Common deficiencies in biogas plants and lessons learned

Torsten Fischer

Krieg & Fischer Ingenieure GmbH
Bertha-von-Suttner-Strasse 9, D-37085 Göttingen, Germany
Tel.: ++49 551 900 363-0, Fax: ++49 551 900 363-29
Fischer@KriegFischer.de
www.KriegFischer.de

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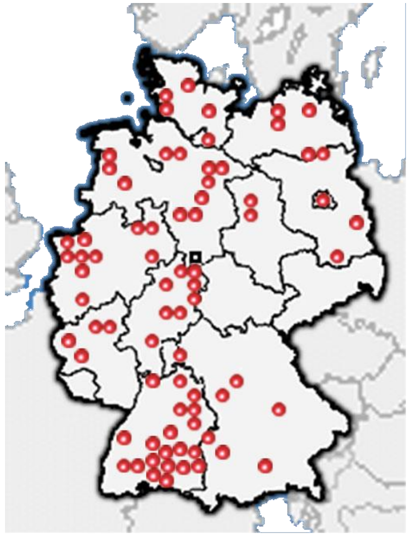
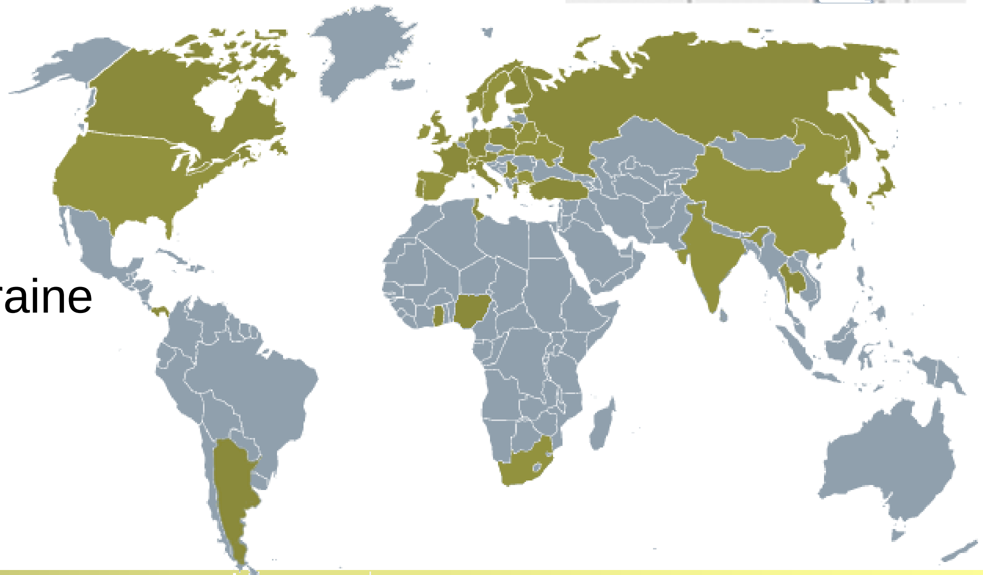
Krieg & Fischer Ingenieure GmbH

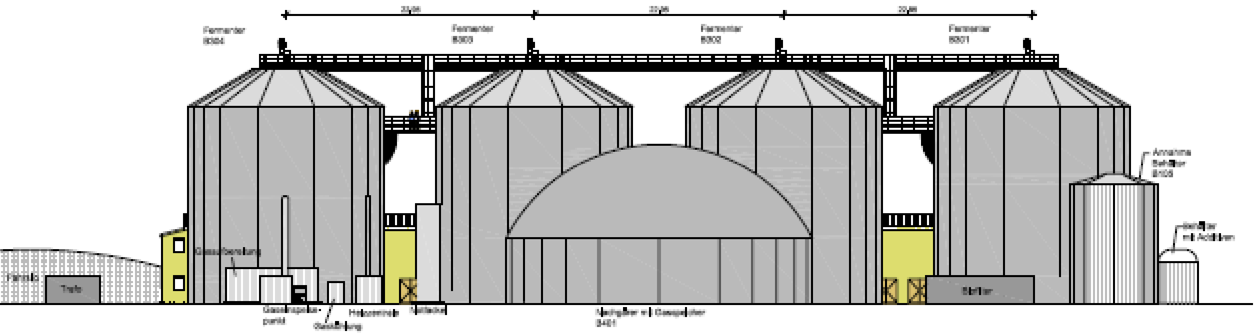
Engineering Office, specialized in Design and Engineering of Biogas Plants

Foundation:	1999
Team:	25
Experience:	> 35 Years
References:	ca. 160 Biogas Plants
in:	Germany, Japan, Netherlands, Austria, Switzerland, Lithuania, Italy, Slovakia, Canada, USA, Spain, France, Ireland, Russia, India, China, Argentina and Ukraine
Partner in:	Japan, Canada, Bulgaria, Poland, Italy, Spain and Ukraine



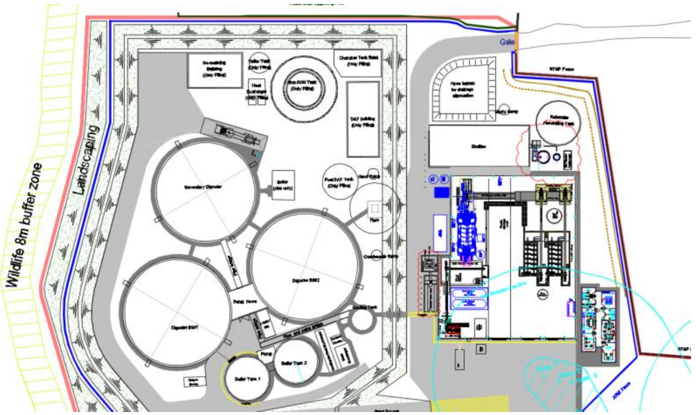


Dinteloord, The Netherlands



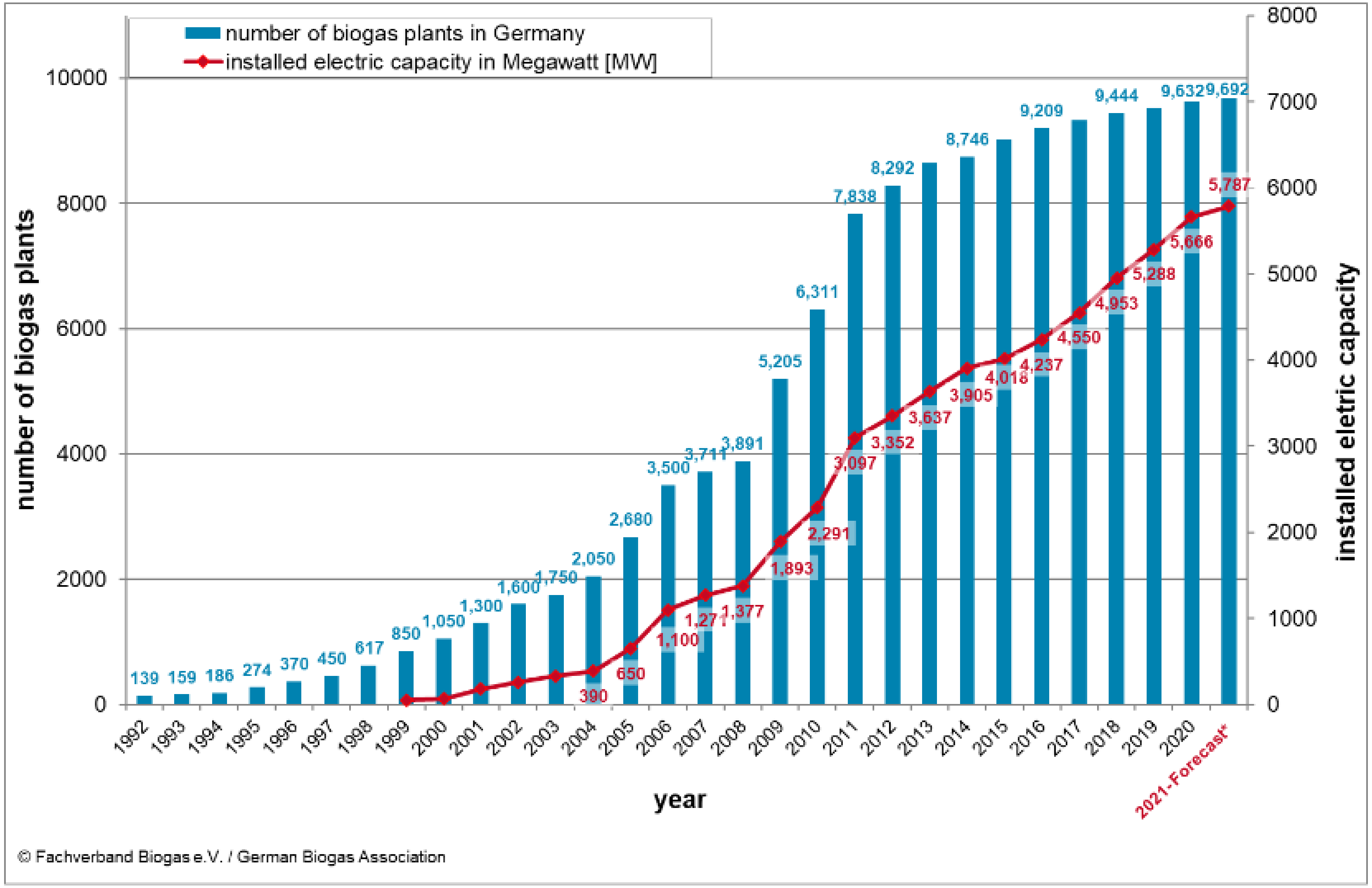
- Build: 2011
- Substrate: sugar beet ends, sugar beet leafs, sugar beet, vegetable waste 114,000 t/a
- Digester: 4 x 4,480 m³ steel tank
- Upgrading of 1,750 m³/h biogas to 990 m³/h methane
- Gas holder above secondary digester
- Treatment of digestate with decanter

Derby, United Kingdom



- Built: 2017/18
- Substrate: Food waste
- Digester: 2 x 5.000 m³ concrete tanks with gas holder roof
- Secondary digester: 4.500 m³ concrete tank with gas holder roof
- Upgrading of biogas
- Mesophilic operation
- Reception of hot substrate

Development of Biogas in Germany

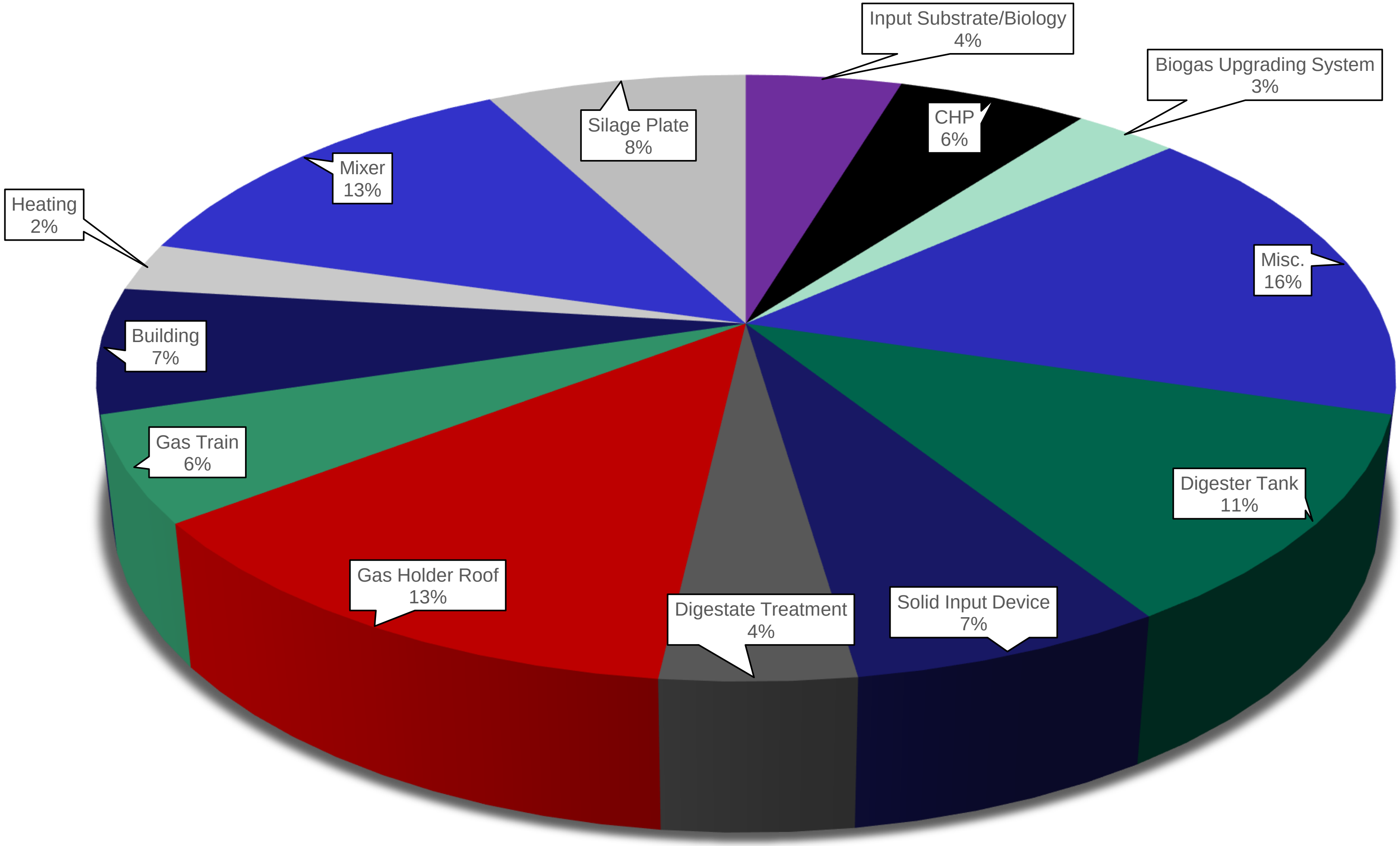


“Common deficiencies in biogas plants and lessons learned“

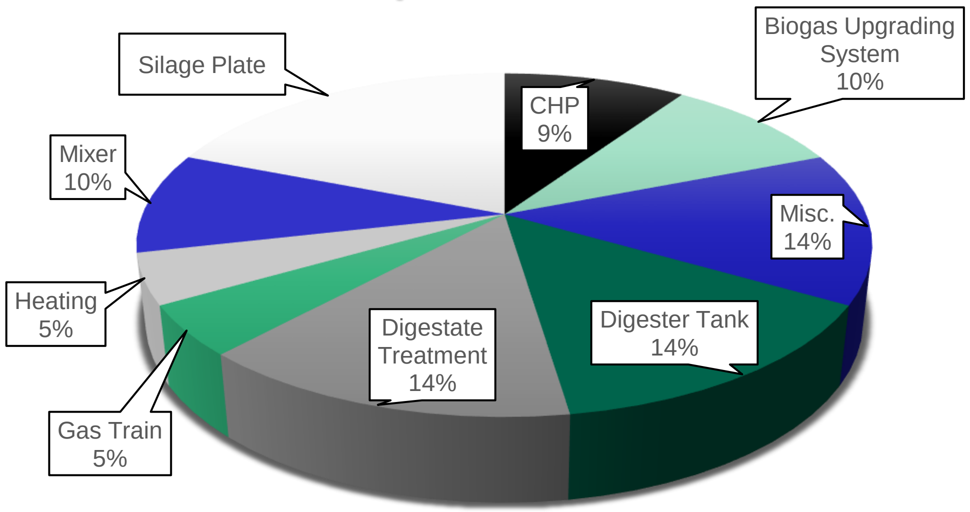
Basis of this Investigation:

- Krieg & Fischer expert reports written in the past 12 years or so.
- Court cases, Insurance cases, private orders.
- Germany, Austria, Netherlands, USA, Japan, France.
- Result: 220 expert reports.

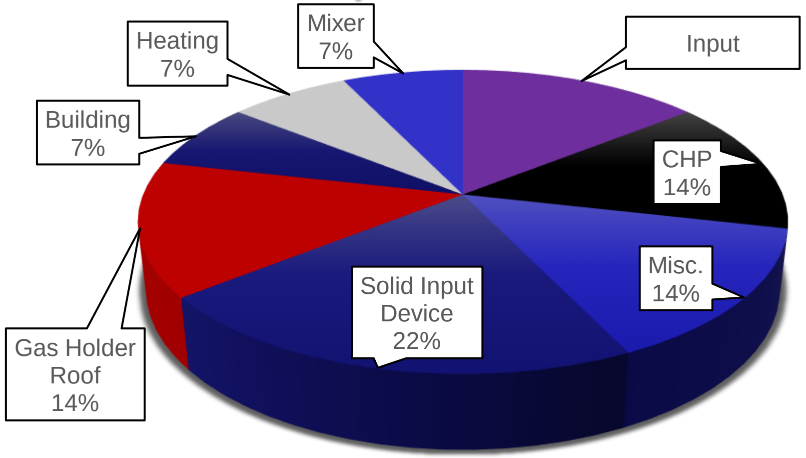
Topics from 2010 to 2022



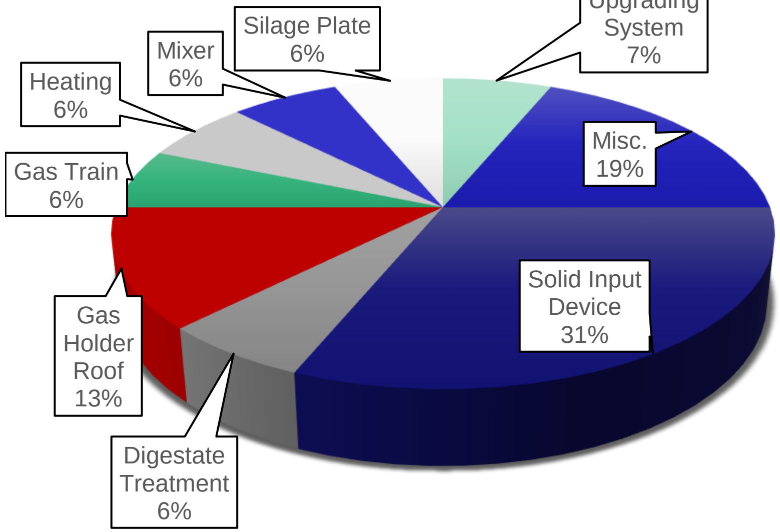
Topics in 2015



Topics in 2010



Topics in 2020



“Common deficiencies in biogas plants and lessons learned“

My experience: There is

- nothing on a biogas plant that does not break, burn, crash, fail.
- no (real) statistical evidence about extremely critical components – it changed over the years.
- a cluster for gas holder roofs, mixers, CHP, silage plates, concrete damages in general. Very seldom: biological problems.

→

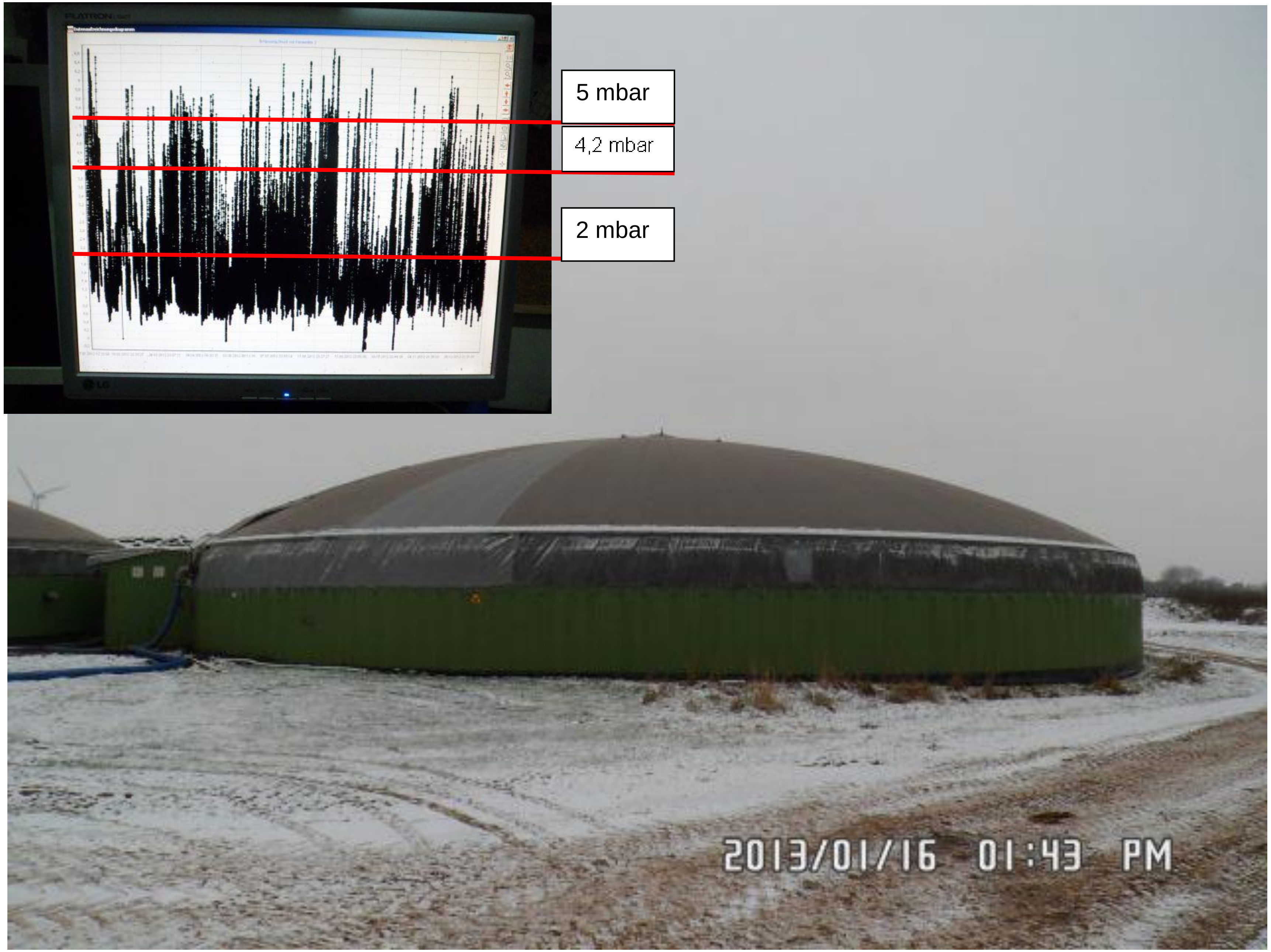
- Here shall be further investigated: gas holder roofs, mixers

1783

2010
Insurance Case
Design: Gastight single membrane
Cover on Storage Tank for Digestate:
2.5 mbar
Real life: no gastight construction
Identical damage on two tanks
Tank Diameters: both 29 m
Both center columns deflected
Heavy Snowload

High snowload in combination with wrong snowload assumptions led to collapse of both roofs

About € 100,000.-



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2084

2012
Court Case
Gastight double membrane Cover on Secondary Digester Tank: 2 mbar
Tank Diameter: 26 m
No evidence about proper installation nor function of PRV at all. No maintenance.

Too high operational pressure
Cracking of outer membrane over a longer period

Center Column:
- 6,0 m concrete
- 0.55 cm foundation
- 1.40 m stainless steel on top

B2595

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2016
Insurance Case
Tank Diameter: 34 m
Originally: gastight single membrane gas holder roof
New: Gastight double membrane Cover on Storage Tank for Digestate
Begin Damage between April 2013 and March 2016 / final damage summer 2016
No definition of „normal operation“
No test run
Unclear layout PRV (pressure, flowrates)
Never observed that inner membrane „went up“
No pressure control
No pressure calculation of gas system
No commissioning
Poor documentation
About € 100,000.-

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B2909
Bioenergy Insight
Report 6

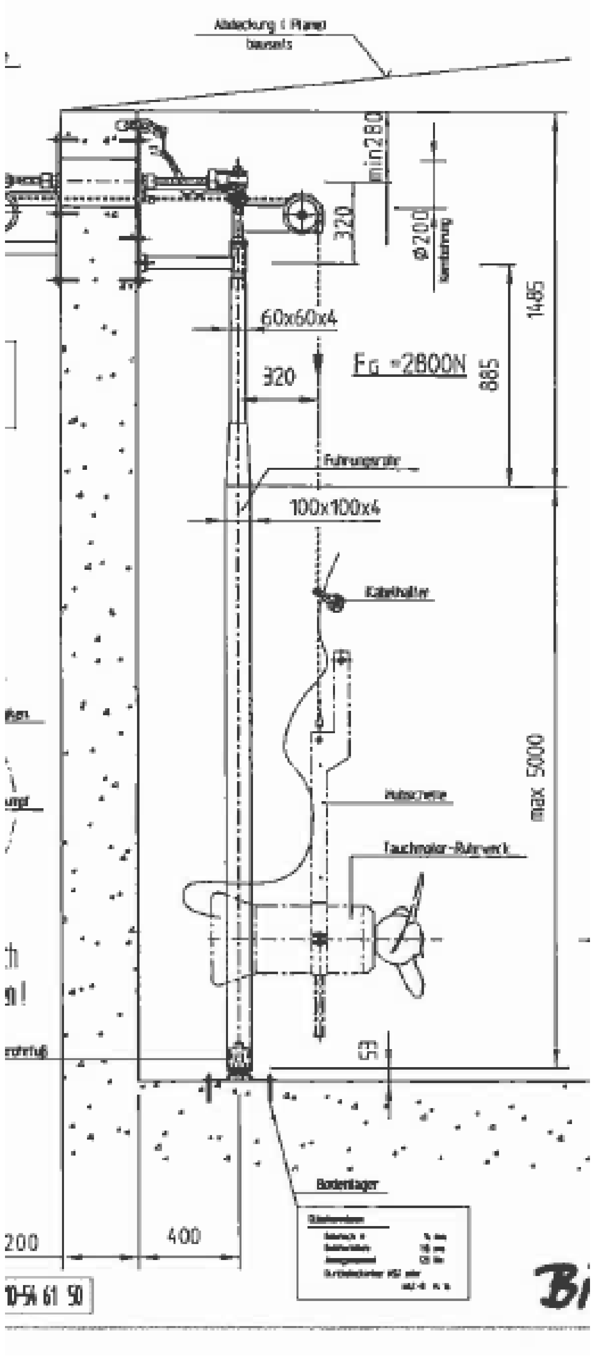
2018
Insurance Case
Small Biogas Plant built in 2006
Design: Gastight single membrane Cover on Digester and Secondary Digester Tanks
Pump between both tanks fed Secondary Digester Tank until single gas holder membrane was destroyed.
Eruption of manure/corn silage mixture into the environment

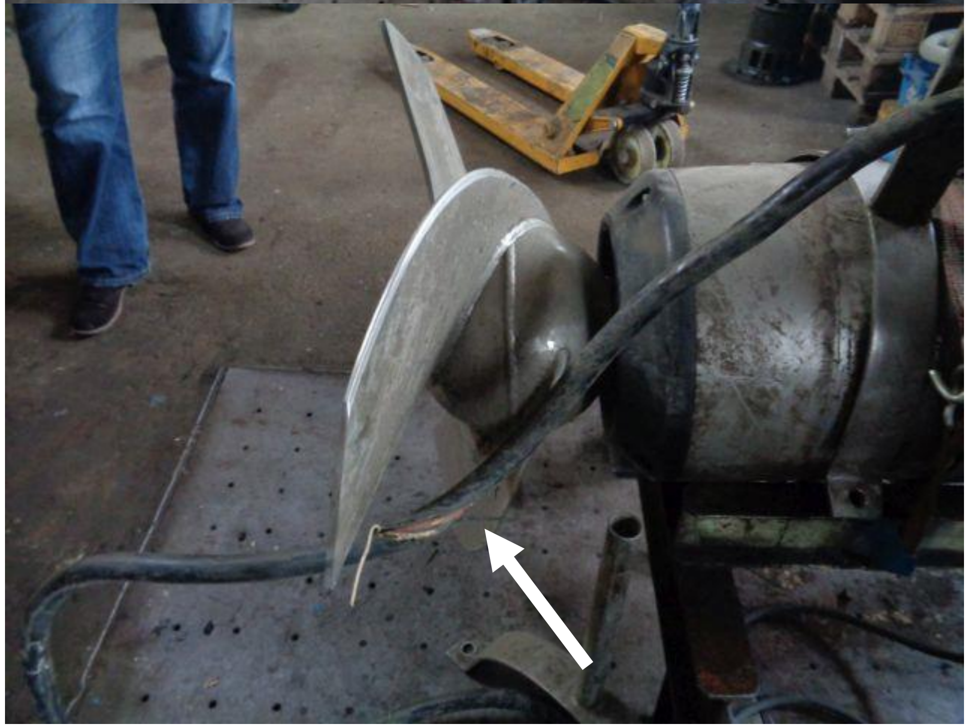
Manual operation, not automatic. No proper safety control nor hazard assessment

About € 25,000.-

Lessons learned
Conclusion Damages Gas Holder Roofs:

- Damages mostly happen with gas holder roofs on top of tanks with big diameters.
- On a regular basis the biogas pressure situation at biogas plants with gas holder roofs with big diameters is underestimated.
- Suppliers often enough ignore the actual situation on site (pressure, safety, snow loads, etc.) but offer their gas holder roof standard with their safety device standards. EPC-Contractors and Engineering Companies often enough do not have the necessary know-how to properly integrate certain types of gas holder roofs into the overall plant design.
- Clients/Operators often enough ignore most simple organizational standards such as test runs, final commissioning, etc.





2287

2014
Court Case
Design: submerged mixer
Failure because of not properly fixed electrical cable at the wooden beams of the roof construction

Poor supervision of construction

2330
Bioenergy
Insight
Report 2

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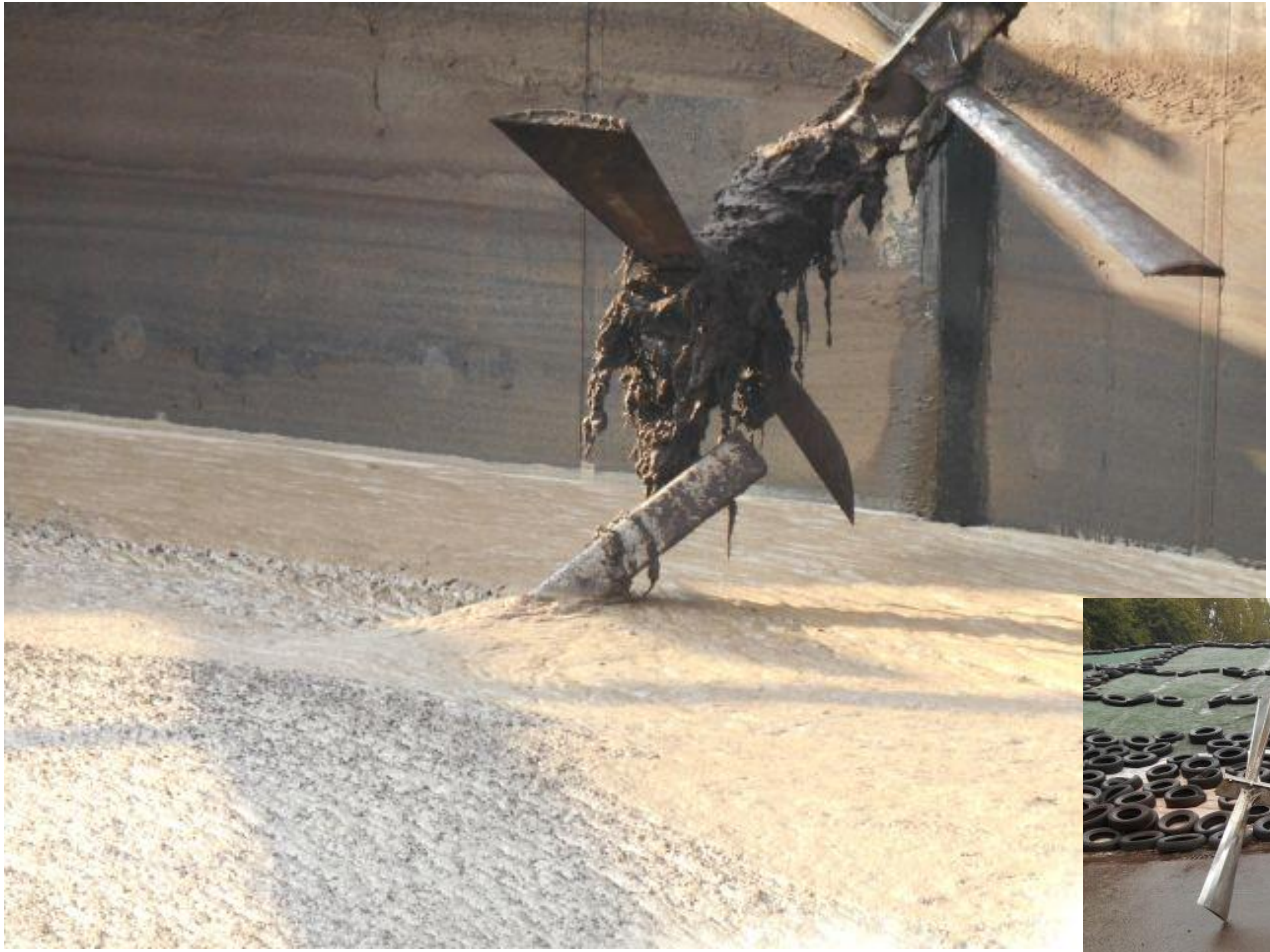
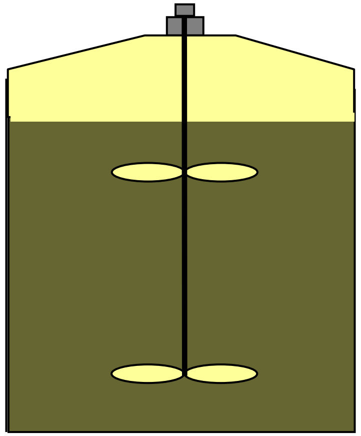


2014
Insurance Case
Design: side-mounted mixer
Broken shaft because of not properly installed lower bearing/shaft + poor material quality.

Poor supervision of construction



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2552

2016
Insurance Case
Design: top-mounted mixer
4 high digester/secondary digester tanks
In 3 out of 4 tanks the blades were broken off the shaft

Poor welding of the stiffener construction
Fatigue break of blades

Lessons learned
Conclusion Damages Mixers:

- Proper supervision of construction, test-runs, final commissioning is of utmost importance.
- In case there are several mixers in one tank – those mixers have to fit together (horizontal & vertical forces and moments) in order to have a long-term solution and not an overload of one/some of the mixers involved.
- Mixers should be designed for a certain input substrate. With the change of the input substrate mixers may have to be re-calculated.
- Mixers are not only good for substrate mixing but also for other jobs such as distribution of heat in the digester tank, easing the rise of biogas bubbles ("increase" buoyancy), etc.

In case somebody is interested in more details:

Krieg & Fischer Ingenieure GmbH

Bioenergy accident investigation

Torsten Fischer of Krieg + Fischer Ingenieure discusses a legal investigation related to the deficiencies of a digestate dryer at a German biogas plant

First-person sleuthing: investigating a digestate dryer

Torsten Fischer, founder and managing director at Krieg + Fischer Ingenieure, has been an expert legal witness for more than 10 years covering 120 cases

My reaction

Dryers are always difficult; this is no easy job.

The job

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