



# PMI PERFORMANCE CHEMICALS

## PMI chemical range

PMI offers a range of chemicals for: -

- Wax inhibition
- Removal of legacy wax and asphaltenes
- Well-bore cleaning
- Corrosion prevention
- Scale removal
- H<sub>2</sub>S neutralisation
- Oxygen and H<sub>2</sub>S scavenging
- SRB removal

The range of PMI chemicals provides a comprehensive and complementary capability to address a wide range of endemic problems experienced in oil and gas production.

### **Ionic & Anionic Compounds**

PMI-107, PMI-108 and PMI-TC4

### **Solvents**

PMI-TC2, PMI-TC3, PMI-TC5 and PMI-TC6

### **De-scalers**

PMI-SC4, PMI-SC5 and PMI-SC8

### **Scavengers**

PMI-107FA, PMI-SC3 and PMI-SC6

### **Biocides**

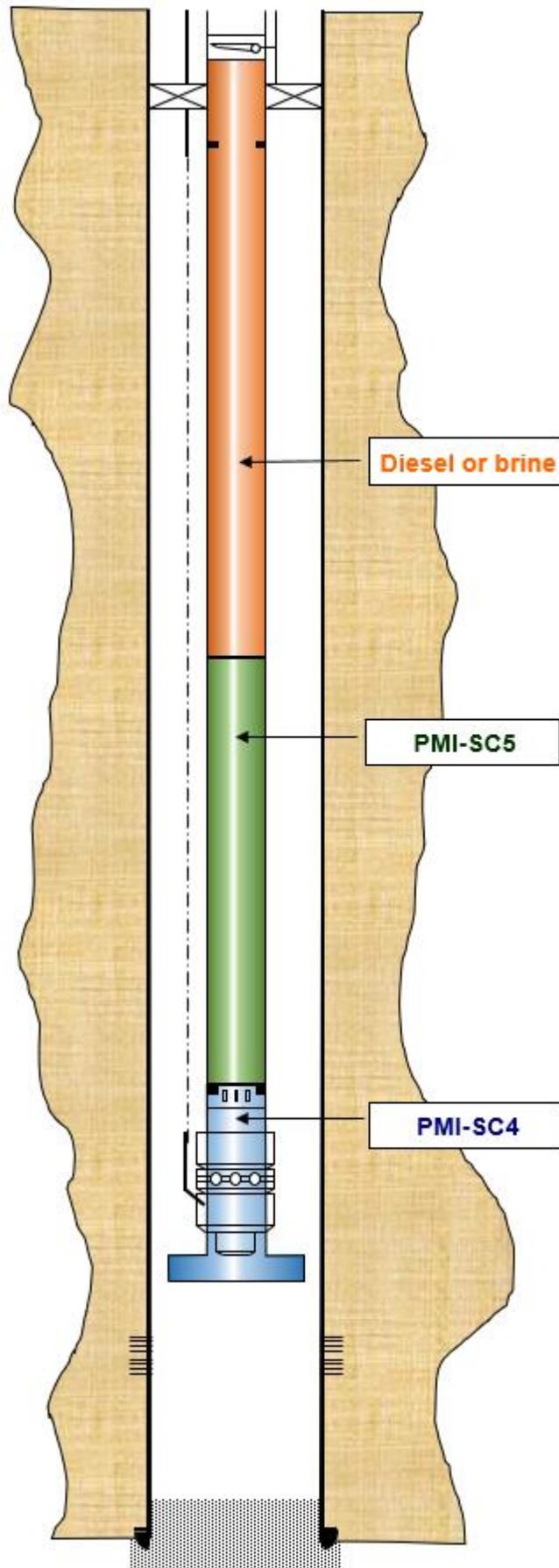
PMI-SC7

## Complementary

The PMI range of chemicals is designed to work sequentially in order to achieve the desired results. Below is an example of how a combination of PMI chemicals might be used in a field application.

### Chemical pumping order:

- 1) PMI-TC2 to depth required and sufficient volume to cover area to be treated. This removes crude / wax / asphaltene from tubing surfaces. Allow to soak for 12 hours.
- 2) Displace with brine.
- 3) Pump PMI-SC4 to cover depth of area to be treated. Allow to soak for 1-2 hours.
- 4) Displace by pumping PMI-SC5 to cover area to be treated. Allow to soak for 12 hours.
- 5) Displace with brine or diesel (as appropriate).
- 6) Prevent recurrence by dosing with PMI-107 as appropriate.



## Ionic & Anionic Compounds

### **PMI-107**

PMI-107 is an anionic molecular compound. It is a single product which maintains the homogeneity of crude as it moves through the production and transportation system. It has an affinity with steel, which means that it coats the contact surfaces of pipes, tanks and all plant and equipment with which it comes into contact. PMI-107 is non-toxic and environmentally safe. It eliminates the use of toxic, carcinogenic chemicals such as Xylene, Toluene and Triazene.

Because the crude is kept in a homogeneous state as it flows, it has no opportunity to drop waxes and corrosive matter, thereby preventing accumulations of waxes, asphaltenes and preventing corrosion damage. Application is by low-level injection as far upstream as possible so that the effects of the treatment can pass right the way through the system.

Existing wax build up is gradually reduced as the PMI-107 migrates along the contact surfaces. The removal of waxes and sludges overcomes the problems of dead spots where SRBs can normally thrive.

By removing blockages in pipelines and sludge build up in storage tanks, productivity is immediately improved without expensive down time and the reduction of problems associated with corrosion, avoids costly maintenance programmes.

PMI-107 and its predecessors have been demonstrably and successfully used around the world, UAE, Kazakhstan, Thailand, Indonesia and elsewhere.

### **PMI-108 (Combination of PMI-107 & PMI-TC2)**

PMI-108 is a specialist combination chemical binding PMI-107 and PMI-TC2. This chemical is specifically designed for applications of badly blocked pipelines and tanks. This is a highly potent chemical to strip out and re-suspend deposits of wax, asphaltene, scale etc. from pipelines and tanks. It will also wet-out to create a protective film so is an excellent corrosion inhibitor. It has an affinity with steel which means that it coats the contact surfaces of pipes, tanks and all plant and equipment with which it comes into contact. PMI-108 maintains the homogeneity of crude as it moves through the production and transportation system.

PMI-108 contains a powerful solvent all of whose active ingredients derive from Oranges (See PMI-TC2, below). This is classified as a non-hazardous solvent (except for the normal issue of not allowing inhalation into the lungs). PMI-108 is not soluble with saline's / brines as it is immiscible with water so cannot cause emulsions. It will dissolve all petroleum hydrocarbons, whatever their condition. It is widely used for clearing up legacy waste problems, oil spill, heavy contamination in tanks, pipelines and any structure where immediate results are required.

### **PMI-TC4**

PMI-TC4 is a well flush. It is a pure surfactant to remove any residual oil film and leave a water wet finish in well bores.

## PMI-107

The PMI-107 formula is a proprietary compound that is bringing change to the oil industry. It is anionic so naturally attracts to positively-charged surfaces, casing and tubing, pumps, formations, production facility equipment, pipelines, storage tanks, rail tankers, shipping tankers, etc. PMI films out to release wax, asphaltene, scale, corrosion and most foreign matter. Also, being anionic it will not release large “chunks”, but will release all by breaking down accumulated matter molecule by molecule, but in a very quick and effective way.

### How is this possible?

**PMI-107** is an anionic nano molecular compound, whose amphiphilic activity means it works on a molecular level by partitioning the ions thereby separating the oil molecules and re-dispersing them back into their original form. PMI acts on the oil in a compatible manner, which does not change the molecules as is the case with most solvents.

Being anionic, **PMI-107** is compatible with almost any type of formation on any type of oil whether it be light oil, heavy oil, sour or light conditions. This natural event allows the hydrocarbon chain to re-suspend, paraffin wax, asphaltenes, bitumen, etc. back into the oil in a uniform suspension and not a stable emulsion. This also fixes the water phase and allows the bi-carbonates and salt to re-suspend and release any scale and corrosion to travel in the water. Being a natural event the wax, asphaltenes, bitumen will travel right to the end of the line (refinery) without falling out in storage tanks, pipelines or transporting systems such as rail tankers, truck tankers, ocean tankers, etc. In all cases our clean oil will assist and clean all the downstream systems.

The negative charge of **PMI-107** has a filming effect on the metal contact surfaces of oil field installations. This has added benefit of eliminating corrosion, scaling and build up. With the interfacial surface tension ceases to being a problem any BSW formation in export oil storage is reduced to absolutely minimum levels. This avoids waiting time for water settlement in the storage tanks or mixing clean oil with high BSW oil to dilute it enough to achieve a lower BSW for export.

With the ions being back to their normal, natural state, they are more miscible which means that the oil is more pumpable! This cellular elastine effect makes heavy oil and oil in colder climates much more readily mobile without costly heating and pumping apparatus and specialized drag reducers.

### The PMI formula creates a four-phase separation;

1. Oil, paraffin, asphaltenes, bitumen etc.
2. Gases, H<sub>2</sub>S, SO<sub>4</sub>, CO<sub>2</sub> etc.
3. Water, bicarbonates, salts, (calcium, magnesium, etc.)
4. Inorganics, foreign matter (sand)

There have been occasions where heavy doses of chemicals used elsewhere in the system have separated into an additional layer on top of the oil phase!

### Where does the PMI go?

**The PMI compound will not travel in the oil phase but will remain in the water phase, which will continue cleaning and filming out;**

When re-injecting the water, the PMI solution will become a full circle solution by keeping the injection wells clean and free flowing at the same time releasing all the oily residue in the formation until it becomes too diluted with the addition of further water. Over enough time to get communication with the production wells, there will be a largely sustainable system with the

production wells being self-cleaning, oil and water naturally separating in the formation, oil being more miscible and flowing unhindered by emulsions to the well bore, clean oil going straight to the production facility!

Where the production water flows to an environmental lagoon or pit the presence **PMI-107** will start to clean the pit by re-suspending existing oil in sludge's and build up. A very common (though not much discussed!) problem is "heavy water" (H<sup>2</sup>S in the water). Because **PMI-107**, prevents the formation of an oily/water emulsion. H<sup>2</sup>S will naturally release from water when the PH is dropped to around 6 to 6.5., Clearly capture of any H<sub>2</sub>S trapped as legacy residues in lagoons or tanks by our H<sub>2</sub>S scavenger needs to be put in place. Past tests on lagoons where H<sub>2</sub>S problems have occurred have shown pH values have been as high as 10as 10 ph **PMI -107** will maintain a natural balance and we have seen results as low as 6.2 ph.

PMI's unique ability to break the bonds of the interfacial surface tension which causes problem emulsions between oil and water, oil and gas, gas and water, etc. reduces oil in water and water in oil. As a result, production equipment can work within its designed operating range, staying cleaner and more efficient. This means less maintenance and a safer working environment!

With oil becoming more difficult and costly to extract, PMI has an important role to play in enhancing productivity on a sustainable basis. It can make sustained improvement to production rates by removing existing wax plugs and coatings on metal surfaces. It uniquely inhibits the formation of future wax build-up and corrosion. **See examples below in Fig. 1 to 3.**

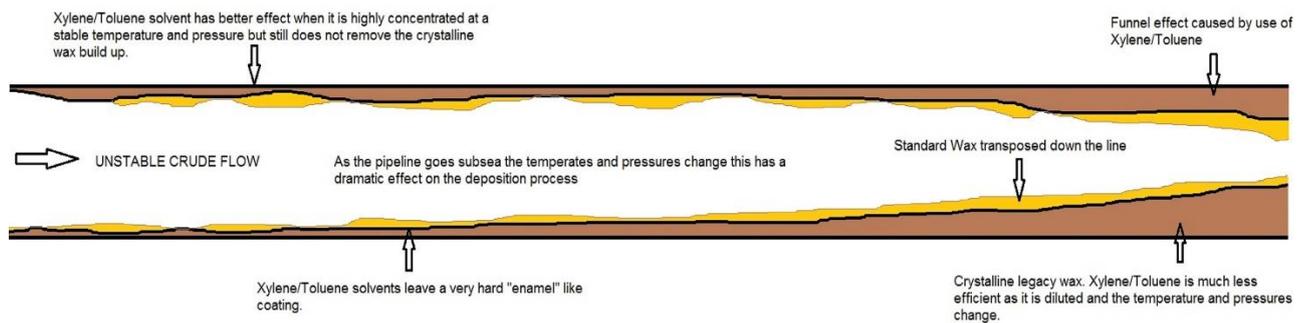


Fig. 1. Unstable Oil flows and legacy build-up of Waxes, (including Macro Crystalline), and Asphaltenes

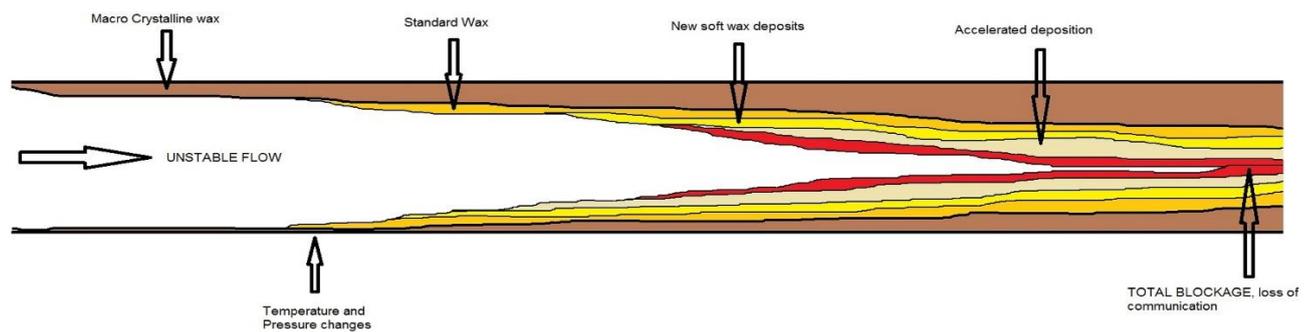


Fig. 2. Ineffective chemical treatments and inability to pig leading to total loss of communication



Fig. 3. Use of PMI-107 will remove even legacy build-up and wet out the pipeline meaning stabilised flows

## Solvents

### **PMI-TC2**

PMI TC2 is a powerful solvent, all of whose active ingredients derive from oranges. This is classified as a non-hazardous solvent (except for the normal issue of not allowing inhalation into the lungs). It is immiscible in water so cannot cause emulsions. It will dissolve all petroleum hydrocarbons, whatever their condition, including macro crystalline waxes and even decanted asphaltenes. It is widely used for clearing up legacy waste problems, oil spill, heavy contamination in tanks, pipelines and any structure where immediate results are required.

It is used for clearing wax plugged wells by Saudi Aramco, and for tank cleaning, by Bonoco for tank cleaning and wellbores among many others. It is used for foreshore cleaning in the event of marine oil spill

### **PMI-TC3**

PMI-TC3 is a solvent specifically designed to remove pipe dope overruns. This formulation has been extensively used by many of the major companies operating in all the major oil producing regions. It is classified as non-hazardous on all HS&E measures.

### **PMI-TC5**

PMI-TC5 is similar in function to PMI-TC6 below but with an enhanced solvency power for situations where hydrocarbon presence is elevated.

### **PMI-TC6**

PMI-TC6 is a speciality product which is a solvent surfactant mixture designed for achieving slow oily water separation. The specific purpose is to lift small solids and particulate matter arising from drilling operations to the surface for effective disposal.

## PMI-TC2

PMI TC2 is a powerful solvent, all of whose active ingredients derive from oranges.

Widely used in the oil and gas sector for clearing wax plugged wells and wellbores, tank cleaning, and general maintenance. It is not a dispersant so is used for foreshore cleaning in the event of marine oil spill.

Classified as non-hazardous (*see SDS for full information*):

- For general use
- For use in enclosed spaces
- For transport (including air)
- For the environment

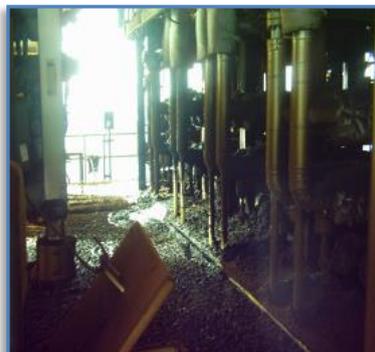
It is immiscible in water so cannot cause emulsions. Enables maximum oil recovery. Minimises waste disposal costs.

Extensively used across the sector, including by: Saudi Aramco, ADCO, Bapco, Petronas, KGOC, Chevron, Shell, Total, BP

### Oilfield cleaning applications

- Oil storage tanks
- Well bores
- Pipes
- Legacy wax and asphaltene problems
- Injection wells
- Pumping equipment
- Marine oil spill
- Contaminated land
- Superstructures
- Concrete
- Workshop maintenance

PowerPoint presentation available



## De-scalers

### **PMI-SC4**

PMI-SC4 is a mixture of organic and inorganic acids and solvents with built in corrosion sequestrants and demulsifiers. It is a multipurpose polymer, carbonate particle and scale dissolver with applications in open holes and as a cake breaker.

PMI-SC4 is widely used by Saudi Aramco and others in combination with PMI-TC2 where oily deposits need to be removed prior to descaling activity in disposal wells.

### **PMI-SC5**

PMI-SC5 is a combination of ammoniated salts and acids. It is a multi-purpose sulphide scale and carbonate cake remover. It is used to recover blocked injection and production streams in injection wells systems. Widely used in conjunction with PMI-TC2 where oily deposits need to be removed prior to descaling. Used extensively by Saudi Aramco in disposal wells.

### **PMI-SC8**

PMI-SC8 is a solvent solution designed to remove high volumes of solid sulphate and carbonate solids from oil and gas down-hole facilities. Dissolves barium, strontium and calcium sulphate, PMI-SC8 is used to target differing dirty well bore environments resulting from oil or water based mud deposition. The product reacts quicker in warm environments (> 40° C) but is largely not temperature dependent to reach depletion with normal reactions within 24 hours at elevated temperatures.

## Scavengers

### PMI-107FA

PMI-107FA is a variant on our mainstream wax and corrosion inhibitor (PMI-107) to neutralise H<sub>2</sub>S at source where H<sub>2</sub>S is an endemic problem in certain formations and individual fields. PMI-107FA is uniquely formulated using a nanotechnology technique developed by PMI to suspend permanently a solid material in the liquid medium of PMI-107. PMI-107FA is designed for continuous low-level dosing into the production flow as part of the preventative programme to ensure wax and corrosion do not form accretions in pipelines and restrict flow. The use of PMI-107 ensures the same inhibitory function is performed, but the formation of H<sub>2</sub>S gas is totally prevented and neutralised at source. See the separate information sheet on PMI-107.

### PMI-SC3

PMI-SC3 is a product designed to neutralise H<sub>2</sub>S in topical situations especially in circumstances where personnel might come into contact and where gas monitors are in use. It completely neutralises the gas on contact. Application can be by spray where a gas emission occurs, for example where tankers are being filled or discharged. Or it can be applied by in-line dosing where periodic occurrences are expected.

PMI-SC3 has none of the hazards associated with triazine or formaldehyde. PMI-SC3 will remove the gas from gas, water or crude and fuel oil. It converts H<sub>2</sub>S and RSH to a stable, non-hazardous sulphide, (liquid sulphate salt). It will also remove mercaptans from liquids.

### PMI-SC6

PMI-SC6 is an oxygen scavenger. It is a widely used product in the industry based on DEHA and is applied by injection.

### PMI-SC3 safe replacement for Triazine as a Hazardous H<sub>2</sub>S Scavenger

Hexahydro-1,3,5-tris(hydroxyethyl)-s-triazine (MEA-triazine) is by far the most widely used H<sub>2</sub>S scavenger globally and occupies at least 80% of the available oilfield market. While almost the perfect scavenger in terms of kinetics and H<sub>2</sub>S uptake, this product does suffer from a number of hazardous and undesirable usage/side effects.

Due to the Safe Drinking Water Act of 1974, the EPA is required to determine the concentration of chemicals which may cause health problems. Triazines are considerably water-soluble. Triazine is commonly detected in ground and drinking water and has been linked to cancer and endocrine gland disruption in people. For triazine, the maximum contaminant level (MCL) is set at 3 parts per billion, ppb or µg/L. Short-term exposure at levels above the MCL may cause heart, lung, or kidney congestion along with low blood pressure, muscle spasms, adrenal gland damage, or weight loss. The long-term effects range from weight loss and cardiovascular damage to muscle degeneration or cancer. Adverse reactions can range from mild reactions including nausea and itching to severe reactions including anaphylactic shock or renal failure.

Studies on the influence of the compounds on animal and human physiological processes and health, that is distribution of triazine in the animal organisms, effects on the regulatory platform in the liver, possible carcinogenesis and endocrine disruption risks are all attributable to triazine.

The harmful effects of triazine compounds on the health of humans appear to lie in their action as endocrine disruptors; evidence of possible carcinogenic or mutagenic effects on humans is high. The EPA has considered restricting or banning its use, but long-term costs would be high. Estimates have shown that non-use would increase production costs dramatically if no alternative is in place. The money lost from non-use or use of more expensive replacements would be passed down to producers and eventually to consumers. Financial disadvantages are currently weighed against health and environmental concerns.

A 2006 a Govt. statement concluded that triazines have a neuroendocrine toxicity mechanism which could result in developmental and reproductive complications, the cumulative effects present reasonable harm to the general population.

This debate is over whether economics and production are more important than health and environmental concerns, or vice versa.

Most importantly, it shows an example of how chemistry is relevant to and impacts the world. Due to its wide usage, triazine is commonly detected in ground and drinking water as well as rivers, reservoirs and even sea water, often at levels exceeding the EPA drinking water limit of 3 ppb. Triazine has been directly linked to health risks in humans, animals, aquatic and marine life. However, economic concerns and lack of a suitable alternative have allowed for its continued use. For this reason, methods to remove triazine from drinking water or prevent triazine from entering ground water are very important. The EPA approved method of removal for triazine from drinking water is granular activated charcoal. However, this non-selective adsorbent is expensive, and its activity is dependent on the type of carbon used and the characteristics of the wastewater. We must encourage discussion and awareness about the impact that simple chemistry has on society and the environment. The potential for environmental remediation was realized by the development of materials to sequester pollutants such as triazine.

In the U.S. More than 100,000,000 lbs of triazine is used every year. These triazines all have a similar structure. The most common triazines are in the form of herbicides and hydrogen sulphide scavengers.

These molecules have already been banned in parts of Europe and Africa because their use has been linked to cancer and endocrine gland disruption in people. The EPA has considered restricting or even banning their use in the US, but long-term costs in reduced production has led to maintained use despite damage to human health and environmental impact.

Triazines form an important group of herbicides as well as wide use in the hydrocarbon industry, which have been used extensively or selectively both in agricultural and non-agricultural areas worldwide for more than fifty years. As a consequence of their massive application, they have become and remain significant environmental pollutants, especially in aquatic ecosystems. Fish are an integral part of the aquatic environment and are, therefore, suitable models for the study of the behavioural, biological, and biochemical effects of triazine exposure. Many summaries have been evaluated on the effects of triazine on fish in order to provide an overview of current information on triazines. The overall effects of triazine exposure on the physiology of fish were evaluated by considering a variety of parameters in a number of reports. Haematological and biochemical profiles of blood provide important information about the internal environment of the organism and the general physiology and health status of triazine exposed fish. According to studies using biotransformation and bioaccumulation indices to estimate the effects of triazines on fish, changes in fish metabolism reflect the pollution of the environment by these triazines. The responses of triazine exposure induced oxidative stress. Acute exposure to triazines affects reproduction or reproductive development in fish.

Triazines are considerably soluble in water and can therefore leach to ground waters or be washed to surface waters, which is why they are among the most often detected xenobiotics in aquatic ecosystems as shown by many studies around the world.

The environmental pollution caused by triazines has become a widespread problem. The high use of these chemicals has caused an increasing concern over their acute and chronic health effects. Persistent pollutants can contaminate organisms at all trophic levels and may cause severe

damage to the organisms through metabolites contained in contaminated bodies of water. The patterns of accumulation and effect of xenobiotics depend on the organism itself, on the properties of the compound, on the quantity of the compound present in the particular part of environment, and – last but not least – on the balance between bio-assimilation and metabolic plus excretion rates.

Another less important reason for the development of alternatives is the quality and exact nature of the spent fluid is critically important to H<sub>2</sub>S scavengers and much effort has gone into the control and handling of the by-product. High sulphur scavenger by-products are almost always solid in nature and can cause numerous operational issues. MEA triazine has such a problem and polymerization of the initially formed monomeric dithiazine to amorphous dithiazine is one of the drivers to develop an alternative.

Many H<sub>2</sub>S scavengers frequently used throughout the oil industry are based on cyclic amine called triazine. Depending on the base materials used to synthesize the triazine, the end product will react with the H<sub>2</sub>S to form an insoluble solid called dithiazine. At extreme temperatures it can also decompose into hydrogen cyanide (HCN) or hydrocyanic acid both extremely toxic and fatal. The triazine scavengers are prevalent in the oil and natural gas industry to treat sour gas by either injecting them directly into the transmission pipelines or by bubbling the gas through amine treater towers. When used in this manner, dithiazine solids begin forming in the pipeline, in valving, and inside the treater towers.

While the triazines are effective H<sub>2</sub>S Scavengers capable of eliminating the hazards of H<sub>2</sub>S and neutralizing the H<sub>2</sub>S corrosivity, the dithiazine solids formed begin to reduce flow within piping, eventually plugging the pipelines and towers and rendering control valves inoperable.

While the scavenger is water soluble, the reaction product is insoluble when formed. These solids are a direct cause of the use of the triazine molecule as a hydrogen sulphide control measure. Accumulations of the dithiazine solids usually need to be removed via mechanical methods. For towers, this often means high pressure (10,000 psig) water blasting of the tower internals. In some cases, plugging of dispersion equipment such as diffusers and/or raschig rings, must be replaced.

For pipelines, pigging is done with scraper pigs to remove the accumulated deposits. Of course, pigging is only applicable to pipelines that can be pigged. Often, the pipeline segment is not constructed to allow the pigging operations, or the pipeline becomes so encrusted with dithiazine solids that a pig cannot be passed through without becoming stuck.

All of the aforementioned hazards, be it health, pollutant or even operational damage has led to the world demanding an alternative to Triazine in all its disguises.

**Pipeline Maintenance International LLC** (PMI) has established itself as a leading designer and manufacturer of specialist production chemicals. PMI's products are approved and used around the world by leading Oil/Gas producers as well as the largest Service companies. PMI has designed the latest, most effective and efficient alternative to Triazine as a H<sub>2</sub>S scavenger. It can be used in all medias be it Oil, Gas or Water. It can be atomised for gas misting neutralisation or by direct injection into Wells, Pipelines, Storage or production facilities.

**This product is called PMI-SC3**

PMI-SC3 is an advanced H<sub>2</sub>S Scavenger. It is applied by direct injection or atomisation as it works in both liquid and gas phases. It is designed to treat a wide variety of media including but not limited to Oil, Gas and Water. It works on contact and immediately and permanently neutralises & converts H<sub>2</sub>S into a harmless benign liquid sulphate salt, which in turn drops into the water phase. This process is irreversible. These salts cannot be regenerated into H<sub>2</sub>S. PMI -SC3 cannot cause or contribute to the formation of scale on contact surfaces. PMI-SC3 ensures the homogenous state of the oil remains. Although PMI SC3 is not designed as a biocide, it acts to decrease bacterial activity by removing the sulphur compounds from the oil stream. The composition of PMI-SC3 is a totally and fundamentally different formulation to anything available in the market today. This brand new and revolutionary product is a direct **REPLACEMENT for TRIAZINE** providing higher efficiency with less ENVIRONMENTAL impact.

The extreme toxicity and HAZARDOUS nature of H<sub>2</sub>S is not our only concern! H<sub>2</sub>S is responsible for more than half of all known corrosion within the Oil/Gas industry. By eliminating the H<sub>2</sub>S at source means we can effectively save the industry \$Billions in maintenance, repair and replacement programs. Our product is safe and actually improves the quality of Oil/Gas as it works. PMI-SC3 also has the ability to reduce TSS (total suspended solids) and Heavy Metals which again is a major concern in the industry. Our product can be used across the entire upstream, downstream and production stages unlike other products.

By eliminating H<sub>2</sub>S we are making the World a better and cleaner place to live in. Our product works on/offshore and in any environment.

## Biocides

### PMI-SC7

PMI-SC7 is a glutaraldehyde based substance to be used as biocide specifically targeted at SRBs, which are a serious cause of corrosion in sour systems. This is of particular importance for dealing with problems of legacy corrosion where dead spaces are created in the flow system. These provide a perfect environment for the bacteria to colonise and give rise to serious problems of corrosion.

Where PMI-107FA is used on continuous dosing regime, the conditions which are supportive of the SRBs do not arise.

## Contact

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