

Safety of biogas plants: General introduction, experiences from practice and lessons learned



Biogas
can do it!

Dipl. Wirt. Ing. (FH) Marion Wiesheu, Head of Training and Safety

Fachverband Biogas e.V., German Biogas Association

Frank Hofmann, International Affairs

Fachverband Biogas e.V., German Biogas Association

Content

- **Why is safety on biogas plants that important?**
- Hazards on biogas plants
- Risk evaluation and precautions
- Pictures from practice

Why is safety on biogas plants that important ?

- Unsafe biogas plants can be a danger to humans and the environment
- Every accident damages the image of the technology and therefore of the sector



- Every accident costs a lot of money
- Every accident can lead to new safety requirements

Accident

Fire in the CHP and electrical room with leakage

How did the accident happen:

- Leaky oil pressure line (approx.. 70 liters of engine oil leaked)
- Ignited on the turbocharger exhaust system
- Fire in 3 CHP units, entire electrical and gas installation
 - Power supply failure
 - Failure of agitators
 - „Yeast dough accident“
- Gas generation could be protected from flying sparks
- Total damage of approx. € 1.2 million (insurance only covered part of it)

Causes for the high extent of damage:

Fire protection concept, smoke detector, fire barrier, automatic gas gate valve, sufficient extinguishing water, ... not available.



Source: Toni Baumann

Hazards on biogas plants

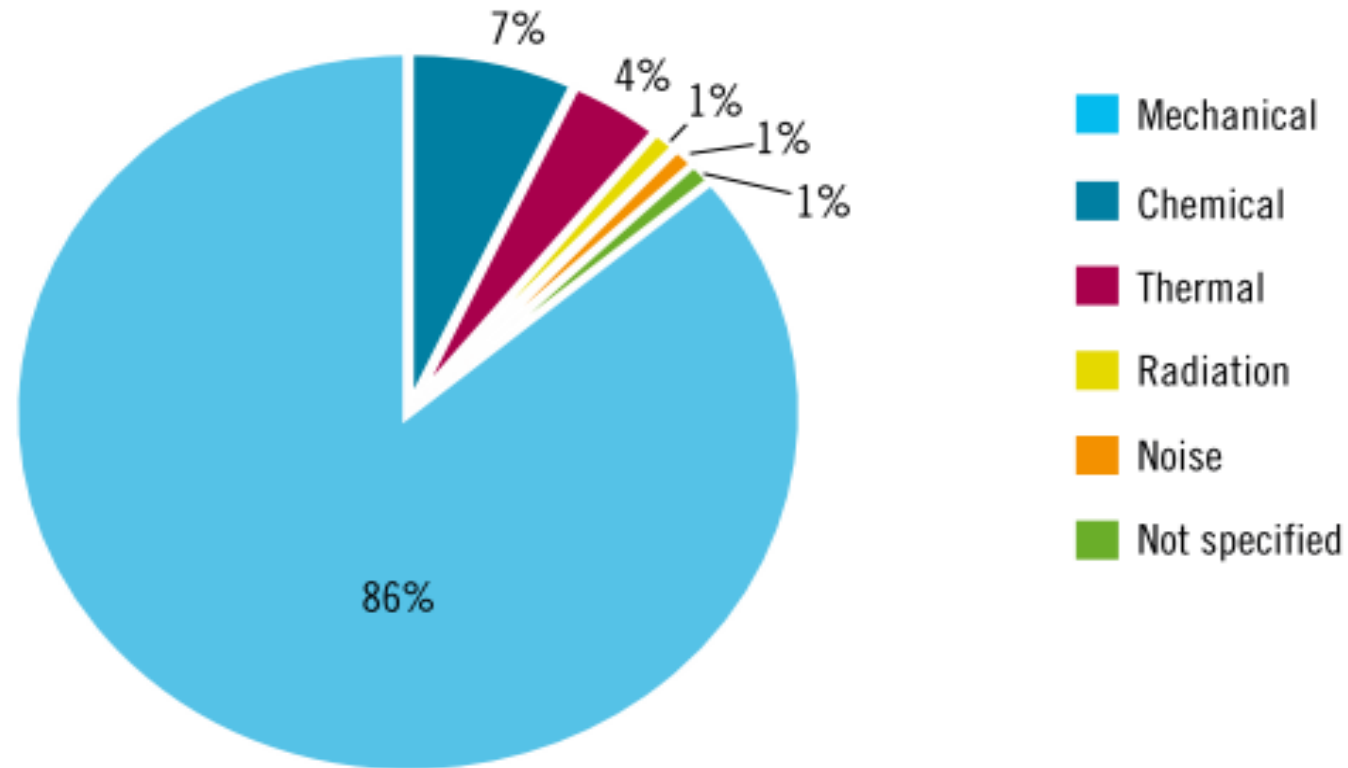
General hazards:

- Health hazards
- Environmental hazards:
 - gaseous emissions (CH₄, CO₂, NH₃, NO_x, SO_x, CH₂O ...)
 - emissions to soil and water (digestate, silage, processing aids...)



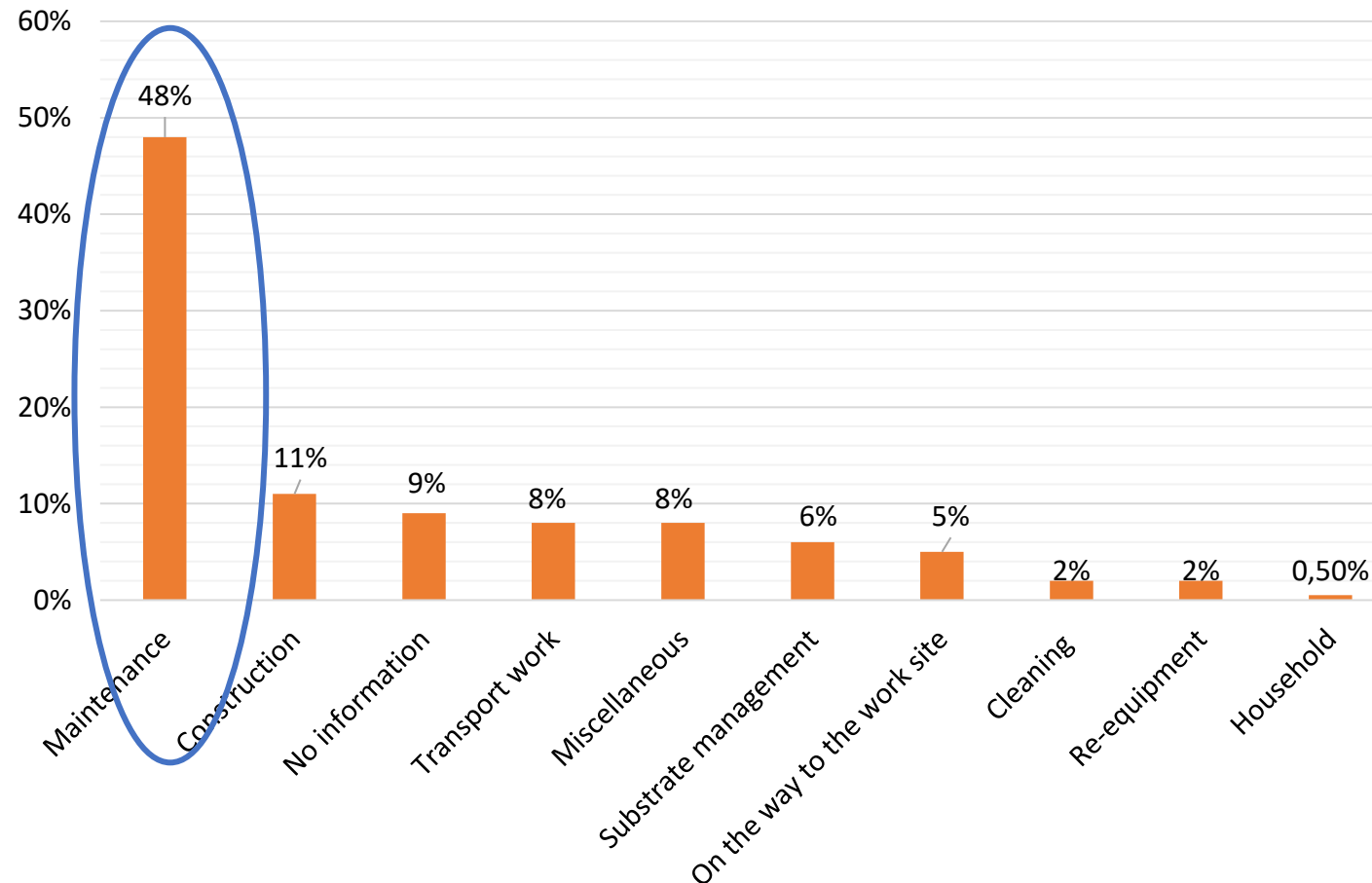
Types of accidents (2012)

Types of accidents with injured persons at biogas plants



Working areas of the accidents

Accidents in biogas plants between 2009 – 2011 in Germany



Health hazards

Danger from fire



Biological agents

Hot surfaces



Noise

Mechanical hazards



Falling, crashing, etc.

Electric shocks caused by electric components



Danger of explosions

Mechanical hazards

- Mechanical hazards are present through moving parts of machinery and dangerous surfaces.
- They are usually not specific to biogas technology.



Gas hazards

Gas hazards are present on biogas plants through dangerous components of biogas itself:

	Properties	Hazardous atmosphere	Workplace exposure limit
CO ₂	Colourless and odourless gas. Heavier than air.	8 % v/v, danger of asphyxiation.	5500 ppm
NH ₃	Colourless and pungent-smelling gas. Lighter than air.	Above 30–40 ppm mucous membranes, respiratory tract and eyes become irritated. Above 1000 ppm breathing difficulties, potentially inducing loss of consciousness.	20 ppm
CH ₄	Colourless, odourless gas. Lighter than air.	4.4–16.5 % biogas = 6-22 Vol. %	-
H ₂ S	Highly toxic, colourless gas. Heavier than air. Smells of rotten eggs	Above a concentration of 200 ppm the sense of smell becomes deadened and the gas is no longer perceived. Above 700 ppm, inhaling hydrogen sulphide can lead to respiratory arrest.	5 ppm



Fire/heat hazards

- Fire hazardous materials:
 - Biogas
 - wooden constructions,
 - trace elements for the biological process
 - sulphuric acid for gas- and air washer
 -
- Hazard of fire due to hot surfaces
 - engines/motors
 - gas flare
 - drying systems for digestate
 - ...
- Hazard of scalding: hot water, steam....



Source: Biogas Safety first! Guidelines for the safe use of biogas technology; Fachverband Biogas e.V.;
Photo: Uwe Mühling

Hazardous substances

- Hazardous substances can take the form of solids, liquids, aerosols and gases.

- Chemicals

- Processing aids
- compounds for desulfurization
-

- Biological agents

- microorganism
- cell culture
- human endoparasite



Photo: Martina Bräsel



- Hazardous properties: harmful to health, toxic, very toxic, corrosive, sensitizing

Electrical hazards

- Electrical equipment:
 - Control equipment, CHP unit, pumps, agitators, measuring instruments, ...
- Causes for accidents:
 - Defective electrical equipment, electrical lines, lightning protection, electrical installations, ...
- Hazards:
 - Explosions, fires or even electrical shocks
- Preventive measures:
 - Use of safe electrical equipment,
 - Turn off electricity,
 - To ask advice from a qualified electrician



Source: ISO 7010

Other sources of hazards

- Surrounding environment:
 - Flooding
 - Earthquakes
 - Storms
 - Ice and/or snow
 - Power outage
 - Heavy rainfall
 - Frost



Source: Biogas Safety first! Guidelines for the safe use of biogas technology; Fachverband Biogas e.V.; Photo: VGH Versicherungen

- Inappropriate behavior:
 - Action by unauthorized persons
 - Dangers caused from the staff (Operating errors, Sabotage, ...)

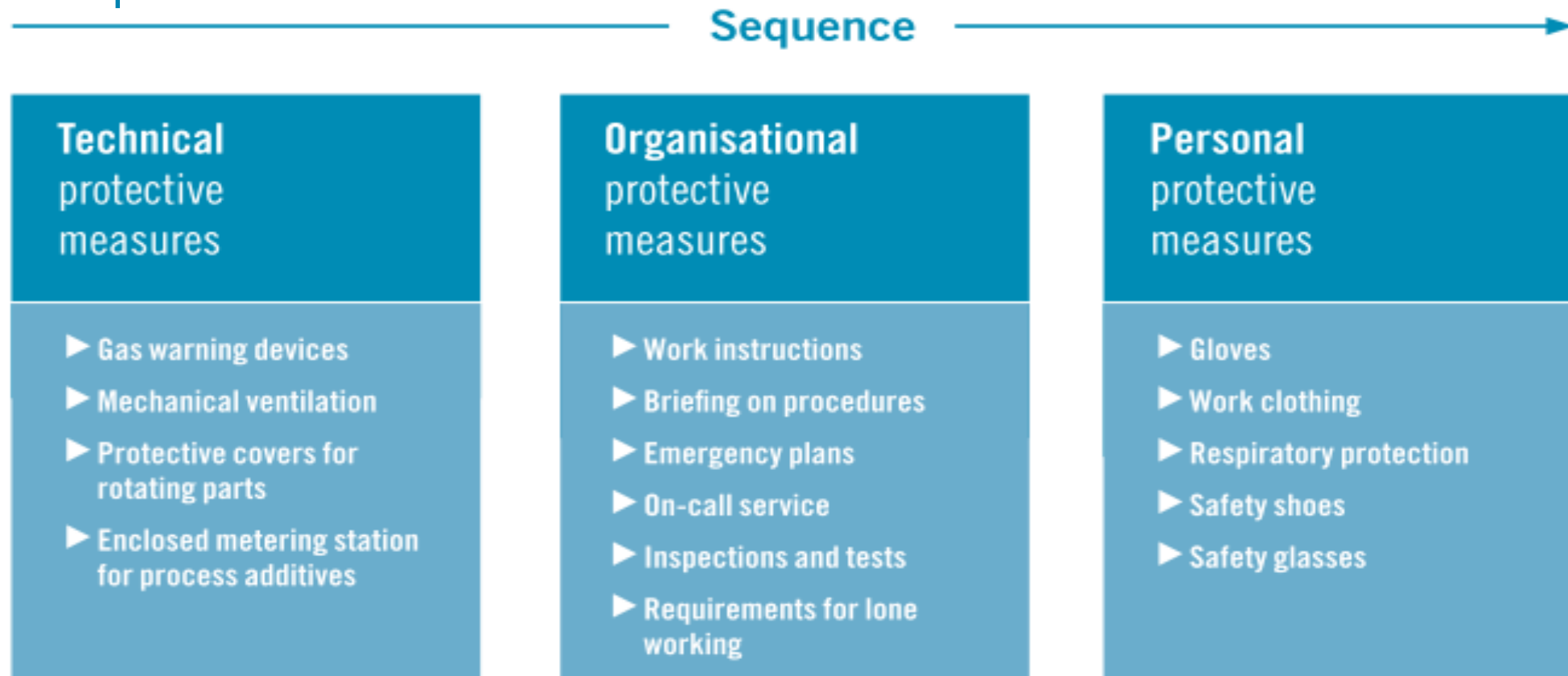
Risk evaluation and precautions

Hazard Assessment

- The hazard assessment is obligatory for operators of biogas plants. Its goal is to protect and reduce the exposure to risks and hazards of employees.
- The results of this assessment should help the operator determine, evaluate and minimize the hazards by appropriate safety measures.
- Its results should be considered in the design and selection of equipment and material and in the design or workplaces, work processes and operating sequences.
- The findings of the hazard assessment and all recurring updates must be documented!

Risk evaluation and precautions

T-O-P Principle

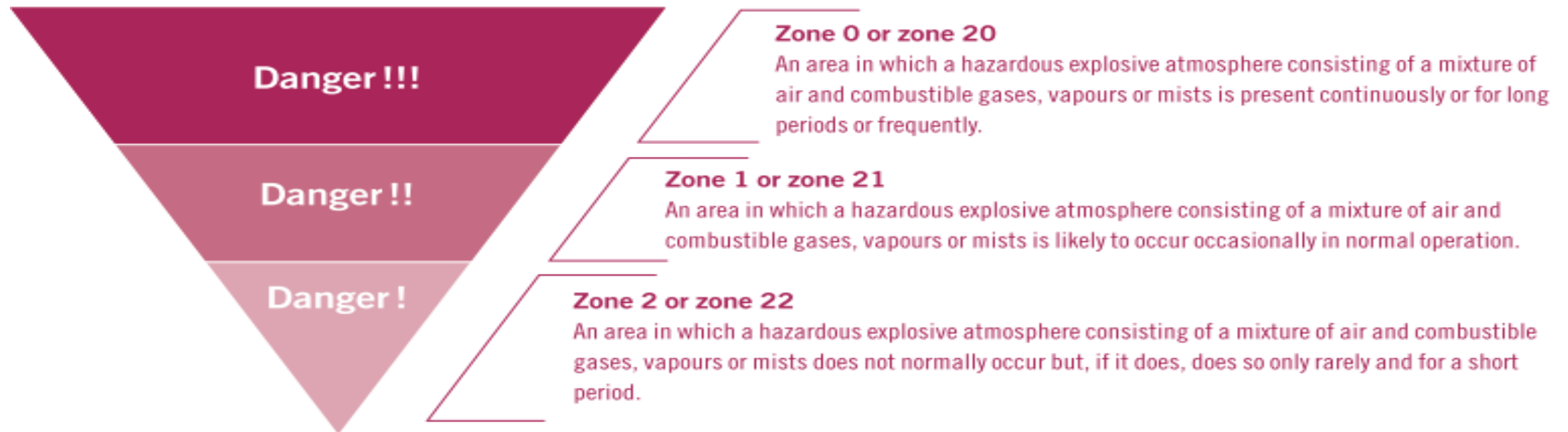


Fire prevention

Possible ignition sources on biogas plants

- Hot surfaces, flames and hot gases, mechanically caused sparks,
- Electricity
- ...

Ex-Zoning



Important experiences from Germany

- A biogas plant is a complex industrial building!
- Experiences show:
 - that the better the planning, the more successful a project can be.
 - it is better to invest more in a reliable plant than buying a low cost technology with low performance parameters.
- Most important is the reliable, stable and safe operation with low maintenance effort and low still stand time.
- Every biogas plant should have a hazard assessment and an explosion protection document.
- The operating staff and the plant owner need professional skills and knowledge for safety, they need to be trained regular.

➔ **Keep it safe and simple!**

➔ For more information see our safety guidelines



Available as a pdf in English, Spanish, French, Portuguese, Serbian, Indonesian and soon in Dutch! www.biogas-safety.com

Examples from Practise I



Unsafe
Genset
installation



Examples from Practise II



Danger of falling into the lagoon

Examples from Practise III



- Outflow regulated by hand. The worker stands in the outflow.
- Slippery standing position
- Several items to stumble

Examples from Practise IV



- Overgrown condensaate trap

Examples from Practise V

- Start up phase of a lagoon is very sensitive
- Membrane is partly swimming on water,
partly filled with biogas
- During operation:
 - Questionable safety,
especially during heavy weather conditions
Like storms rany season etc



Examples from Practise VI

- Gas storage membrane is not technically fixed



Thank you for your attention!

For more information:

Fachverband Biogas e.V. (*German Biogas Association*)
Angerbrunnenstr. 12
85356 Freising - Germany

Tel: +49 8161 9846-60

Email: info@biogas.org

Web: www.biogas.org



Available as a pdf in English, Spanish, French, Portuguese, Serbian, Indonesian and in Dutch
www.biogas-safety.com