

# SAFETY ISSUES IN THE TREATMENT PLANT

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NATIONAL ASSOCIATION OF WASTEWATER TECHNICIANS CONFERENCE

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You never know where the problem will crop up.

Or the depths you will have to plumb to fix it.



# OVERVIEW

- Threats to safety in wastewater treatment plants come from several directions and change through the process. Primary, secondary and tertiary treatment processes have characteristic hazards.
- From unloading, sampling, treating, discharging the waste, to operation and maintenance – the vehicles, equipment, process equipment, generated substances and treatment chemicals there are many possible hazards.
- Chemical and biological hazards come from the processes used to treat the wastewater, are inherent to sewage or may be introduced by industrial or illegal discharges of hazardous chemicals.
- Confined spaces are obviously present in WWTP's, but the hazards we discuss here extend beyond those present in confined spaces.

# ATMOSPHERIC HAZARDS

- Biological processes break down organic components of wastewater. These processes may be aerobic (done in the presence of atmospheric or dissolved oxygen) or anaerobic (without free oxygen).
- Lipids (fats, greases), carbohydrates (sugar, starches), proteins and metabolic wastes (urine, feces) are hydrolyzed by biota that consume these substances.
- These biota in turn create metabolic byproducts. Some of these are gasses. These gasses may be flammable, toxic or displace oxygen.
- These gasses may accumulate to dangerous levels. Where they accumulate is related to their relative densities.

# FLAMMABILITY

- METHANE AND OTHER BIOGENIC GASSES ARE FLAMMABLE.
- ILLEGAL OR ACCIDENTAL DUMPING OF FLAMMABLE LIQUIDS MAY REACH THE WWTP, ESPECIALLY IF IT IS A COMBINED SEWER SYSTEM.
- NO WWTP WILL KNOWINGLY ACCEPT FLAMMABLE OR COMBUSTIBLE LIQUIDS WITH A FLASH POINT BELOW 140 DEGREES F. IF BATCH TREATMENT IS BEING USED, E.G. FOR INDUSTRIAL FACILITY WASTEWATER PLANTS, STRICT SAMPLING AND TESTING PROCEDURES MUST BE FOLLOWED BEFORE UNLOADING INTO THE TREATMENT PROCESS.

# AEROBIC PROCESSES

DIGESTION OF DISSOLVED OR SUSPENDED SOLIDS BY MICROBES THAT NEED OXYGEN.

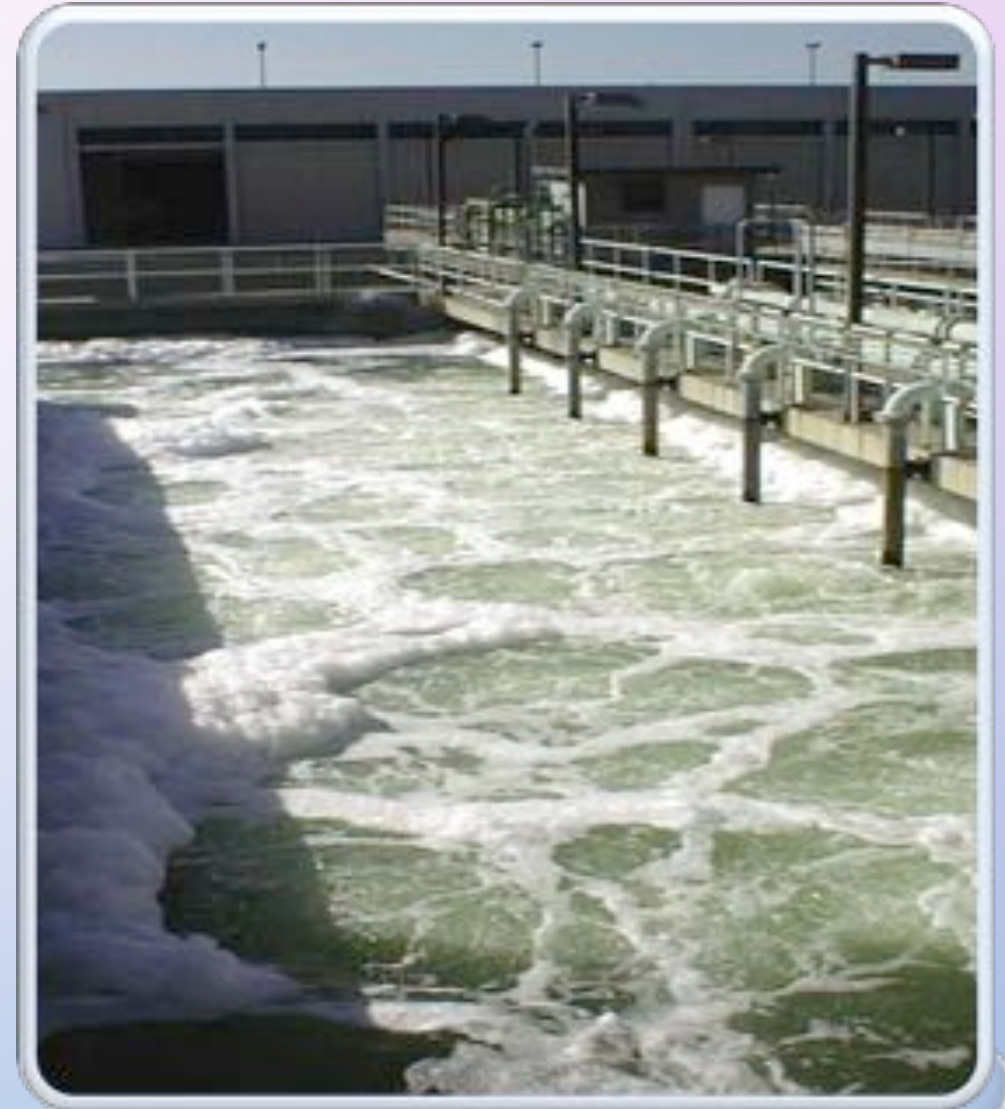
AERATION TANKS, TRICKLE FILTERS, ROTATING BIOLOGICAL CONTACTORS, ETC.

AEROBIC ORGANISMS EMIT CARBON DIOXIDE ( $\text{CO}_2$ ) AND AMMONIA ( $\text{NH}_3$ ).

CARBON DIOXIDE CAN DISPLACE OXYGEN AND IS HEAVIER THAN AIR

AMMONIA IS LIGHTER THAN AIR AND FLAMMABLE IN VERY HIGH CONCENTRATIONS.

BOTH GASSES ARE CORROSIVE -  $\text{CO}_2$  ACIDIC,  $\text{NH}_3$  ALKALINE



# ANAEROBIC PROCESSES

DIGESTION OF DISSOLVED OR SUSPENDED SOLIDS BY MICROBES THAT AVOID OXYGEN.

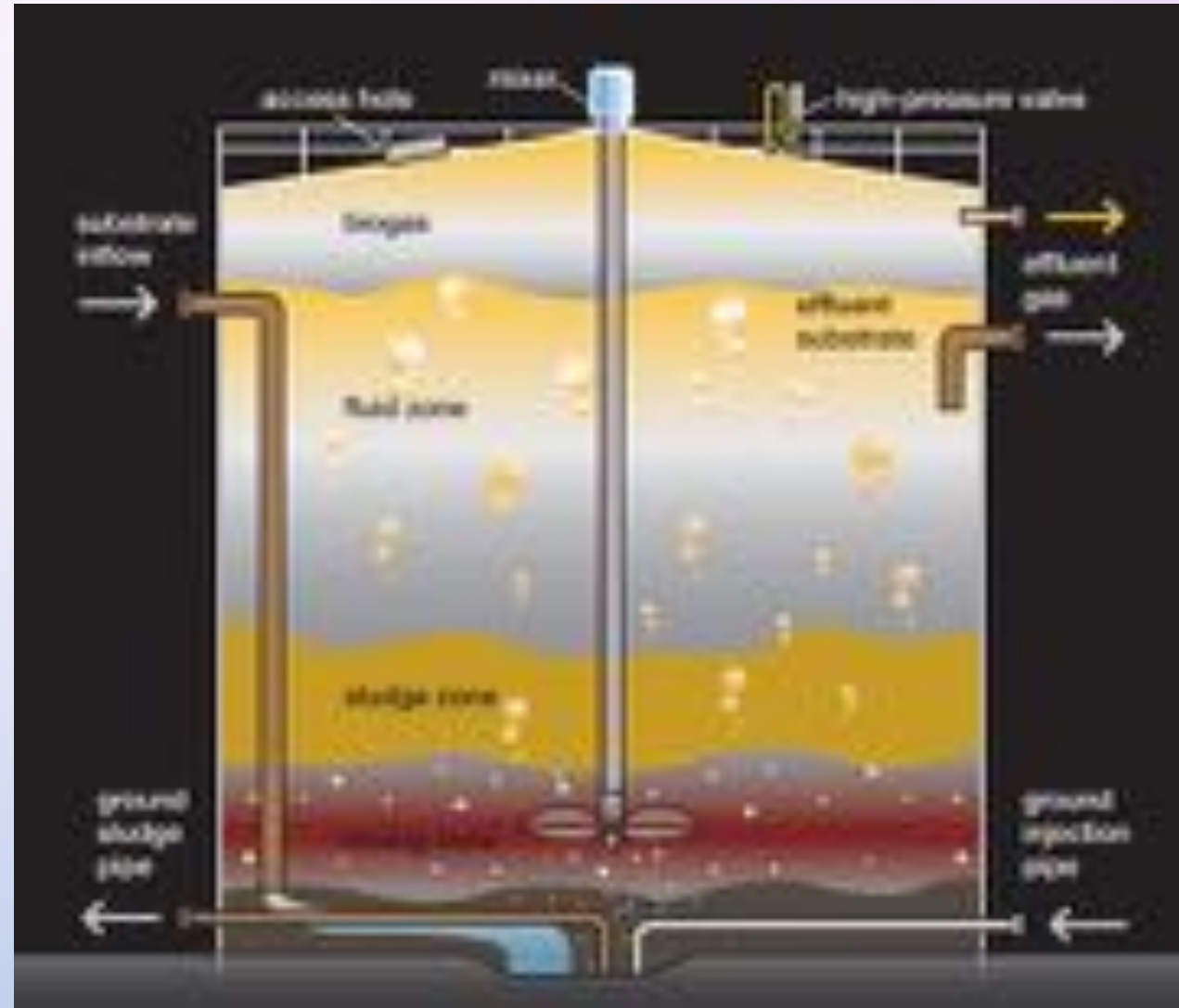
DIGESTER TANKS

ANAEROBIC ORGANISMS EMIT HYDROGEN SULFIDE ( $H_2S$ ) AND METHANE ( $CH_4$ ).

HYDROGEN SULFIDE IS POISONOUS, FLAMMABLE AND HEAVIER THAN AIR.

METHANE IS FLAMMABLE.

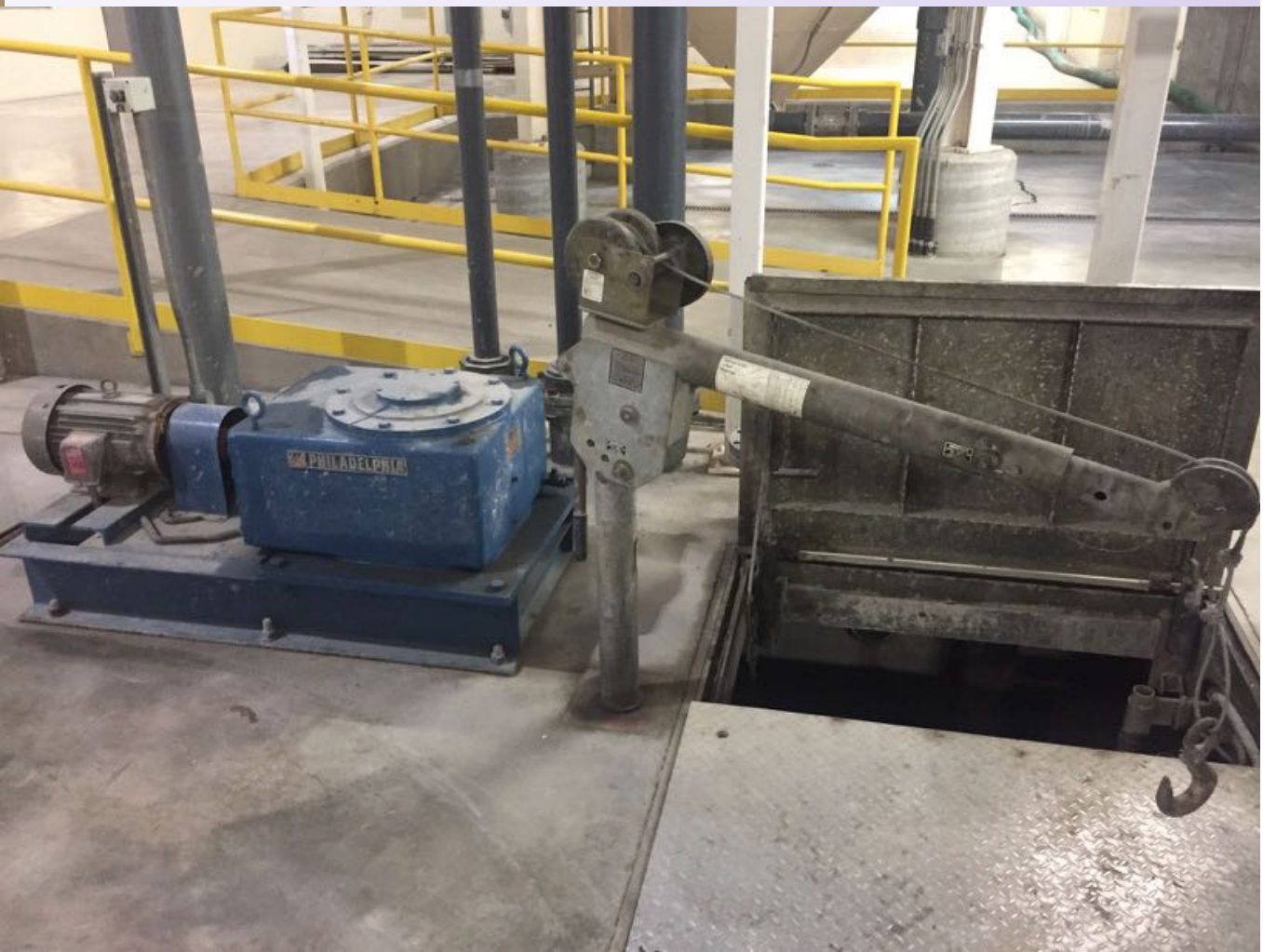
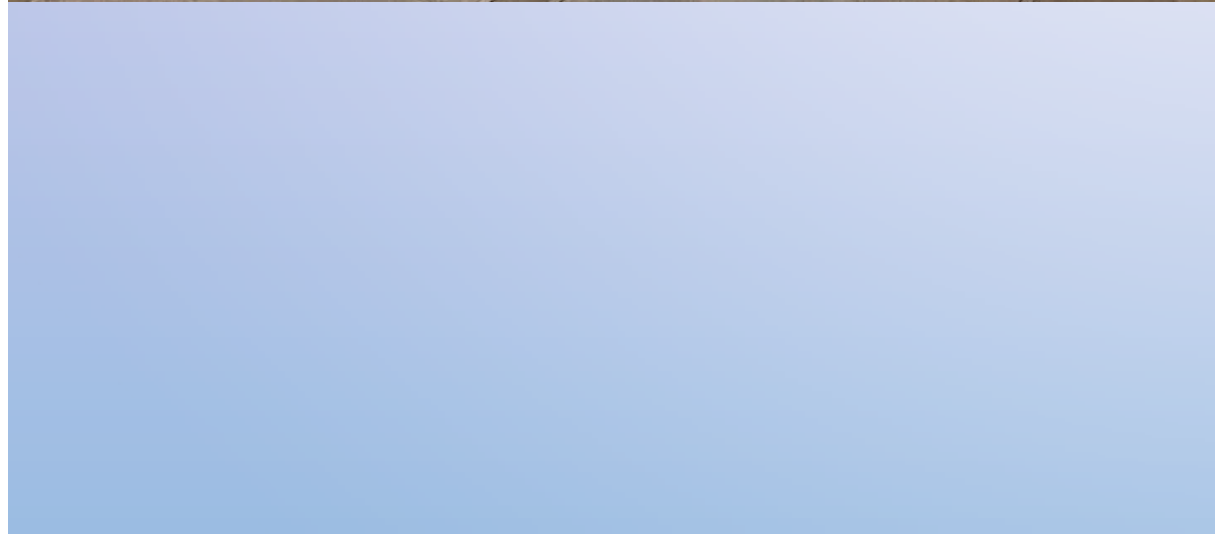
ALL KNOWN METHANOGENS ARE ANAEROBIC.



# HAZARDOUS ENERGY (LOTO) AND MACHINE GUARDING

- THE OSHA STANDARD FOR CONTROL OF HAZARDOUS ENERGY IS 29 CFR 1910.147.
- THE OSHA GENERAL REQUIREMENTS STANDARD FOR MACHINERY GUARDING IS 29 CFR 1910.212.
- HAZARDOUS ENERGY AND MACHINERY HAZARDS EXIST THROUGHOUT THE WWT PROCESSES. PRIMARY PROCESSES INCLUDE GRIT REMOVAL, E.G. SCREENING SYSTEMS, SCREW CONVEYORS, CLARIFIERS; SECONDARY PROCESSES INCLUDE TRICKLE FILTERS, BIOLOGICAL CONTACTORS, PUMPS, AERATOR SYSTEMS, MIXERS, FILTER PRESSES.
- PLANT MAINTENANCE OPERATIONS INVOLVE FIXED AND PORTABLE POWER TOOLS, HOISTS.



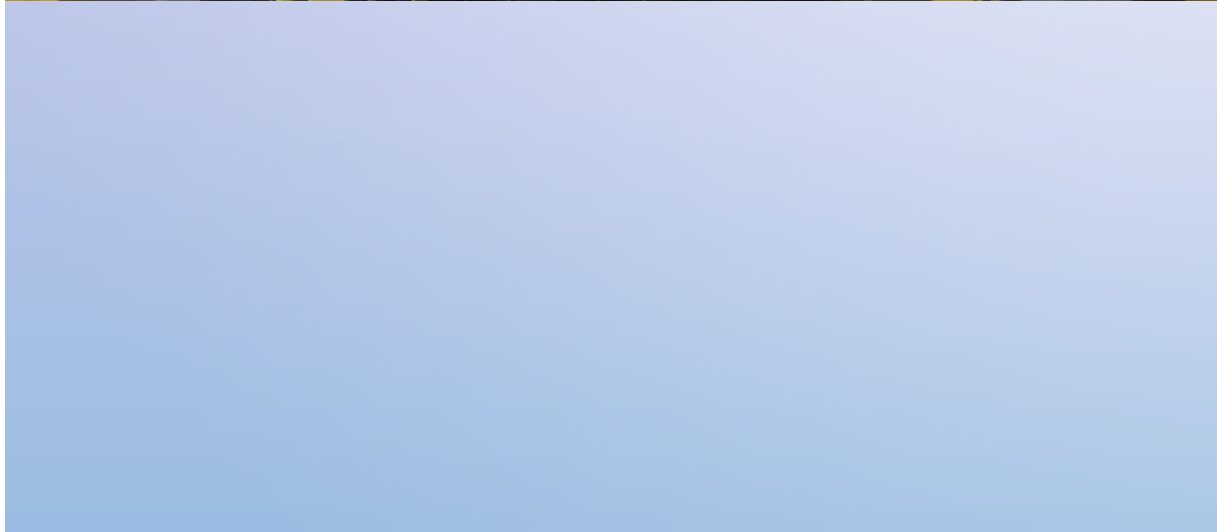


# HAZARDOUS ENERGY (LOTO) AND MACHINE GUARDING

- CONTROL OF HAZARDOUS ENERGY INVOLVES MORE THAN JUST APPLYING A LOCK AND/OR TAG TO A POWER SWITCH. ALL RESIDUAL ENERGY MUST BE ISOLATED OR BROUGHT TO THE GROUND STATE.
- RESIDUAL ENERGY MAY BE PRESENT IN MOTOR CAPACITORS, AIR LINES, FLUID POWER (HYDRAULIC) SYSTEMS AND MECHANICAL APPARATUS. PRESSURE CAN DEVELOP IN LINES FROM CONTINUING BIOLOGICAL PROCESSES GENERATING GASSES.

# FALL HAZARDS

- OSHA FALL PROTECTION STANDARD FOR GENERAL INDUSTRY REQUIRES FALL PROTECTION OR FALL ARREST SYSTEMS FOR WORKERS WHO COULD FALL MORE THAN FOUR FEET ONTO THE NEXT LOWER LANDING SURFACE OR WHEN OVER A HAZARDOUS AREA.
- TRUCK TOPS (SAMPLING, TARPING), CATWALKS, TANK ROOFS, AND EDGES OF TANKS AND PITS ARE ALL HAZARD AREAS.



# AERATION TANKS

LARGE VOLUMES OF COMPRESSED AIR ARE SPARGED (BUBBLED) FROM THE BOTTOM. THIS HELPS DESTROY IRON COMPOUNDS AND SULFIDES AND, CAUSES BENEFICIAL AEROBIC BIOTA TO BE FRUITFUL AND MULTIPLY.

AERATION REDUCES THE DENSITY AND SURFACE TENSION OF THE LIQUID. A HUMAN MAY NOT BE ABLE TO FLOAT OR SWIM IN AN ACTIVELY AERATING TANK.

AERATION GENERATES MISTS THAT CONTAIN HARMFUL MICROBES AND TOXIC CHEMICALS THAT CAN BE INHALED OR CONTAMINATE WORKER'S FOOD, WATER AND CLOTHING.



# TERTIARY TREATMENT

- TERTIARY TREATMENT PROCESSES USUALLY EMPLOY CHEMICALS TO EFFECT THE FINAL REMOVAL OF CONTAMINANTS FROM EFFLUENT BEFORE DISCHARGE.
- CHEMICALS MAY ALSO BE USED TO CONDITION EFFLUENT TO MEET PERMIT CONDITIONS (E.G. OXYGENATION).
- DISINFECTION IS OFTEN PERFORMED WITH CHLORINE OR CHLORINE-CONTAINING COMPOUNDS. THE CHLORINE IS THEN SCAVENGED BY SULFUR DIOXIDE OR SULFATE SALTS SUCH AS SODIUM BISULFITE.

# TERTIARY TREATMENT

- FLOCCULATION, PRECIPITATION AND OXIDATION OF ORGANIC COMPONENTS (E.G. CRESOLS) INVOLVE CHEMICAL ADDITIONS OF pH-ADJUSTING ACIDS OR ALKYLALS, POLYMERS AND PEROXIDES OR PERMANGANATES.
- THESE CHEMICALS ARE IN AND OF THEMSELVES HAZARDOUS, AS THEY ARE IN CONCENTRATED FORM. FOR EXAMPLE, SULFURIC ACID IS USUALLY PRESENT IN 93% PERCENT STRENGTH.
- INCORRECT OR INADVERTENT MIXING OF CHEMICALS CAN CAUSE A VIOLENT REACTION OR GENERATE LARGE VOLUMES OF TOXIC GASSES.

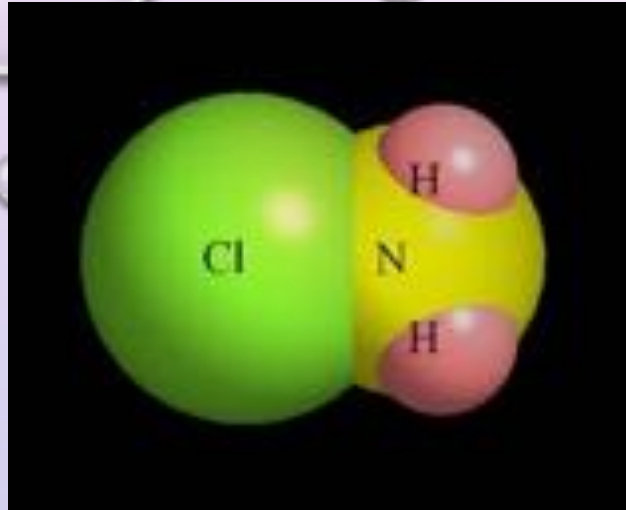


Chlorine was the first poison gas used in WWI.

Sulfur dioxide may be used to scavenge chlorine prior to discharge. It is also the combustion product of hydrogen Sulfide.





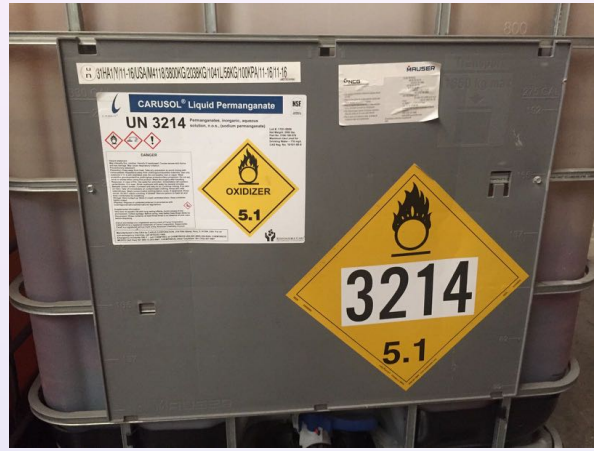


(mono) Chloramine is used to disinfect water. Chlorine and chloramine can both form hazardous compounds with hydrocarbons, such as carbon tetrachloride and chloroform. Chloramine is formed by the reaction of chlorine with ammonia.

Dangerous reactions can occur between various treatment chemicals. These reactions may release large amounts of heat energy, resulting in fire or explosion. They may generate toxic gasses, or both. For example, sulfuric acid and permanganate yield manganese heptoxide, An unstable explosive compound. Acid and hypochlorite release chlorine. Acid and bisulfite yield sulfur dioxide or hydrogen sulfide.



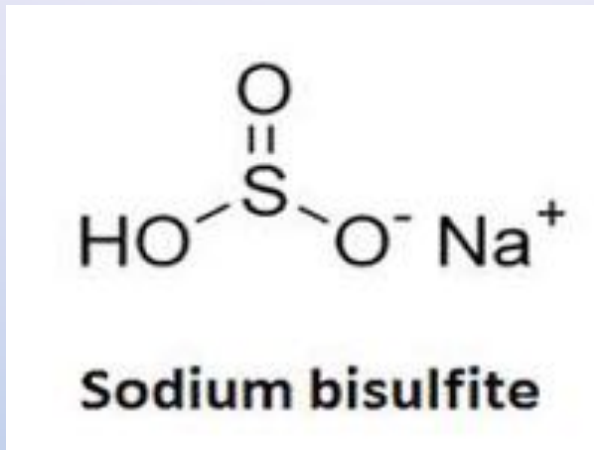
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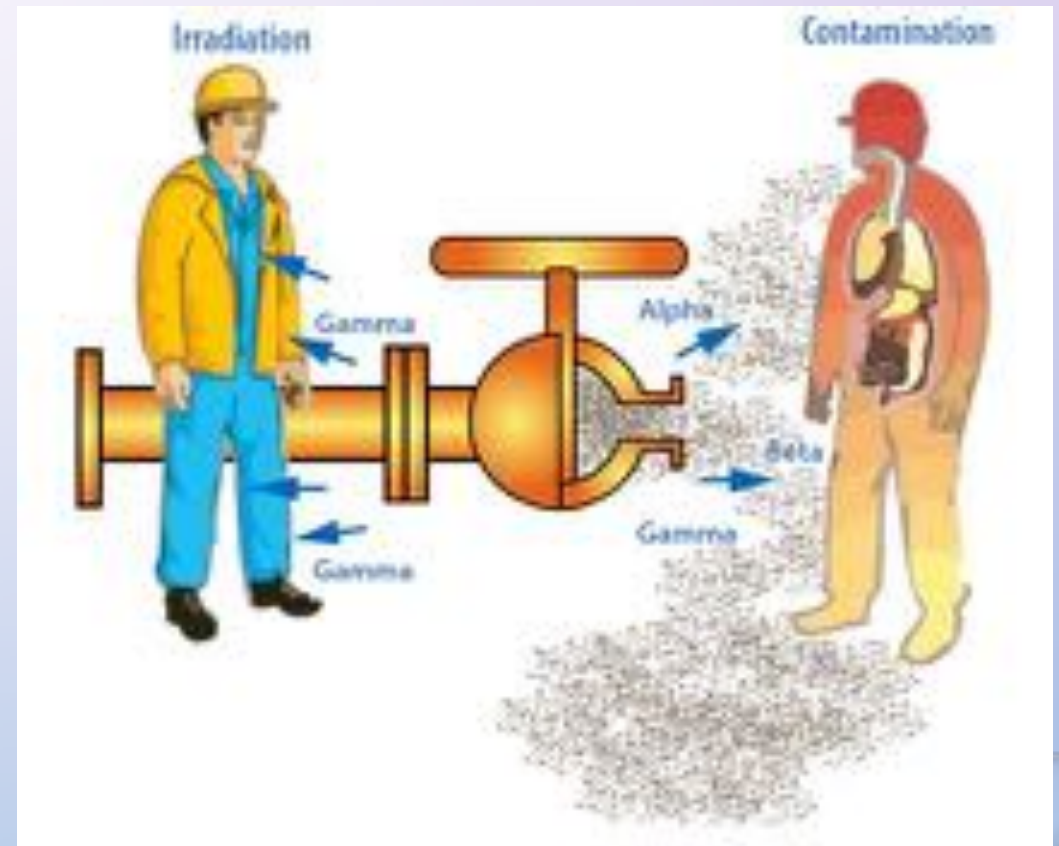


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# NORM – NATURALLY OCCURRING RADIOACTIVE MATERIAL

- SOME GEOLOGIES HAVE AN ABUNDANCE OF NATURAL RADIOACTIVE ELEMENTS.
- THESE ARE URANIUM, THORIUM AND THEIR DECAY DAUGHTERS, PRIMARILY RADIUM AND RADON.
- WWTPs THAT PROCESS WASTES GENERATED FROM OIL AND GAS E&P MAY ACCUMULATE RADIOACTIVE MATERIALS. THESE BECOME CONCENTRATED IN PROCESS EQUIPMENT, PIPING AND EXTRACTED SOLIDS (E.G. FILTER CAKE).
- AWARENESS OF THIS HAZARD IS NEEDED TO KEEP WORKERS SAFE.



# STRUCK-BY, CAUGHT-BETWEEN HAZARDS

- VEHICULAR TRAFFIC IS OFTEN OVERLOOKED AS A HAZARD, BUT IS ONE OF THE MOST FREQUENT CAUSES OF DEATH AND INJURY IN ANY INDUSTRIAL SETTING.
- DANGER AREAS INCLUDE LOADING DOCKS, ENTERING AND LEAVING BAYS AND ANYWHERE PEDESTRIANS AND VEHICLES CAN MIX.
- SEGREGATE VEHICLE AND PEDESTRIAN TRAFFIC, USE SPOTTERS AND ALWAYS PERFORM A 360° CHECK BEFORE MOVING.



# PROTECTIVE MEASURES

- FIXED AIR MONITORING SYSTEMS WITH ALARMS
- IGNITION-PROTECTED SYSTEMS IN NEC CLASS 1 LOCATIONS.
- HANDHELD MULTI-GAS METERS
- EMERGENCY SHUTDOWN DEVICES
- APPROPRIATE PPE, INCLUDING SCBA FOR LINE MAKING/BREAKING OF  $\text{Cl}_2$  AND  $\text{SO}_2$  SYSTEMS.
- GOOD INDUSTRIAL HYGIENE PRACTICES INCLUDING SHOWER AND CLOTHING EXCHANGE.

# PROTECTIVE MEASURES

- FACILITIES SHOULD BE SURVEYED FOR HAZARDS AND EVALUATION TESTING DONE. THIS INCLUDES TESTING FOR THE PRESENCE OF RADIOACTIVITY.
- THESE INCLUDE CONFINED SPACES, CHEMICAL STORAGE AREAS AND PROCESS AREAS.
- THESE SURVEYS SHOULD BE REDONE PERIODICALLY TO ENSURE THAT NO CHANGES HAVE OCCURRED.

# CLOSED CUP FLASH POINT TESTING

THIRD PARTY VERIFICATION AND WASTE PROFILES CAN KEEP YOU IN REGULATORY COMPLIANCE, BUT POINT OF TREATMENT TESTING IS NEEDED TO KEEP YOU SAFE.

TRUST NOT – BUT VERIFY!



**THANK YOU!  
QUESTIONS?**