Safety of biogas plants during construction and operation

Lucas Wagner
Head of Training and Safety
Fachverband Biogas e.V.
Agenda

• German Biogas Association

• Current status of safety of biogas plants

• Building requirements

• Obligations of operators and manufacturers

• Lessons learnt
### Structure of the German Biogas Association

- **Headquarters in Freising**
  - 23 employees, organised in 10 departments

- **Berlin Office**
  - 5 employees

- **Regional offices (North, South, East, West and Editorial Office Biogas Journal**
  - 5 employees

- **23 Regional groups in Germany**

- **Steering Committee**
  - 7 members, elected by all members for a 4-year-period

- **Board of Trustees**
  - Elected honorary spokesmen of regional groups, working groups and advisory boards

- **Advisory Boards, Working Groups**
  - Advisory boards of plant operators, companies, the legal profession, funders; Working groups for the areas permissions, safety, feeding-in of biogas, environment, heat, waste and fertiliser law

- **23 Regional groups in Germany**
  - Over 400 honorary experts

### Members of the European Biogas Association (EBA)

- Operators of biogas plants
- Providers of feedstock
- Research Institutions
- 4,800 Members
- Interested private individuals
- Public authorities
- Lawyers
- Companies and manufacturers
- Corporate finance
- Planners, advisers, laboratories

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Current status of safety of biogas plants

Schwerpunkte der Prüfungen 2013 nach Anlagenarten der §29b BImSchG
Sachverständigen

Quelle: Dr. Ziegenfuß (KAS), eigene Darstellung
Current status of safety of biogas plants

Examples of deficiencies (extract)

- Missing statics of the gas storage
- Components are not frostproof
- Missing lightning protection
- Over-/underpressure protection was constructed without podest
- Design of the Gas storage was deficient
- Flare was inoperable
- Operating instructions were missing
- Inspection report was missing
- No backup power supply

Quelle: Josef Ziegler, § 29b BImSchG Sachverständiger
Current status of safety of biogas plants

Examples of deficiencies (extract)

- Process control engineering partly not functional, e.g. flame detector, leak probe, overfill protection, emergency stop
- Explosion protection document not up to date or was missing
- Many deficiencies regarding the documentation
  - Emergency response plan, ground plans for fire brigade use, fire safety regulations, plans of evacuation routes are missing
  - Documentation incomplete (flowcharts, list of hazard materials, plans)
  - Concept for the prevention of incidents was missing
  - Deficient documentation of safety management system
Current status of safety of biogas plants

Quelle: Josef Ziegler, § 29a BImSchG Sachverständiger
Current status of safety of biogas plants

17.03.15 – Memmingen – fire in chp building

12.03.15 – Weißenburg – explosion - maintenance

16.06.15 – Arnstorf – substrate leakage
Current status of safety of biogas plants

Source: SVLFG
Reasons for deficiencies during construction and operation

- Important information of the plant are not handed out to the plant operator
  - Flow chart
  - Process control matrix
  - ...

- Wrong design of plant components
  - Over-/underpressure valve
  - flares
  - ...

- Deficient concrete quality
  - Crack formation
  - settlements

- ...

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Reasons for deficiencies during construction an operation

- Many plant operators are overchallenged
  - Industrial standards are claimed, plant operators are not familiar with these requirements.

- Plant operators have not sufficient knowledge to scrutinize/to challenge the work of manufacturers.

- Lack of communication between manufacturers and operators
  - Mangelhafte Kommunikation führt zu Missverständnissen in der Aufgabenverteilung bzw. zu mangelhaftem Verantwortungsbewusstsein des Betreibers.
  - Deficient communication leads to misunderstandings regarding task allocation and to an insufficient sense of responsibility

- ...
Agenda

- German Biogas Association
- Current status of safety of biogas plants
- Building requirements
- Obligations of operators and manufacturers
- Lessons learnt
Building requirements

• Overground built parts of the biogas plant need a safe foundation and have to be protected against damages. The stability has to be ensured.

• Gas-carrying parts have to be protected against chemical and weather caused influences. In exposed areas they have to be protected against mechanical influences and damages (e.g. collision protection).

• Electrically conductive parts have to be connected with each other and with the earth wire (equipotential bonding).
Building requirements

- Control stands and control panels of agitators, pumps and purging devices have to be built overground, if not possible: forced ventilation. Sufficient ventilation has to be guaranteed.

- Insulation of digesters has to be at minimum normally inflammable, e.g. B 2 DIN 4102.
Building requirements

- Gas storages have to be gastight, pressure-resistant and resistant to aggressive media. Materials have to fulfill the following requirements:
  - Tear strength min. 500 N/5 cm or
  - Longitudinal strength 250 N/5 cm
  - Gas permeability regarding methane < 1000 cm³/m² x d x bar
  - Temperature-resistance for special usage (mesophiler, thermophiler Vergärungsprozess)
  - Gas tightness has to be proven before commissioning
Building requirements

- Between gas storages and other buildings/plants (height < 7.5m) or thoroughfares the protective distance has to be 6m (horizontal).

- Buildings with $h > 7.5m$ (gas storage or other buildings):
  
  $$0.4 \times H_1 + 3m$$

- In case of two buildings with a height < 7.5 m (gas storage or other buildings):
  
  $$0.4 \times H1 + 0.4 \times H2$$
Building requirements

- Between gas storages and chp-buildings the protective distance has to be 6 m
- The protective distance can be reduced through fire barriers or earth deposits.
Building requirements

Concrete for foundation

- Exposition class: XC4, XA1
- Concrete grade: C25/30
- Cement/water ratio ≤ 0,60
- No protective measures necessary
- Control class 2
- Concrete protection of the reinforcement 40 mm

Quelle „Gäutfuttersilos, Güllebehälter, Biogasanlagen“
W. Rothenbacher, W. Hemrich, H. Zimmermann, (BetonMarketing Deutschland)
Building requirements

Concrete for digester with outside insulation

- Exposition class XC4 (inside), XC1 (outside), XA3
- Concrete grade : C35/45
- Cement/water ratio ≤ 0,45
- Protective measure necessary
- Control class 2
- Concrete protection of the reinforcement 40 mm

HS cement is recommended.

Quelle „Gärfuttersilos, Güllebehälter, Biogasanlagen“
W. Rothenbacher, W. Hemrich, H. Zimmermann, (BetonMarketing Deutschland)
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Obligations of manufacturers and operators

- **Statutory basis:**
  - EU Machinery Directive (old: 2006/42/EG new: 95/16/EG) = Product Safety Act (ProdSG) in Germany

- **Manufacturer has to forward all information, which are necessary for a safe plant operation, to the plant operator:**
  - Operation instruction and hazard analysis for the product (biogas plant or components)
  - Declaration of incorporation (z.B. ATEX / Ex-Zone)
  - European Conformity (CE)
  - Maintenance instruction

- **Watch out!** operators can also become manufacturers,
  - Modifications of the machine, regarding
    - Power, scope
    - function
    - Safety engineering
    - Own production of machines!
Obligations of manufacturers and operators

BetrSichV

- Contractors must have technical knowledge

- Operator and contractors have to inform each other about the risks/hazards of their works.

- If a hazard cannot be barred, the employers have to create a risk assessment.

- If there are exceptional hazards, a coordinator has to be consulted.
Obligations of manufacturers and operators

BetrSichV

- The employer/operator has to implement maintenance measures. The work equipment has to be save. Information of manufacturers have to be taken into account.

- Maintenance measures have to be implemented on the basis of a risk assessment.

- Maintenance measures have to be done by expert, ordered and instructed employees or by extern experts.
Obligations of manufacturers and operators

First and recurring safety-inspections of work equipment/facilities

- Inspection of the explosion protection every 6 years

- Extra inspection of devices, protection systems and appliances after RL 94/9/EG every 3 years

- Additional expectations of vents, gas detection devices and inertisation devices every year
Obligations of manufacturers and operators

- Substitution of hazards after TRGS 600
  -> This implies the reduction of...

  - CMR-substance -> no CMR-substance
  - Very toxic -> toxic -> harmful -> no attributes
  - High amounts -> small amounts
  - fluid -> paste
  - dusty -> grained -> coated products
  - Open system -> closed system

additives, which are acute toxic (Kat. 1, 2, 3), carcinogenic, mutagen, keimzellmutagen and toxic for reproduction (jeweils Kat. 1A und 1B) have to be substituted if there are technical alternatives.
Obligations of manufacturers and operators

Dosage of additives

- acute toxic (Kat. 1, 2, 3), carcinogenic, mutagen, keimzellmutagen and toxic for reproduction (jeweils Kat. 1A und 1B) have to be dosed by a closed system,
- Only experts are allowed to implement the dosage
- The safety data sheet has to be available
Obligations of manufacturers and operators

Responsible person

- employer
- one person of the circle of employees

Qualified substitute

- one person of the circle of employees
- extern

or
Obligations of manufacturers and operators

An explosion protection document and an explosion-protection-zone plan have to be implemented into the risk assessment after GefStoffV.
Obligations of manufacturers and operators

- Implementation is obligatory

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Beispiel</th>
<th>Merkmale/Bemerkungen/ Voraussetzungen/Hinweise</th>
<th>Schutzmaßnahmen nach TRBS Teil 2</th>
<th>Festlegung der Zonen (Zündquellenvermei- dung TRBS 2152 Teil 3)</th>
<th>Schutzmaßnahmen nach TRBS 2152 Teil 4</th>
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<tbody>
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<td>(Sp.1)</td>
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4.8.6.2 Umgebung einfacher Foliensysteme

a) Die technische Dichtheit wird erstmalig und wiederkehrend, z.B. Ortung mit Gaskamera und Kontrolle mit schaumbildenden Mitteln oder geeignetem Gaspärgerät, überwacht.

| 2.4.3.3 | 2.4.3.5 | Keine Zone | Keine |

b) wie a), jedoch ohne wiederkehrende Kontrolle

| 2.4.3.3 | Zone 2: 3m um Folie und 2m nach unten mit 45° siehe Bild, ... | Keine |

![Diagram of a gas tank with zones marked by circles and angles.]
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Further Activities of the German Biogas Association

- Latest tools and pamphlets
  - A-001 safe working in digesters
  - A-002 briefing for subcontractors
  - A-003 checklist for safe operation of the biogas plant
  - A-004 requirements regarding the organisation
  - A-005 concretisation of the TRGS 529 additives
  - A-006 guideline for an emergency power system
  - ...

- Safetytour across Germany (regional groups of operators) until the end of 2015

- ISO TC 255 „Standardization of Biogas“: 2 work groups in operation (Terms/Definitions und Gasfackeln)
Further Activities of the German Biogas Association

- pamphlet DWA M 377: Biogas – storage systems - draft (Juli 2015)
- Pamphlet for the requirements of gasflares until 2016 => Input for ISO-TC 255
- Pamphlet for the requirements of the piping: in progress
- Technical Safety Management System (TSM) Biogas: pilot phase with 2 succesfull inspections
Further Activities of the German Biogas Association

- **Explosion protection**
  - Collection of examples
  - DGUV R 113-001
  - Explanation by GBA

- **Gas storages**
  - 2 pamphlets (DWA/DVGW) in progress
  - Statik

- **Trainings**
  - Qualification of operators
  - Schulungsverbund
  - Criteria for speakers and institutes
  - DVGW / G1030

- **Umsetzung der AISV-Empfehlungen für 29a SVs**
  - A-003 checklist for safe operation of the biogas plant

- **Störfall IV**
  - A-004 requirements regarding the organisation
  - Protective distance
Lessons learnt

- The safety of biogas plants is significantly influenced during the planning and construction
- Independent expertise should be involved during the planning of the plant
- The manufacturers of biogas plants must adhere to the planning requirements (distances, concrete quality,…) and hand out the documentation to the operators.
- Operators often have insufficient knowledge. The mandatory participation in a training course can lessen that.
- Experts should help operators with the documentation
- The German Biogas Association supports the operators with pamphlets etc.
Thank you for your attention!