

TRAINING OF TRAINERS PROGRAMME ON CAPACITY DEVELOPMENT OF ETP OPERATORS

Promotion of Sustainability in the Textile and Garment Industry in Asia - FABRIC



Day 5: Presentation 2

Safety & health in ETPs



Contents

- Basic concepts of occupational safety & health
- Common Hazards in ETP
- Managing hazards & risk
- Managing Hydrogen sulphide

Basic concept of occupational safety and health

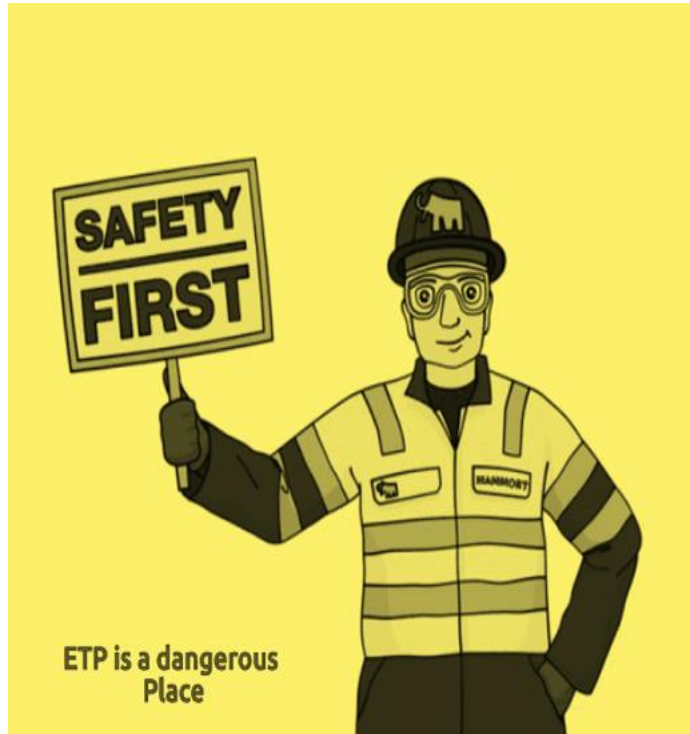
Basic concept of occupational safety & health



Relevance of occupational safety and health (OSH)

- Personal concern for one's and others' well-being
- Maintaining motivation at work
- Economic angle
 - ✓ Accidents leading to work-stoppage, investigation and fines by authorities
 - ✓ Payment of compensation to injured or sick workers
 - ✓ Lower productivity of workers when sick
 - ✓ Cost for replacement of workers (recruitment, training)
 - ✓ Good and safe working conditions for keeping key personnel

Basic concept of occupational safety & health



Focus of OSH management

- **Promoting and maintaining** highest degree of workers` physical, mental and social well-being
- **Eliminating and controlling** work-related **hazards** and **risks** to safety and health
- **Adapting work to workers** and each worker to his/her job
- **Preventing workers` departures** for health reasons and poor working conditions
- **Enabling workers** to protect themselves

Basic concept of occupational safety & health



Aspects of OSH management

- **Identifying** and **assessing hazards and risks** (regular and non-regular operations and situations)
- **Eliminating hazards** (e.g. hazardous materials or operations)
- **Minimizing exposure** to hazards
- **Implementing** engineering **controls**
- Promoting and using **personal protection & hygiene**
- Providing **training** and instructions
- Monitoring and reporting

Basic concept of occupational safety & health

Aspects of OSH management



- Machine safety
- Electrical safety
- Chemical safety
- Ergonomics
- Work environment related safety
- Workloads and material handling
- Psycho-social safety
- Personal protection
- Emergency preparedness

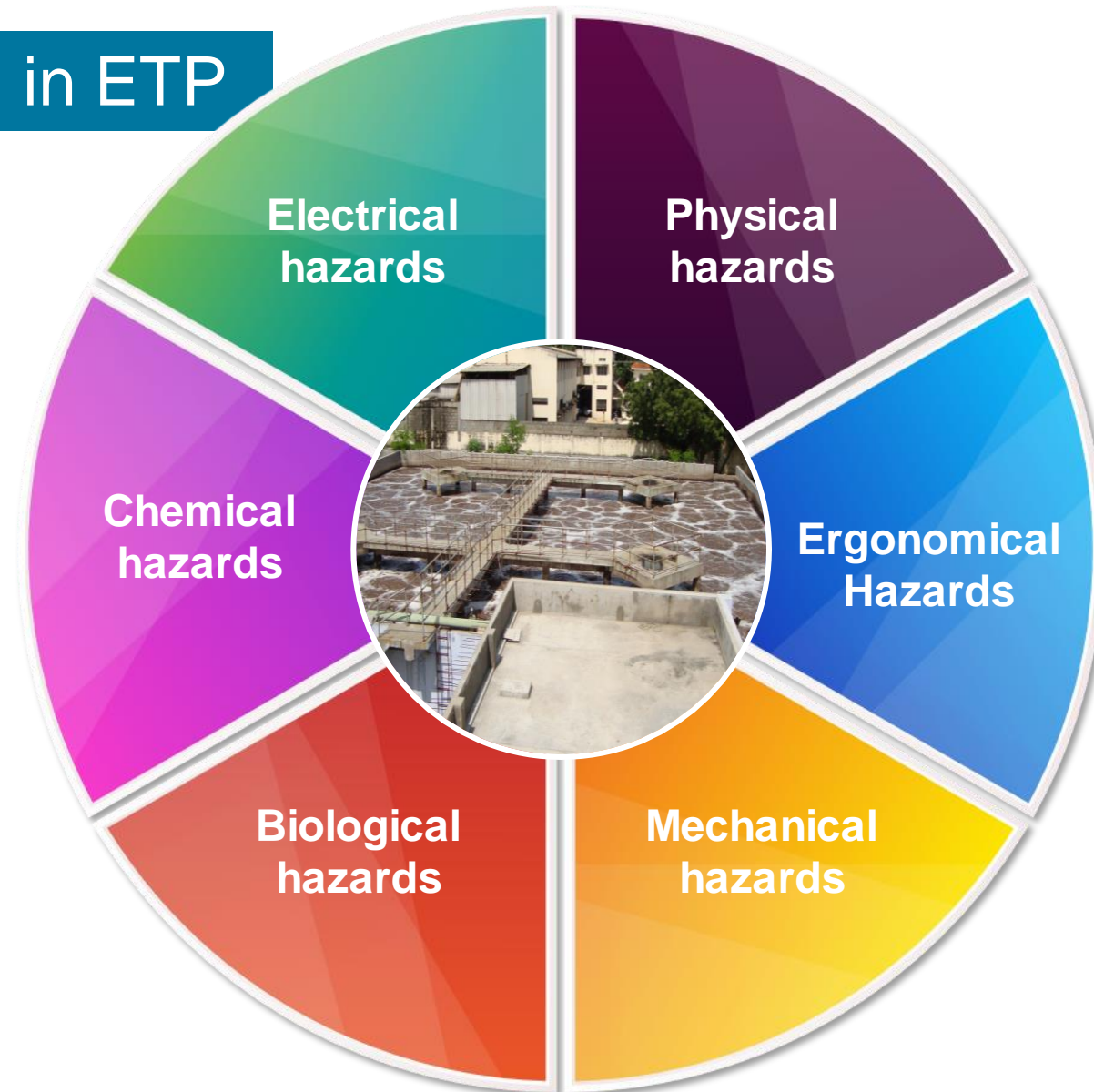


Common hazards in ETPs

What are the common hazards in the ETP?



Common hazards in ETP



Common hazards in ETP



Mechanical hazards

- **Contact with**
 - ✓ **moving machine parts** (e.g. gears, motors)
 - ✓ **sharp edges**
 - ✓ **hot surfaces**
 - ✓ other hazards with potential to crush, burn, cut, shear, stab, strike workers
- **Risk of**
 - ✓ occupational injuries, burns and fatalities

Common hazards in ETP



Electrical hazards

- Contact with **high voltage** in
 - ✓ motors
 - ✓ switchboard
 - ✓ Cables
- Enhanced risk due to poor installations, maintenance, wet and corrosive environment
 - ✓ electric shocks and (fatal) electrocution
 - ✓ electrical burns
 - ✓ fall injuries caused by jolts after contact with electricity
 - ✓ igniting fire (faulty wire, poor wiring, static electricity)

Electrical safety hazards



Common hazards in ETP



Work-environment related hazards

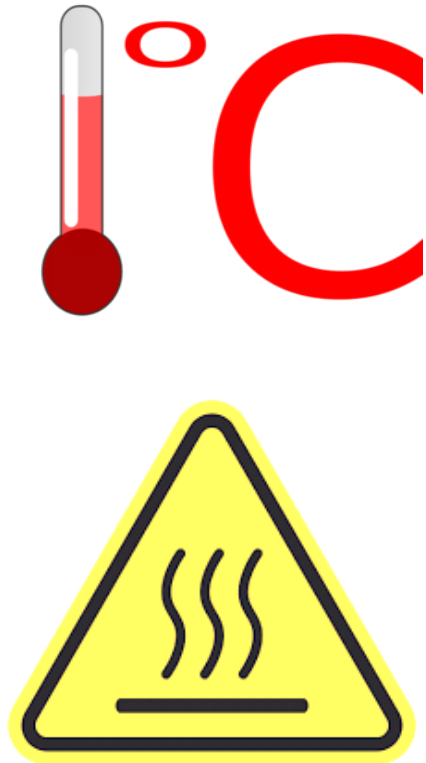
Noise

- **Air blowers**
- **Sludge centrifuges**
- Poorly maintained or lubricated moving machine parts
- Pressurized air leaks or bursts

Noise exposure for long period causing

- gradual and often irreversible hearing loss
- stress and high blood pressure
- indirect cause of injuries due to lack of concentration or distraction

Common hazards in ETP



Work-environment related hazards

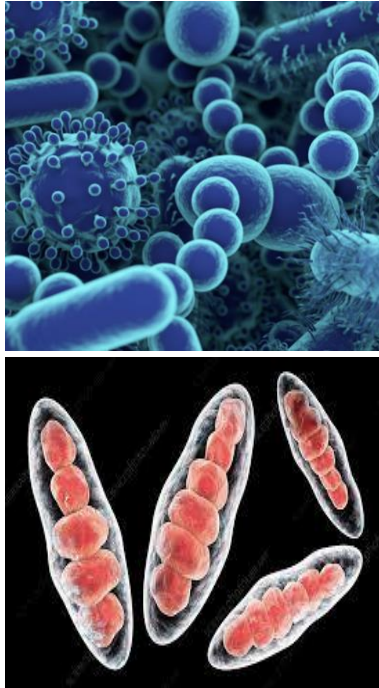
Heat-stress

- Exposure to **high ambient temperature** and direct sunlight during work in ETP
- Exposure to high radiant temperatures from raw effluent as well as hot or heat emitting equipment

Risk of

- heat exhaustion
- dehydration
- heatstroke and fatigue

Common hazards in ETP



Biological hazards

- Exposure to disease causing biological agents (bacteria, viruses, fungi, mould, blood borne pathogens, parasites)
 - ✓ Ingestion (eating, drinking or smoking at workplace or without washing hands)
 - ✓ Inhalation (small droplets, aerosols)
 - ✓ Skin and eye contact (e.g. skin wounds, softened skin, splashes on eyes)
- Bites by disease-carrying mosquitos
- Many places in ETP (aerated tanks, mixers, inflows)

Common hazards in ETP



Chemical hazards

- Exposure to and contact with treatment chemicals by
 - ✓ Skin and eye contact
 - ✓ Inhalation (gases, dust, vapours, mist and fume)
 - ✓ Accidental ingestion (eating, drinking or smoking at workplace or without washing hands after handling chemicals)

Common hazards in ETP



Chemical hazards

- Common ETP locations with chemical hazards (primary treatment)
 - ✓ Chemical storage
 - ✓ Chemical preparation and dosing
 - ✓ Disposal of chemical waste (e.g. residuals, packaging)
 - ✓ ETP laboratory

Common hazards in ETP



Chemical hazards

- Potentially hazardous chemicals in ETP:
 - ✓ Lime (e.g. dust released during handling)
 - ✓ Acidic chemicals (e.g. Ferrous Sulphate/Alum.)
 - ✓ Acids/Alkali stored and used for neutralization.
 - ✓ De-foamer used for foam control.
 - ✓ Chlorine used for disinfection and sludge bulking control
 - ✓ **Identify** possible **hazards** by consulting **safety data sheets**

Common hazards in ETP



Ergonomic hazards

- In processes involving
 - ✓ heavy lifting or handling of heavy tools or loads (e.g. machine maintenance, replacement of aeration systems, tank cleaning)
 - ✓ prolonged unconformable or strained working position
- Risk of
 - ✓ injuries
 - ✓ musculoskeletal disorders

Common hazards in ETP



Other hazards

- Asphyxiation (suffocation) while
 - ✓ working in confined space
 - ✓ Cleaning of clogged pipes
 - ✓ Removal of sludge and sediments
- Drowning following falls or slips into tanks
- Risk of Fatalities

Managing hazards and risks

Fredex / stockadobe

What steps you suggest to manage these hazards in ETP?



Managing hazards & risks



How to proceed

- Become **aware of hazards**
- **Identify and map** locations with such **hazards** (e.g. using eco-mapping) in ETP
- Observe and record **unsafe conditions and practices**
- **Assess** risk (**how likely, how severe effects**)
- Consider ways for improving focusing on
 - ✓ eliminating hazards
 - ✓ reducing risk
 - ✓ protecting against hazards
- Prepare and implement **corrective actions**

Managing hazards & risks



Example - Eliminating hazards

No hazard-no risk

- Substitution with safer equipment or chemicals
- Process modification (switching from manual to semi-automatic dosing)
- Change/ or modification of plant layout
- Provision of covers for man holes and pits

Managing hazards & risks

Example – Minimizing risks

Hazard still there but less chance of doing harm



- Installation of machine guards and cover
- Installation of fences and railings
- Installation of noise muffling devices
- Installation and maintenance of local exhaust facilities and general ventilation
- Insulation and proper earthing of electrical installations (chemical corrosion protection)

Managing hazards & risks



Machine safety

Good practices to check (Examples)

- Coupling guards for centrifugal pumps, screw pumps, high pressure pumps
- Guards around agitators of chemical preparation tanks and flash mixers
- Guards around drive assemblies of clarifiers and clariflocculators
- Guards on air blowers
- Noise reduction devices on air blowers
- Active guards on filter press

Managing hazards & risks

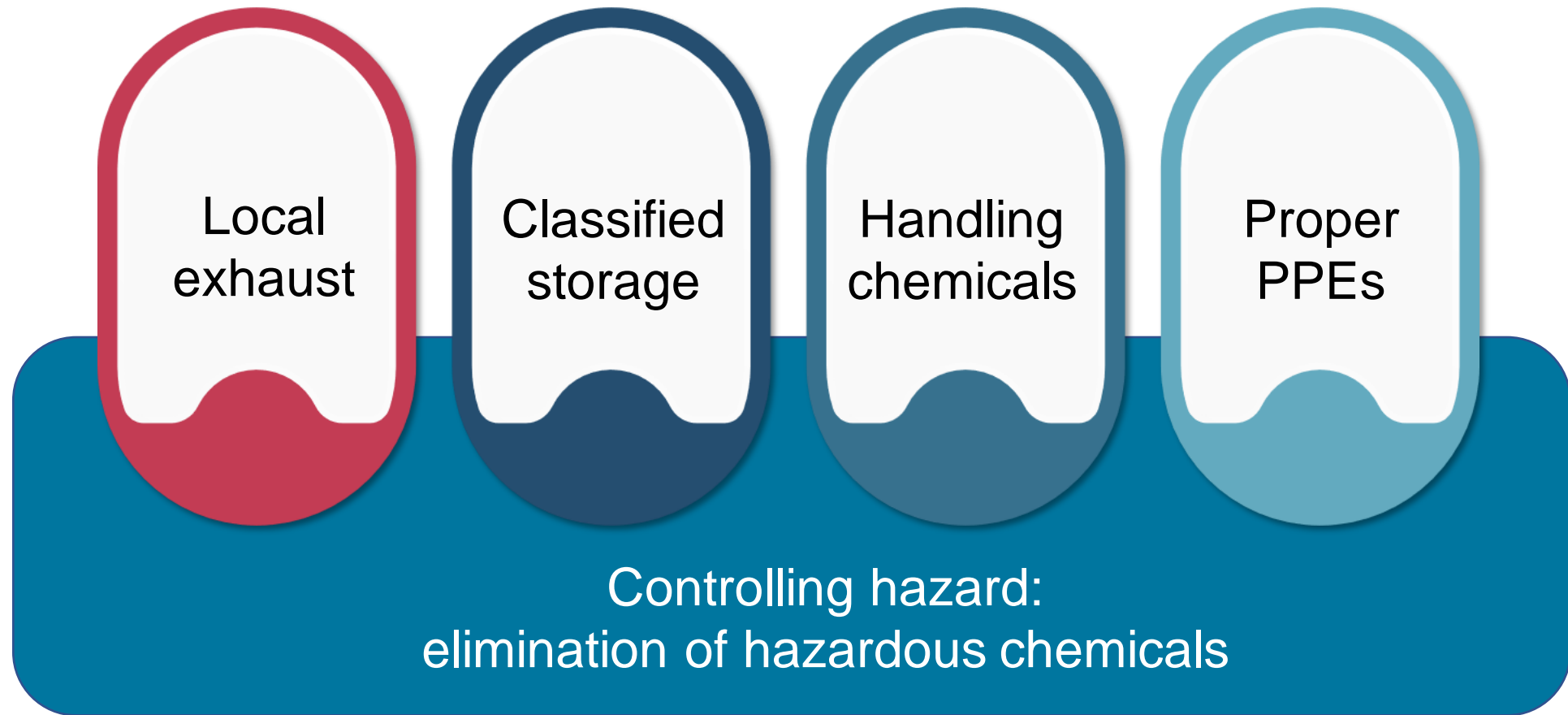


Electrical safety

Good practices (Examples)

- Correct and clean installation of cable connection, switches and control boards
- Earthing of motors
- Proper IP rating of switches and motors
- Provisions against corrosion
- Provision of properly rated fluted rubber mats in front of switch boards

Chemical safety



Managing hazards & risks

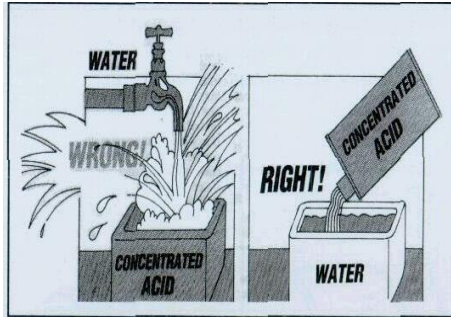


Chemical safety

Good practices (Examples)

- Standardised **labelling and markings** of all chemical containers
- Creating awareness using standardized **warning and precautionary signs**
- **Segregation** of incompatible chemicals and secondary containments
- Properly use required **personal protective** equipment (respiratory, skin and eye protection)
- Apply good **personal hygiene** practices

Managing hazards & risks



Chemical safety

Good practices (Examples)

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Managing hazards & risks



Chemical safety

- **Replace** existing chemicals **with non- or less hazardous** ones
- **Change processes** (e.g. dosing systems) to reduce need of directly handling chemicals
- Use **engineering controls** to reduce chance of exposure (e.g. local exhaust ventilation, general ventilation)
- Use **administrative control** to reduce exposure time of workers
- Prepare and communicate **work procedures**
- **Train** and **instruct workers** on safe handling practices
- Provide and use specified **personal protective equipment**

Managing hazards & risks

Chemical safety

- Good practices – Using and following safety signs



**How do you define
ergonomic hazard?**



Managing hazards & risks

Ergonomic safety



Managing hazards & risks



Ergonomic safety

- To optimize human interactions with products, equipment and processes
- design of workstations, workplaces and machine controls
- implementation labor-saving processes (e.g. lifting)
- Common focus on avoiding
 - ✓ strained position
 - ✓ handling of heavy loads
 - ✓ situations causing physical and mental stress

Managing hazards & risks

Ergonomic safety



Managing hazards & risks



Personal protection

- **Covering**
 - ✓ Use of personal protective equipment (PPE)
 - ✓ Personal hygiene practices
- **Use of PPE last option in hierarchy of control measures**
 - ✓ **Immediate measures** (!) until other options in place
 - ✓ **Protection rating** of PPE limited
- Proper **selection of PPEs**
 - ✓ Specific to situation and need
- **Training** on proper use and maintenance needed

Managing hazards & risks



Typical PPE in ETPs (selected)

- Helmet
- Safety gloves (e.g. chemical, electrical)
- Overall
- Boots and safety shoes (hardened toe caps)
- Noise protectors
- Safety goggles and shield
- Respiratory protection
 - ✓ Air-purifying masks
 - ✓ Air supply system (confined space, emergency)
- Safety harness

What should be the emergency safety provisions in the ETP?



Managing hazards & risks



Emergency provisions and facilities

- On-site emergency plan
- Safety shower (nearby)
- Eye / face rinse station (nearby!)
- First aid box and trained first aid personnel on each shift
- Fire fighting equipment
- Lifebuoys and rescue hooks at tanks

Managing hazards & risks

Emergency provisions and facilities

First aid box - Suggested content



Absorbent gauze [packet of 10 pcs]	Adhesive plaster roll [1.25 cm width]
Crepe bandages [5.0 cm height]	Crepe bandages [7.5 cm]
Disposable glove	First aid pamphlet
Individually wrapped sterile adhesive dressing	One-way valve transparent mask or two-way mouthpiece
Safety pins	Scissors
Sterile water or saline in 100 ml disposable container	Triangular bandage

Managing hazards & risks

Supportive measures



- **Induction and refresher **safety training** to staff at all levels**
 - ✓ Basic and advanced safety measures (dealing with common hazards)
 - ✓ First aid and emergency training (including regular drills)
- **Hazard and safety communication**
 - ✓ Sign boards and safety information
 - ✓ Emergency contact numbers of fire station, doctor, EHS manager and staff
 - ✓ Establishment of **safety committee**
 - ✓ Periodical **health monitoring**

Managing hazards & risks



Supportive measures

Awareness creation

- Prevalent hazards
- What to do
- What not to do

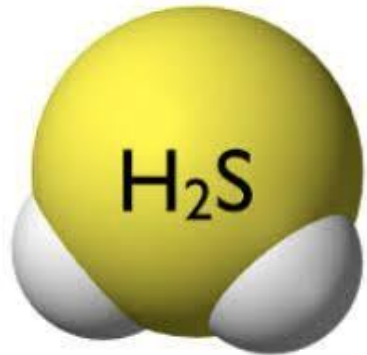
Safety risks & precautions against Hydrogen Sulphide gas

Image: Metalcare Group

What do we know about Hydrogen sulphide?



Management of Hydrogen sulphide



- Generation and release of Hydrogen Sulphide (H₂S) gas key risks in ETP
 - ✓ **highly toxic**, colorless gas, **heavier than air**, invisible, strong **unpleasant odor** (in low concentrations)
 - ✓ causing drowsiness, nervous problems, loss of consciousness, death (in high concentration)
- Detection of H₂S critical:
 - ✓ **strong odor in very low concentration** not having adverse effects on health
 - ✓ **Severe health effects in higher concentrations**, when not detectable by humans by smell
- Often wrong assumption about no H₂S being present (!)

Management of Hydrogen sulphide

Impact of H₂S gas on humans

Exposure in ppm	Time	Effect on unprotected person
0.03	No limit	No effect
0.03-2		Odour threshold
10	Up to 8 hrs	No effect
10-20		Threshold for eye irritation
20-200		Headache, nausea, general weakness, pain in legs
200-500	1 min.	Irritation of nose & throat, vertigo, blurring of vision, temporary loss of consciousness
500-900	1 min.	Profound coma, muscular spasm- twitching convulsions, disorientation after recovery
900 and above	1 min.	Instant coma and death

Management of Hydrogen sulphide



ETP locations with Hydrogen Sulphide gas risk

- Raw effluent channel
- Manholes
- Pumping stations and receiving sump at ETP
- Valve and pump pits
- Equalization tank, effluent transfer pump sump and valve pits
- Unutilized pits and tanks
- Primary sludge pumping room and tanks
- Sludge thickener
- Sludge dewatering equipment feed tank

Management of Hydrogen sulphide

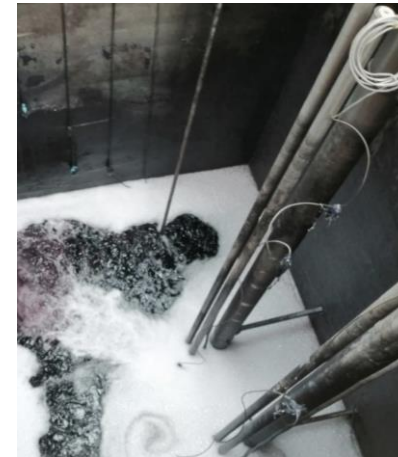
ETP locations with Hydrogen Sulphide gas risk



Effluent channels



Sludge collection tanks



Deep pits

Management of Hydrogen sulphide



Detection and measurement of H₂S

H₂S meters commonly used

- **On-line meters** installed in fixed location
 - ✓ in raw effluent and sludge handling areas
 - ✓ to alert operators with alarm at set concentrations (e.g. 10 to 15 ppm)
- **Portable meters** for real-time accurate reading
 - ✓ For testing confined spaces and general work areas to verify presence or elevated levels of H₂S
- **Personal detectors** worn by workers
 - ✓ to alarm workers at set concentrations (e.g. 10 to 15 ppm)

Management of Hydrogen sulphide

Detection and measurement of H₂S

Alternative methods without meters

- using lead acetate paper as emergency measure
- Similar to pH papers and handy.
- paper strips extended into tank or areas for few minutes,
- coloration indicate gas presence, but not very reliable compared to H₂S meter
- Moist lead acetate paper turning black due to formation of lead sulphide when reacting with gas.



Management of Hydrogen sulphide



Protecting against H₂S

Need for external supply of clean air (oxygen)

- Self contained breathing apparatus (SCBA)
- Air line supply system

Management of Hydrogen sulphide



Using air line supply system to work in deep tanks

- **Compressed air cylinders** supply for one or two wearers
 - ✓ 1.5 hours for two persons or 3 hours for one person
 - ✓ depending on workload, ambient temperature, wearer's stress level.
 - ✓ **air supply** to be constantly **monitored**
- **Wire embedded rubber air hose** with adjustable couplings of at least **at least 15 meters**.
 - ✓ protected against contact with sharp edges
 - ✓ regularly tested for wear, tears and leaks.

Management of Hydrogen sulphide



Work procedure for areas with H₂S

- ✓ Use mechanical equipment to avoid manual entry
- ✓ Agitate tank or areas manually or mechanically
- ✓ Induce temporary air circulation using blowers
- ✓ Check H₂S gas with gas meter (or lead acetate paper)
- ✓ Enter with safety harness, air supply unit, gloves and boots
- ✓ Person outside maintains clear and constant communication with worker inside
- ✓ Compressor to placed at distance to draw fresh air
- ✓ Compressed air to be free of moisture, oil and carbon monoxide

Management of Hydrogen sulphide

Precautions for dealing with Hydrogen Sulphide gas



How do you respond to an emergency due to H₂S?



Management of Hydrogen sulphide



Being prepared for emergencies

- **Exclusive emergency** and safety **equipment**
 - ✓ ready in properly **marked location**
 - ✓ **clean** and in **good order**
- First aiders and yourself **trained on required measures**
- **Rescue drills** for all risk locations in your ETP
 - ✓ in particular from tanks, pits, manholes

Management of Hydrogen sulphide



Being prepared for emergencies

- **Contact numbers** of fire brigade and hospital on display.
- Close liaising with nearest **fire brigade** for immediate assistance
- Close liaising with **company doctor** and nearest **hospital** to assure their emergency preparedness
- **On-site emergency provisions to match response time of emergency services!**

Management of Hydrogen sulphide



Responding to emergencies

- Protect yourself before rescuing victim using appropriate safety equipment
 - ✓ Do not enter area if not adequately protected!
- Immediately remove victim from accident area
- Alert emergency service
- Start providing first aid (see next slide)
- Arrange for transport to nearest doctor or hospital

Management of Hydrogen sulphide



Responding to emergencies

First aid measures

- Artificial respiration if victim not breathing
- If breathing and unconscious, place victim on side with face down
- Attend to wounds and stop bleeding
- Treat for shock.
 - ✓ Place victim on side and
 - ✓ Cover with blanket to keep warm.

Management of Hydrogen sulphide

Responding to emergencies

First aid measures

H ₂ S exposure	Symptoms	Preventive measures	First Aid measures
Inhalation	Cough, dizziness, headache, sore throat, lung edema, unconsciousness	General ventilation Local exhaust ventilation Respiratory protection	Fresh air and rest Artificial respiration Medical attention including oxygen supply
Eye contact	Redness, eye pain	Safety goggles Eye protection combined with respiratory protection	Washing eye with fresh water Rest

To remember!



- Efforts to focus on eliminating hazards & reducing risks
- Use of personal protective equipment helpful but only one step in controlling hazards and risks
- Priority to **avoid need for entry** into confined and H₂S risk areas
- Develop and use **standard operating procedure**
- Keep ready and use necessary **safety and emergency equipment**
- Important to update one's safety knowledge and skills by regular training and drills

For further reading and reference

UNIDO Pocketbook “How to deal with H₂S gas in ETPs

- <https://open.unido.org/api/documents/4670868/download/How%20to%20deal%20with%20hydrogen%20sulphide%20gas%20in%20tanneries%20and%20effluent%20treatment%20plants>

UNIDO Safety Video

- www.youtube.com/watch?v=xQkXMyetLfM&t=157s

UNIDO e-learning

- <https://leatherpanel.org/content/unido-line-course-how-deal-hydrogen-sulphide-gas>

**Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH**

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de