Start-Up of a Biogas Plant
Organization, Technology, Responsibility

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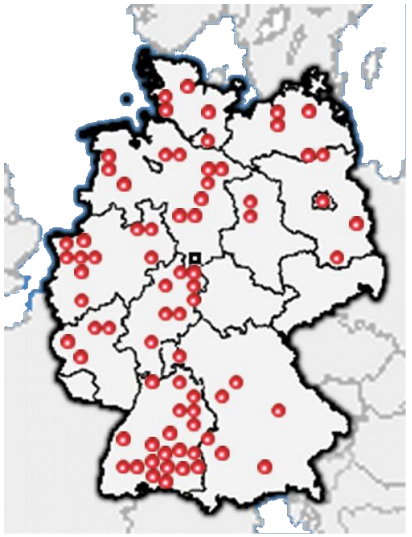
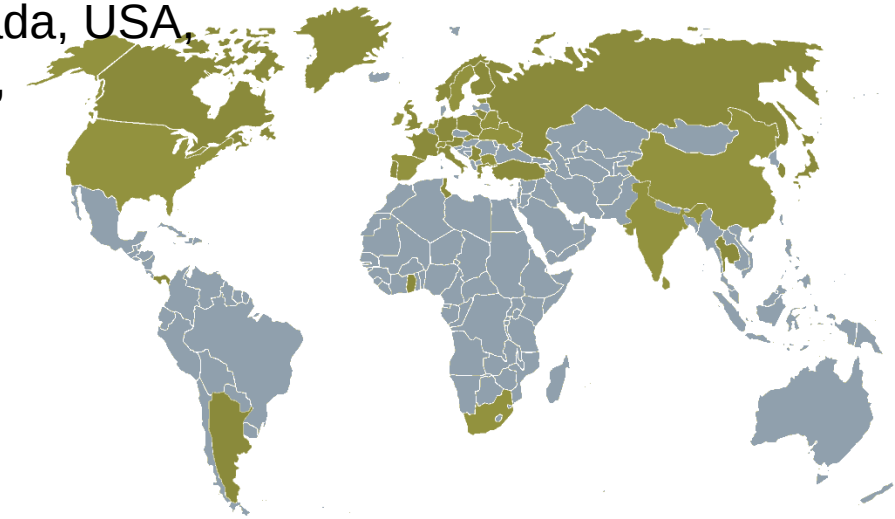
Engineering Office, specialized in Design and Engineering of Biogas Plants

Foundation:	1999
Team:	20
Experience:	> 25 Years
References:	ca. 150 Biogas Plants
in:	Germany, Japan, Netherlands, Austria, Switzerland, Lithuania, Italy, Slovakia, Canada, USA, Spain, France, Ireland, Russia, India, China and Argentina
Partner in:	Japan, Canada, Bulgaria, France, Poland, Italy, Spain, Serbia, Greece and China





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Nachrichten Artikelkommentare Oktoberfest 2010

Gerissene Leitung

Biogasanlage Bilshausen havariert: Tausende Liter Gärsubstrat ausgelaufen

Von Gerald Kräft | 25.03.2015 18:18 Uhr

Aus der Biogasanlage südlich von Bilshausen sind am Mittwochnachmittag an einem Leck tausende Liter Gärsubstrat ausgelaufen. Die Feuerwehren Bilshausen und Gieboldehausen verstopften die gerissene Leitung am Gärbehälter mit Keilen.

© Schauenberg

Eichenried

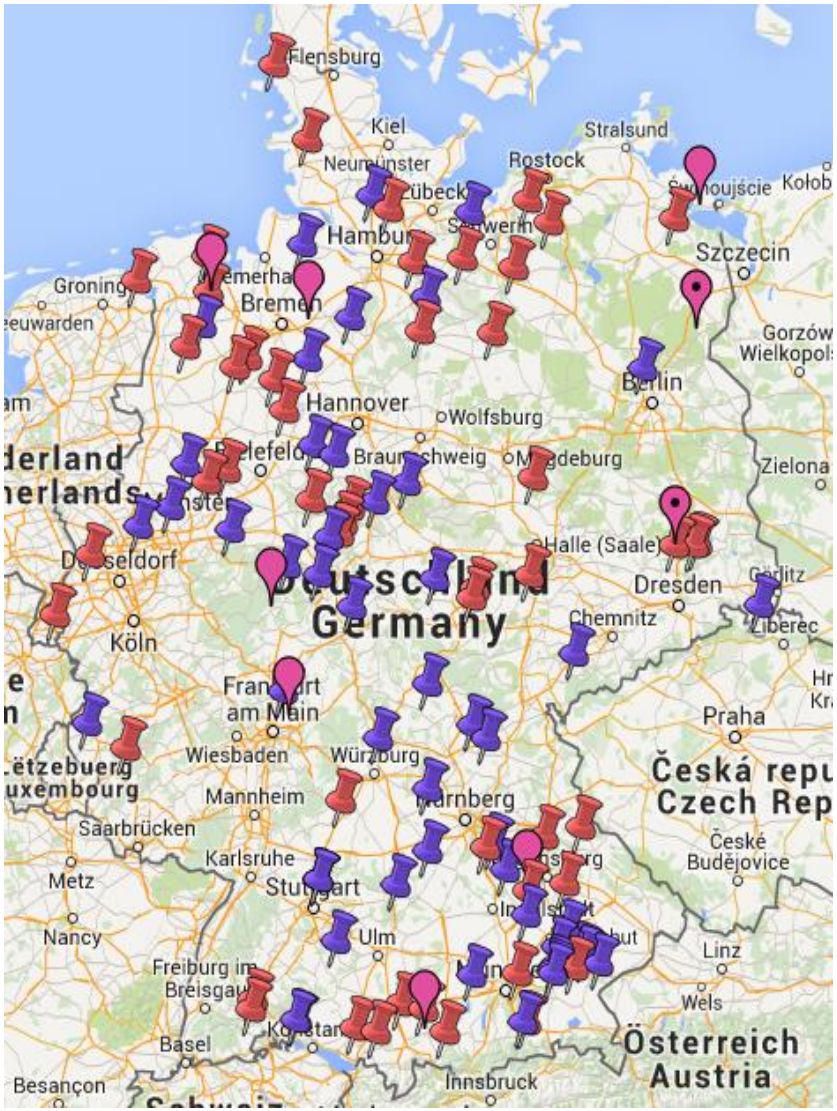
Explosion in Biogasanlage

letzter und bis zu 300.000 Euro Sachschaden: In

uf 200.000 bis 300.000 Euro.

Broken pipe - digestate spilled What a job!

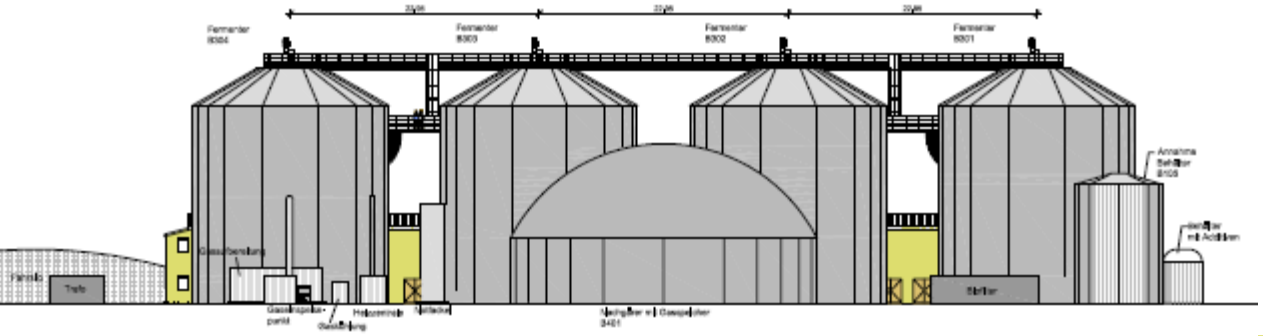
Failure at biogas plants



- Fire / deflagration, explosion
- Damage by releases substances
- Personal injury

Source:
http://www.initiativen-mit-weitblick.de/16.html

Sugar industry
Dinteloord, The Netherlands



- Built: 2011
- Substrate: sugar beet ends, sugar beet leafs, sugar beet, vegetable waste 114,000 t/a
- Digester: 4 x 4,480 m³ steel tank
- Upgrading of 1,750 m³/h biogas to 990 m³/h methane
- Gas holder above secondary digester
- Treatment of digestate with decanter

Inland Empire, California, USA

- Built: 2006/2007
- Substrate: cattle manure (270 tons/year, DM 12%), liquid waste from food industry
  (83 tons/year) food waste
- Sediment removal from the digester
- Gas distribution in a biogas grid, expected gas production 18.813 m^3 per day
- Expected power generation capacity: 1,500 kW_e

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organizational aspects
legal aspects
biological aspects
documentation

Ordinance on Industrial Safety and Health – BetrSichV

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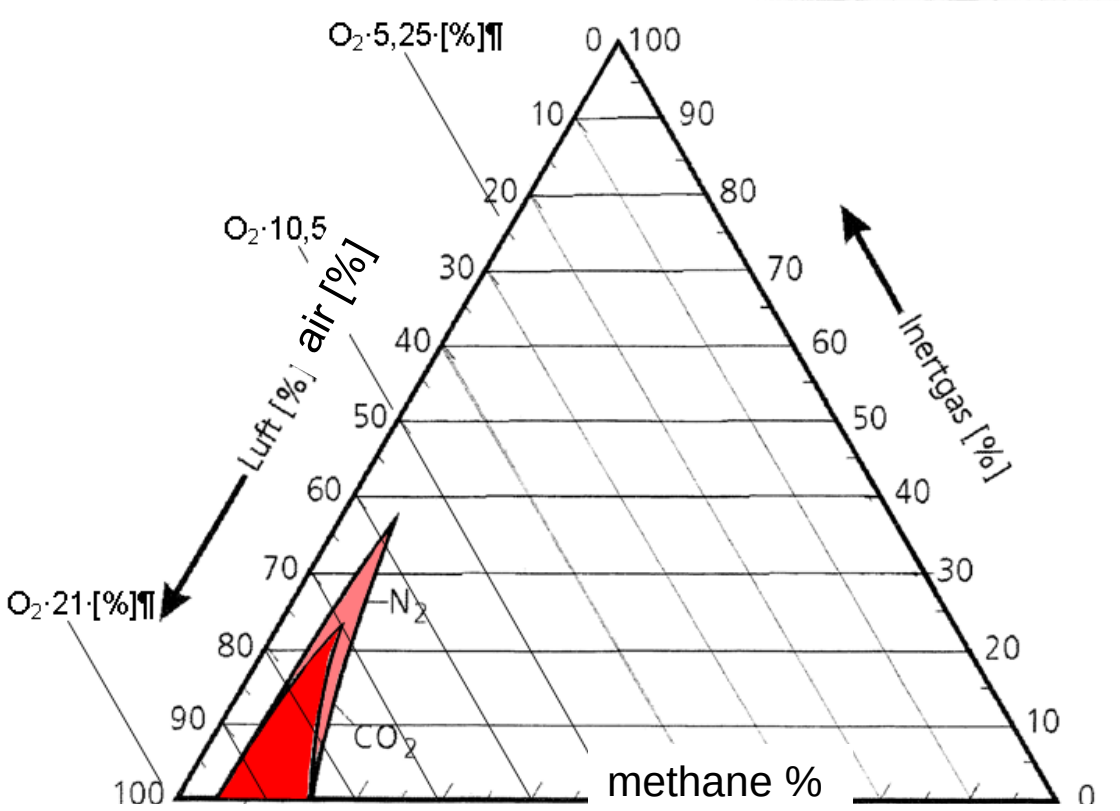
Ordinance concerning the protection of safety and health in the provision of work equipment and its use at work, concerning safety when operating installations subject to monitoring and concerning the organization of industrial safety and health at work.

Betriebssicherheitsverordnung

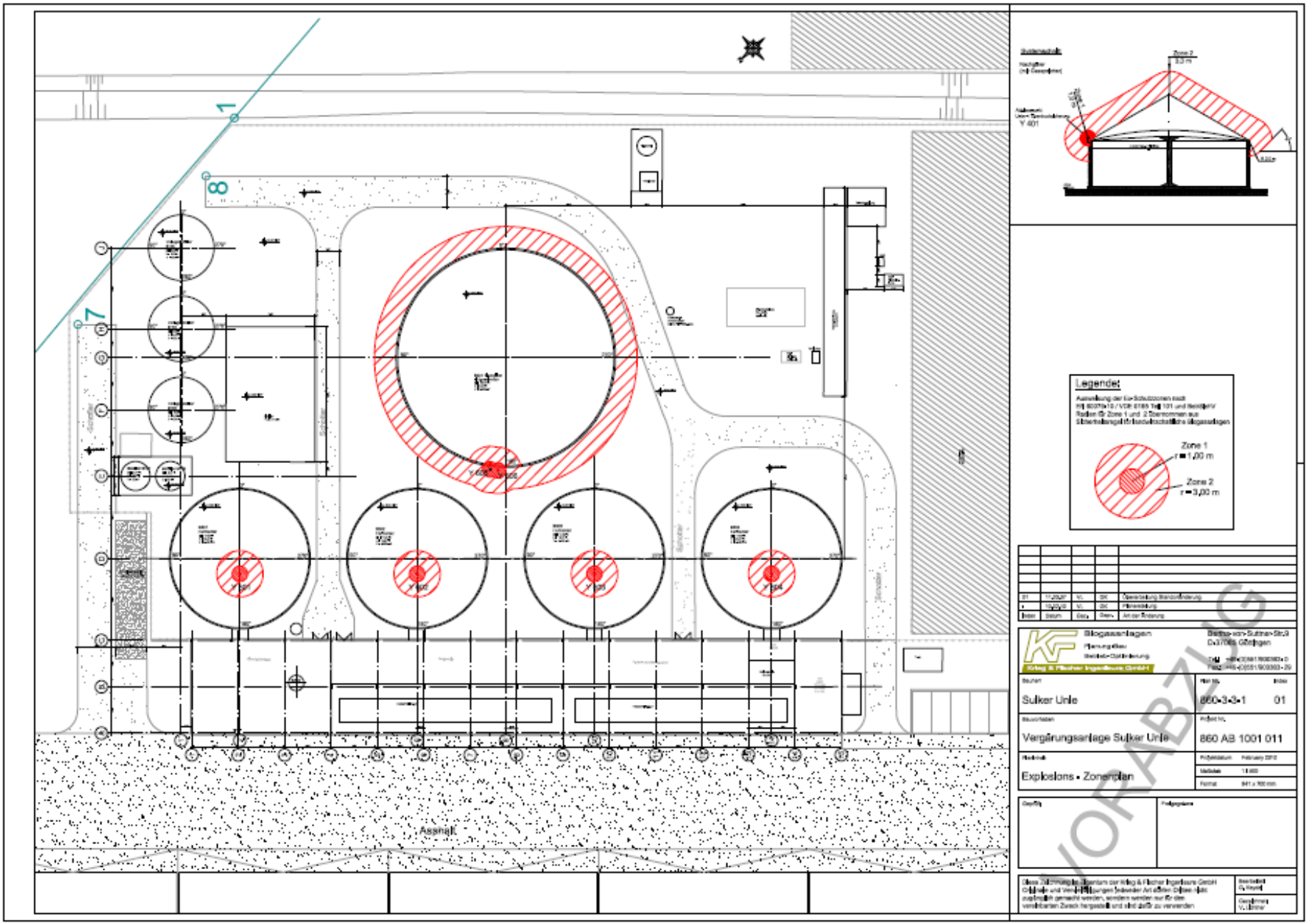
- Ordinance on Industrial Safety and Health
- Hazard Assessment

Safety
Lower and Upper Explosive Limit



Explosion area:
Exceeding of 11,6 Vol% oxygen
and
between 4,4 Vol% methane (100% LEL) and
16,5 Vol% methane (100% UEL)

source: after Tabarasan / Rettenberger – UBA Forschungsbericht 12/1982, Nr. 1030227 Teil 1


1
8
7
Asphalt
Legende
Zone 1
r = 1,00 m
Zone 2
r = 3,00 m
Sulker Unle
860-3-3-1
01
Vergärungsanlage Sulker Unle
860 AB 1001 011
Explosions - Zonenplan
VORABZUG

Agenda

- Basics start-up
- Definition of the phases of start-up
- Process of start-up
- Documentation – Who and When?
- Responsibilities during start-up procedure

Basics start-up

Status quo:

- There are no standards for start-up
  - ➢ no legal, technical or contractual requirements
- BetrSichV or technical directives contain no definition or standards of start-up operations
- Variety in terms requires definitions: Commissioning, putting into operation, initial operation, trial operation, start-up

Basics start-up

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Definition of the terms:

- **Normal operation**

State in which the equipment or plants and other devices are used or operated within their design parameter (compare BetrSichV and TRBS 2152).

- **Stationary operation**

The biology of the biogas plant is established. There are no significant changes in the state of biological process parameters any more.

- **Continuous operation**

Substrates are supplied almost continuously. Biogas and digestate are continuously discharged.

- **Start-up**

Transfer of a biogas plant from production of the first molecule of methane in the fermenter, up to biogas production of 50% of the predicted gas amount with a methane content of 50%.

Basics start-up

Classification of Start-up:

<table>
<tr><td rowspan="3">Preparing technical operational readiness incl. “cold start-up”</td><td rowspan="2">Start-up
(Phases I-III)</td><td colspan="2">Continuous operation</td><td rowspan="2">Shut-down</td></tr>
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Basics start-up

To whom does the plant belong during start-up operation? (→ work safety)

- Construction by EPC-contractor

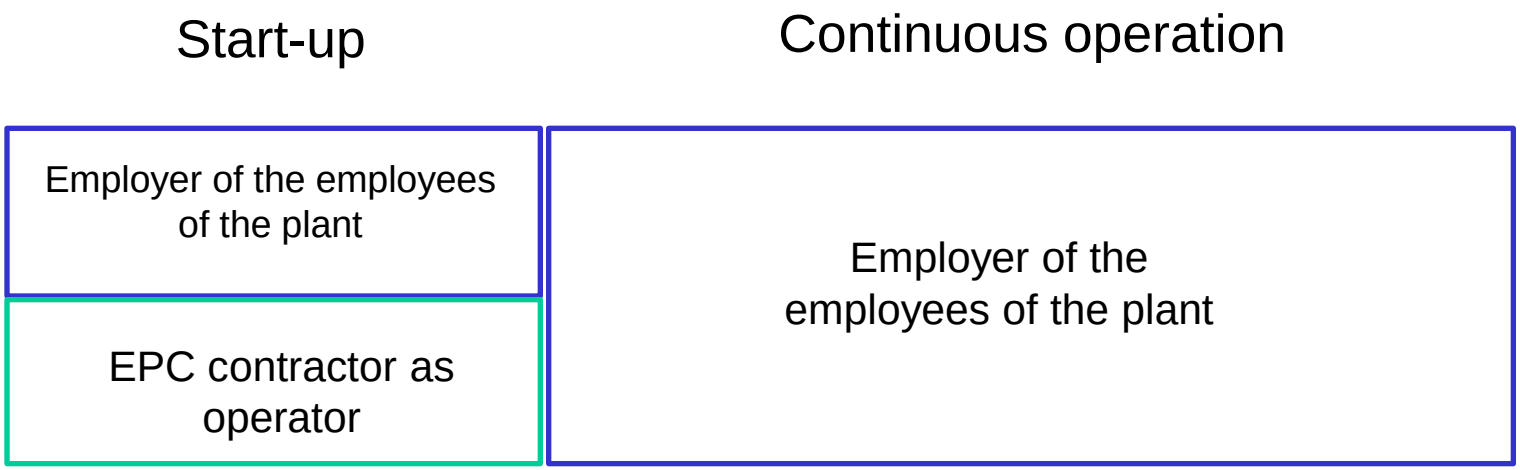
  → EPC is (probably) owner of the plant during start-up

- Planning by engineering office

  → future operator is owner of the plant

Basics start-up

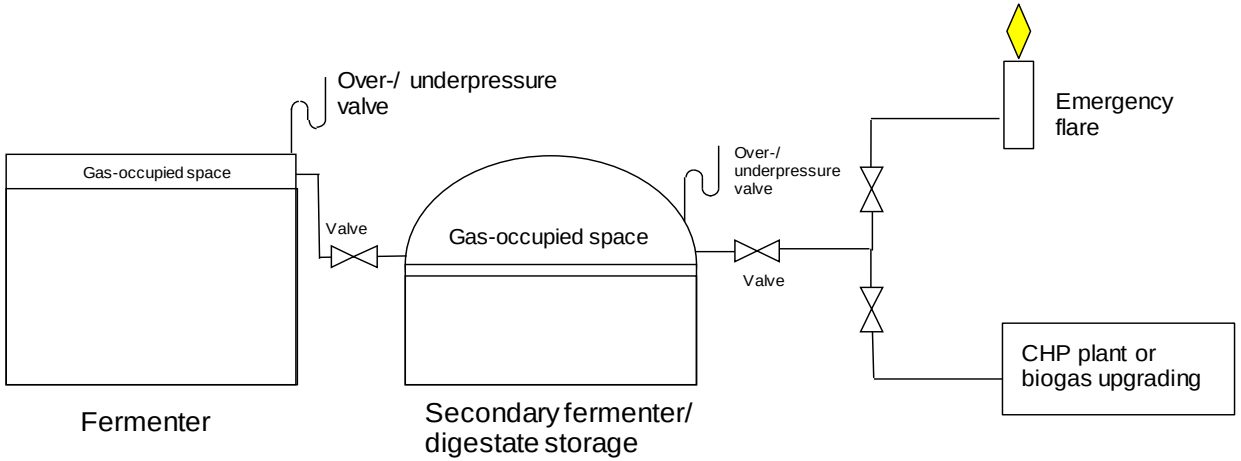
Who has to prepare the hazard assessment regarding start-up and normal operation?



➢The basis of the start-up of the biogas plant has to be the hazard assessment of the employer and the EPC-contractor.

Basics start-up

Plant system:



Gas occupied space: A room filled with biogas in each individual tank (above the substrate surface)

Gas occupied space system: Totality of all gas spaces incl. all the connected between them gas lines.

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Basics start-up

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Definition of the phases of start-up

Dividing phases of start-up - Why?

- Long period of time
- Structuring of the process:

  Clear definition of beginning, end, and transition from one phase to the other
- Concrete assignment of necessary documents and responsibilities during the single phases
- Probably limitations of safety relevant standards to single phases.

Definition of the phases of start-up

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Phases of start-up:

Phase I	Phase II	Phase III
Start-up begins with the first introduction of substrate in the fermenter, which can produce methane. Phase I lasts until biogas with a methane content is produced, which allows the connection of a flare (from approximately 25%).	In the gas-occupied space of the last tank of the considered gas occupied system, a gas production is done with a methane content of about 25% - 50%. The gas is burned using the flare.	In the gas-occupied space of the last tank of the gas-occupied space system, a gas production is done with a methane content of more than 50%. The gas is utilized in the CHP or the gas processing. End of Start-up: • 50% of expected gas amount • CH_4 content above 50% • Acceptance CHP/gas consumer took place • Documentation received

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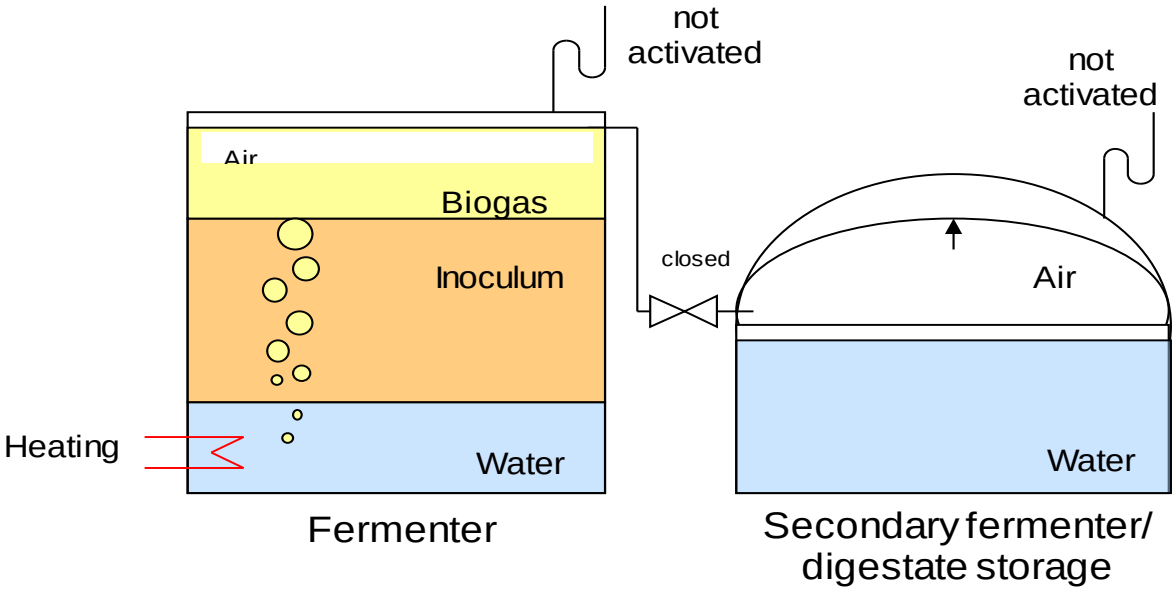
Process of start-up

Phase I

Section 1 of the start-up process:

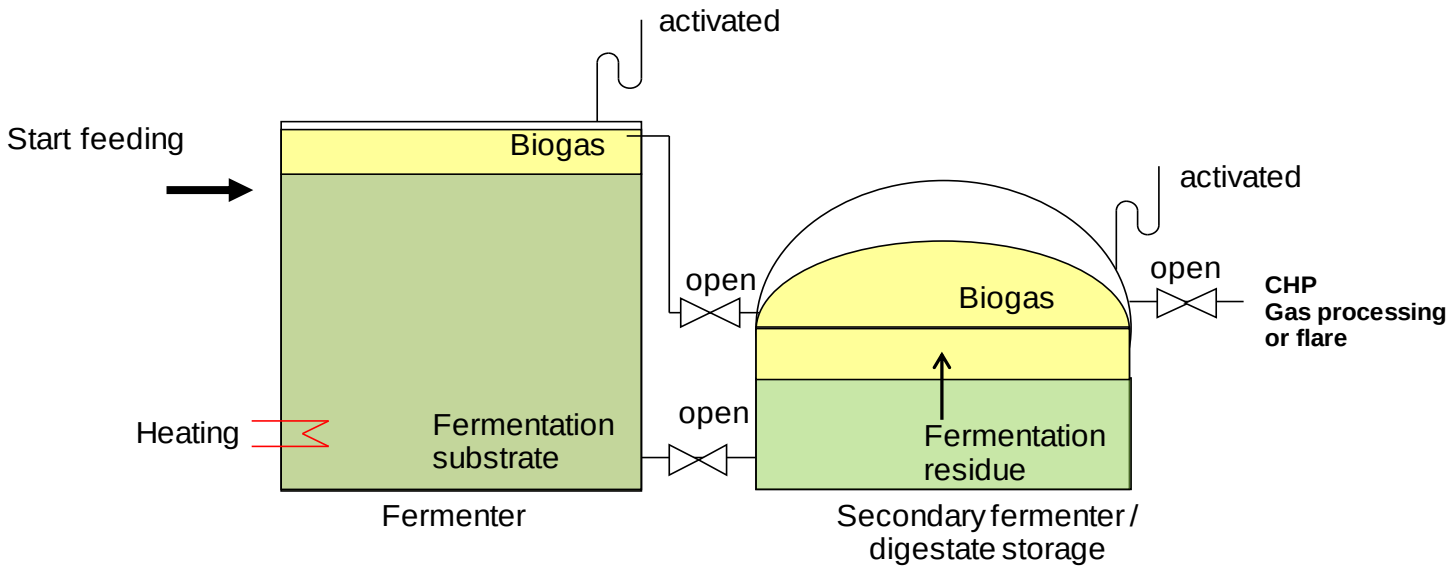


Process of start-up

Phase I

Section 4 of the start-up process:

:



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Documentation needed for start-up

General requirements documentation

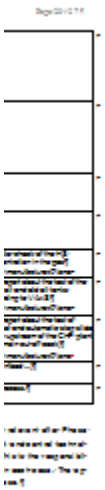
- At the beginning of start-up the documentation can not be complete
  - Reasonable (Pre-) documentation

- Responsibility lies with:
  - Client
  - Employer
  - Plant manufacturer / Planner
  - Operator

Documentation needed for start-up

e

Documentation on training and instruction of the operating staff



Plant manufacturer / Planner
Employer within the meaning of BetrSichV

Documentation needed for start-up

Test report for cold start-up of each unit (incl. measuring and control technology), which is used within the scope of Phase I

Plant manufacturer/Planer

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Responsibility during start-up procedure

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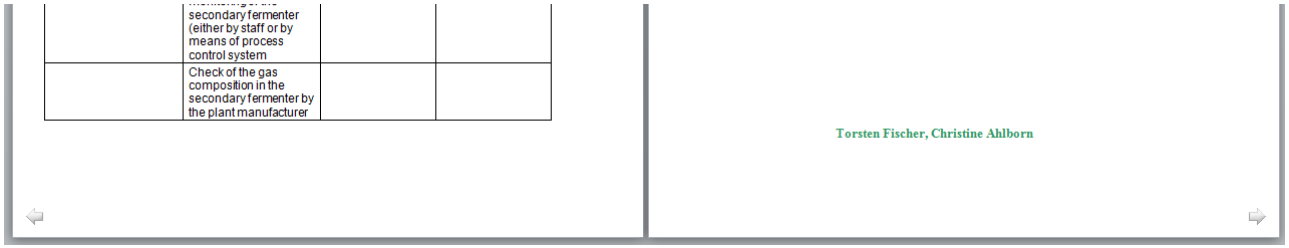
- Structured approach by clear allocation of responsibilities
- Determination of responsibilities i.a. in contracts and start-up concept

Responsibility during start-up procedure

Plant manufacturer / Planner

Has to determine the amount of produced biogas that is required to safely displace the oxygen in the fermenter.



	secondary fermenter (either by staff or by means of process control system		
	Check of the gas composition in the secondary fermenter by the plant manufacturer		

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Summary

- Start-up is complex
- No publications about start-up so far
- No definition of start-up (beginning, procedures, etc.) so far
- No properly documented start-up concepts
- No proper hazard assessments

Aim: number of accidents must be reduced in future.

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