF) licensing.

Keep in touch with industry trends and community expectations

Explosives standards and regulations change relatively slowly. What does change is the way regulators may interpret standards and regulations. It is important to be aware of the trends in the external regulatory and political environment. What was acceptable in the past may no longer be acceptable today. Community expectations of safety and risk change much more quickly and are driven by major incidents and incidents all over the world. The Beirut AN explosion is a case in point. Regulatory and community concerns about AN storage is now very much in focus on a local level and is likely to have a significant impact of the way regulators assess the risk of AN storages.

Over the last 15 years some of the more important regulatory and community trends include:

- The threat of terrorism has required higher levels of explosives and AN transport and storage security, and security clearances for personnel with access to these materials
- Regulators are requiring more rigorous and detailed hazard studies, risk assessments, safety systems and operating procedures
- Increased frequency of inspections and compliance audits by regulators
- Use of IMESAQR as a sophisticated QRA tool to assess risk of manufacturing and storage facilities. There is a growing use of IMESAQR by the industry. Unfortunately, not all regulators are convinced of its scientific validity.

This remains a challenge for the industry.

- We have a much more consistent and agreed approach to the storage and handling of ammonium nitrate emulsions (ANE – UN3375). The codes of practices developed by the Australian Explosives Safety Industry Group (AESIG) have been widely adopted by all regulators in Australia. AESIG Codes of practice have been referenced as a valid standard in regulations in many jurisdictions.
- Modern communication and social media mean that news of disasters such as the West Fertiliser AN storage explosion in Texas and the Beirut AN explosion can rapidly escalate on a local level and lead to heightened levels of community concern. Community concern and political pressure is starting to have an impact on the way regulators view risk minimisation vs. the consequence of an incident. The trend in some jurisdictions is for regulators to give more weight to the consequences of an incident even if the risk has been assessed as being acceptable.

The biggest challenge facing the industry today is the regulation of ammonium nitrate (AN) storage

Ammonium nitrate is a critical raw material that underpins the entire commercial explosives industry. This material has been widely studied and we have a high-level understanding of its chemical properties. The explosive properties of AN are much more uncertain and a source of debate (ie things like TNT equivalence, sympathetic detonation of adjacent stacks). There is also not a globally consistent view of how AN storage risk should be assessed. The explosives industry needs to close these knowledge gaps with solid scientific evidence as a high priority, particularly in the light of increased community and regulatory focus on AN storage following the Beirut disaster.

Further reading

This is the best book on consulting that I have read:

The Consultant's Calling. Bringing who you are to what you do.
Geoffrey M. Bellman, Jossey-Bass Publishers, San Francisco USA.

<https://www.amazon.com/Consultants-Calling-Bringing-What-Revised/dp/0787958476>

EU standards for explosives for civil uses:

Review of existing standards, upcoming work, and state of art of on-site explosives manufacturing units

By

Emmanuel Baudet (EPC Groupe) ;Lionel AUFAUVRE (INERIS) ;Alexander Von Oertzen (BAM)

In September 30, 2019 the European Commission (EC) adopted the Implementing Decision "C (2019) 6634 final". In short, this decision requests the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (Cenelec) to draft new harmonized standards in relation to Directive 2014/28/EU for explosives for civil uses. The Standardization Request from the EC was accepted by CEN and given to CEN/TC 321 "Explosives for civil uses" which scope is *Standardization of explosives substances and articles, including safety requirements, terminology, categorization and test methods. Pyrotechnic articles and ammunition are excluded, and explosives intended for use by the armed forces or the police are also excluded.* The original structure of the CEN/TC 321 was redesigned, to better fit the work programme and the given deadlines of the standardization activities, in two working groups as follows:

- CEN/TC 321/WG4 - Detonators and relays (Convenor Mrs Veronica Andersson – Secretariat SIS)
- CEN/TC 321/WG6 - Explosives and propellants (Convenor Dr Alexander von Oertzen – Secretariat AFNOR)

Where the given programme mainly concerns the revision of more than 50 standards, it also includes the drafting of two new documents:

- A European standard based on CEN/TS 13763-27 to cover electronic detonators including remote firing systems (allocated to WG4); which is based on previous Technical Specification works,
- A Technical Specification on assessment of on-site mixed explosives and associated manufacturing units (allocated to WG6), which helps to determinate whether a new EU standard would be possible and relevant,

Interestingly, although there are existing documents produced by national regulators or industry representatives and covering some aspects of on-site mixing of explosives, the later document will be the first initiative to produce an international (at EU level) standard-type document on the subject. The WG6 set up a dedicated Task Group called "TS On-site mixed explosives" and lead by Emmanuel Baudet from EPC Groupe to handle the specific work during the period of 36 months. The TG is in an early phase of preparation and all contribution may be valuable. Official participation to the actual CEN is limited to CEN members but it should be always possible for international explosives manufacturers groups to be involved through their European national subsidiaries.

IATG now available in French and Spanish

By Hans Wallin

SAFEX Newsletter are pleased to inform that the full set of the **International Ammunition Technical Guidelines (IATG)** are now available in **French** and **Spanish**.

<https://www.un.org/disarmament/un-saferguard/guide-lines/>

As a reminder, the IATG are also available in Arabic, English, Portuguese and Russian. A few modules have also been translated to German. The IATG were translated to these critical languages – French and Spanish--with generous funding provided by Germany and Switzerland.

Please also note that the IATG are currently undergoing a thorough update, as per the ISO guideline to update such guidance every 5 years. The UN SaferGuard Technical Review Board is fully seized of this undertaking. Therefore, **Version 3 of the IATG** will be available in **early 2021** at which time the respective updates will also be translated to French and Spanish.

For more info please contact hans.wallin@cesium.se

FIGHTING ELECTROSTATIC HAZARDS

By

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Introduction

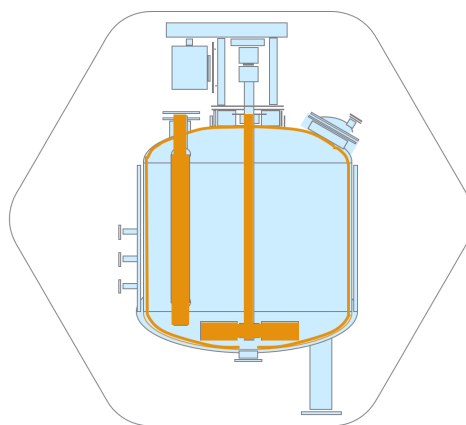
Electrostatic charging can occur when solids or fluids move relative to the plant they are contained in or charged by in-

duction. Electrostatic charging therefore occurs frequently in industrial process plants. If charge can accumulate and discharge, an electrostatic hazard may arise. A static related incident can cause a serious fire or explosion.

Where explosion risks cannot be removed, electrical sources of ignition should be managed beside other actions by design of equipment avoiding hazards due to static electricity by bonding all conductors together and to ensure potential equalization.

Glass and Glass Lined Equipment ^[1]

Glass and Glass Lined Equipment is widely known as electrical isolator under normal conditions. Stirring solids in nonconductive solvents using conventional glass or glass lined reactors can lead to electrostatic charging of the product. When flammable gas mixtures are involved, this static electricity can result in tremendous problems.

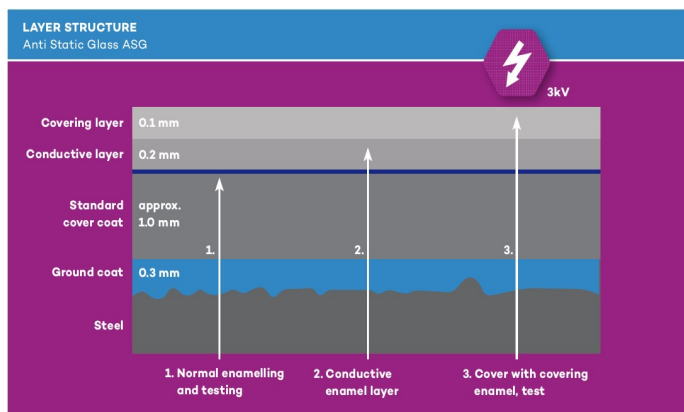


Glass Lined Equipment

The electrostatic charge problem can be solved using **Pfautler AntiStatic Glass® (ASG)**. Electrical charges are diverted due to its special surface without causing any damage.

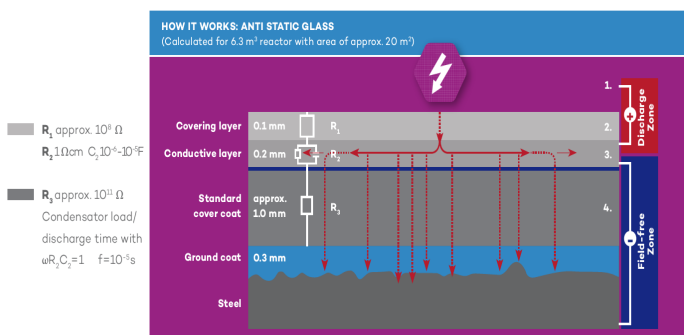
The distinguishing feature of **Pfautler Anti Static Glass® (ASG)** is its layer structure. This means that an apparatus produced with Pfautler ASG is carried out in multiple steps:

- Production of an enameled apparatus according to DIN EN 15159-1 with a layer structure consisting of ground coat and cover coat. Authorization after careful testing of the glass lining and a spark test according to DIN.
- Application of conductive cover coat glass.
- Additional thin cover coat with **Pfautler World WideGlass® (WWG)**.
- Conductivity test with 3kV test voltage (no discharge, but response of device).



How it Works:

1. Existing electrostatic charge discharges towards apparatus wall.
2. The charge flows through the upper-most cover coat without damaging the enamel layer.
3. Electrical charge is distributed throughout the large surface area within the ASG coating (condenser effect).
4. The actual covering enamel layer is not damaged. The charge is grounded via the entire enamel surface down to the steel body.



The stirring method also plays a critical role in the generation of electrostatic charges. Relevant factors are selection of the type of stirrer, the single or multi-stage design, baffle and number of revolutions. Pfautler experience allows coordination of these parameters to obtain the most ideal optimum results.

Pfautler Anti Static Glass® (ASG) has the same chemical durability as the highly durable **Pfautler World WideGlass® (WWG)** standard enamel. The chemical durability of this special enamel is not affected in any way by its electrical conductivity. The enameled glass surface remains chemically inert without any catalytic effects (as can be the case with platinum fibers when they come into direct contact with the product). Aside from components with sensing technology, all components can be coated with an **Anti StaticGlass® (ASG)**.



Glass Equipment^[2]

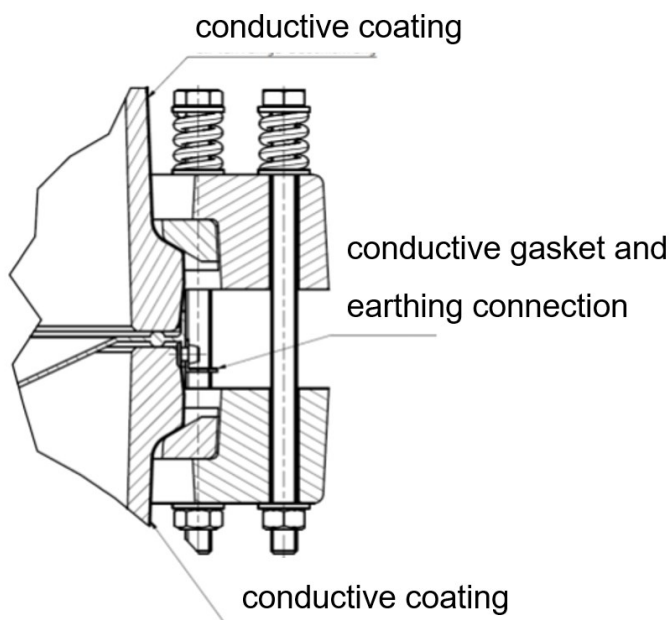
For applications of glass units in EX-zones are the ATEX-guideline 2014/34/EU as well as the guideline for electrostatics TRGS 727 of importance. Generally, there are no limitations in the use of glass components and apparatuses if the corresponding components are chosen with respect to the existing EX-zones. Glass components can be used directly in the outer EX-Zone 1 (IIA/B) and 2 (IIA/B/C). Only for the outer EX-Zone 1 (IIC) are additional requirements to be considered. Examples are the conductive coating of glass components combined with a corresponding earthing. Coating is only applied on the outside; not in contact with the product.

If for - as a standard nonconductive material - electrostatic loading might occur, then the requirements according to TRBS 2153 needs to be considered in addition. Depending on the dimension of the component correspondingly earthing of outer metal parts as well as the use of conductive PTFE-components with earthing might be required. Components made of conductive PTFE with earthing contact can be delivered as a standard.



Transparent conductive coating is a PU-based coating with conductive activated groups. Permissible temperature range -40/+140 °C, short term up to 160 °C. The coating is characterized by very good transparency, good conditional chemical resistance to oils, fats, benzine and various solvents as well to water and weak caustic solutions. UV-consistency surface, resistance < 109 Ohm, suitable for applications even with electrostatic loading media in the EX-zone according to guidelines 2014/34/EU and TRGS 727.

Earthing of the conductive coating can be made by various methods. On one hand a metallic conductive contact together with an earthing wire can be connected directly with the glass component, for example with a bracket. On the other hand, earthing can be made via a conductive gasket with earthing lid and contact to the conductive coated surface of the glass components.



Exemplary connection with a conductive coating, conductive gasket and earthing connection

Summary

Pfautler Normag Systems provides solutions to avoid electrostatic charging on Glass and Glass Lined Equipment. The chemical durability of the glass and enamel is not affected in any way. The enameled and glass surfaces remain chemically inert without any catalytic effects.

For more detailed information of this topic please contact one of the authors.

References

[1] Brochure Pfautler Anti Static Glass617 – 4E

[2] NORMAG Catalogue ProcessTechnology Chapter 10 Technical Information

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ARTICLES FOR NEWSLETTER

This is a reminder that through the Newsletters we share knowledge in the areas of Safety, Health, Environment and Security pertaining to the Explosives Industry. SAFEX thus call on all members to submit articles on these subjects within their own companies and countries.

The deadline for articles for the April 2020 Newsletter is 31 March 2021 .I look forward to your continued support .

SAFEX thanks all the authors and contributors as well as the editing team Andy Begg and Noël Hsu for their for their invaluable support.