Conceptual Planning of integrated MLBGP Project Solutions

中大型沼气工程项目解决方案的规划

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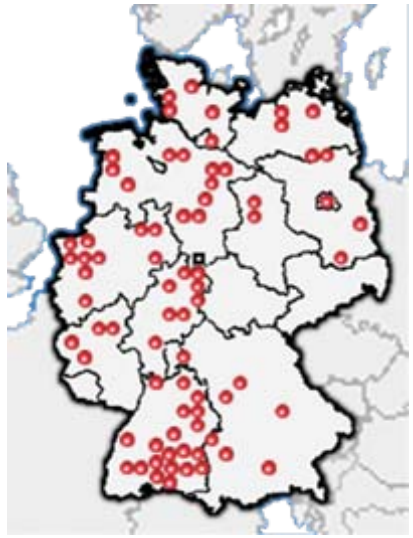
Krieg & Fischer Ingenieure GmbH

Krieg & Fischer 工程设计有限公司

Engineering Office, specialised in Design and Engineering of Biogas Plants
工程学办公室，专门从事设计和沼气工程

Foundation: 1999
成立： 1999
Team: 18
组： 18
Experience: > 20 Years
经验： >20年
References: ca. 140 Biogas Plants
参考： 加拿大140生物气工厂
in: Germany, Japan, Netherlands, Austria, Switzerland, Lithuania, Italy, Slovacia, Canada, USA, Spain, France, Ireland
在： 德国，日本，荷兰，澳大利亚，瑞士，立陶宛，意大利，加拿大，美国，西班牙
Partner: Japan, Korea, USA, Canada, Bulgaria, France, Hungary, Turkey, Poland, Italy Spain, Ireland
参与者： 日本，韩国，美国，加拿大，保加利亚，法国，匈牙利，土耳其，波兰，意大利，西班牙，爱尔



Krieg & Fischer Orders at this Moment (October, 25th, 2009)
此时Krieg & Fischer 的发展（2009年10月25日）

in France, Spain, Italy, Ireland, USA, Germany, Panama, Greece, Norway, Serbia, Poland und Canada.

在法国，西班牙，意大利，爱尔兰，德国，巴拿马，希腊，挪威，塞尔维亚，波兰和加拿大

Torsten Fischer

•President of Krieg & Fischer Ingenieure GmbH

•Krieg & Fischer工程设计有限公司主席

→founded by Andreas Krieg and Torsten Fischer in 1999

由Andreas Krieg和 Torsten Fischer 在1999年成立

•Education: Engineer for Shipbuilding Construction

•学历：造船业工程师

•Experience in the field of biogas since 1992

•从1992年开始有沼气领域研究的经历

→special fields: - waste management and municipal engineering - safety aspects of biogas plants

特殊领域-废物管理和市政工程学-生物气工厂的安全方面

•**Lecturer** at the University of Höxter

•Höxter大学讲师

•Accreditation of the Chamber of Engineers of Germany as
Expert Witness in the field of biogas

•在沼气领域评选德国工程师

Service Offerings of Krieg & Fischer in the field of Biogas
沼气领域Krieg & Fischer 的服务项目

- Studies
  研究
- Concept Development
  理念发展
- Calculations
  计算
- Permits & Approvals
  许可和批准
- Engineering
  工程学
- Tendering and Commissioning
  投标和试运转
- Construction
  建造
- Start-up
  启动
- Optimization/Retrofits
  优化/变化
- Suvervision and Consulting
  调查和咨询

Development of Biogas in Germany
德国沼气研究的进展

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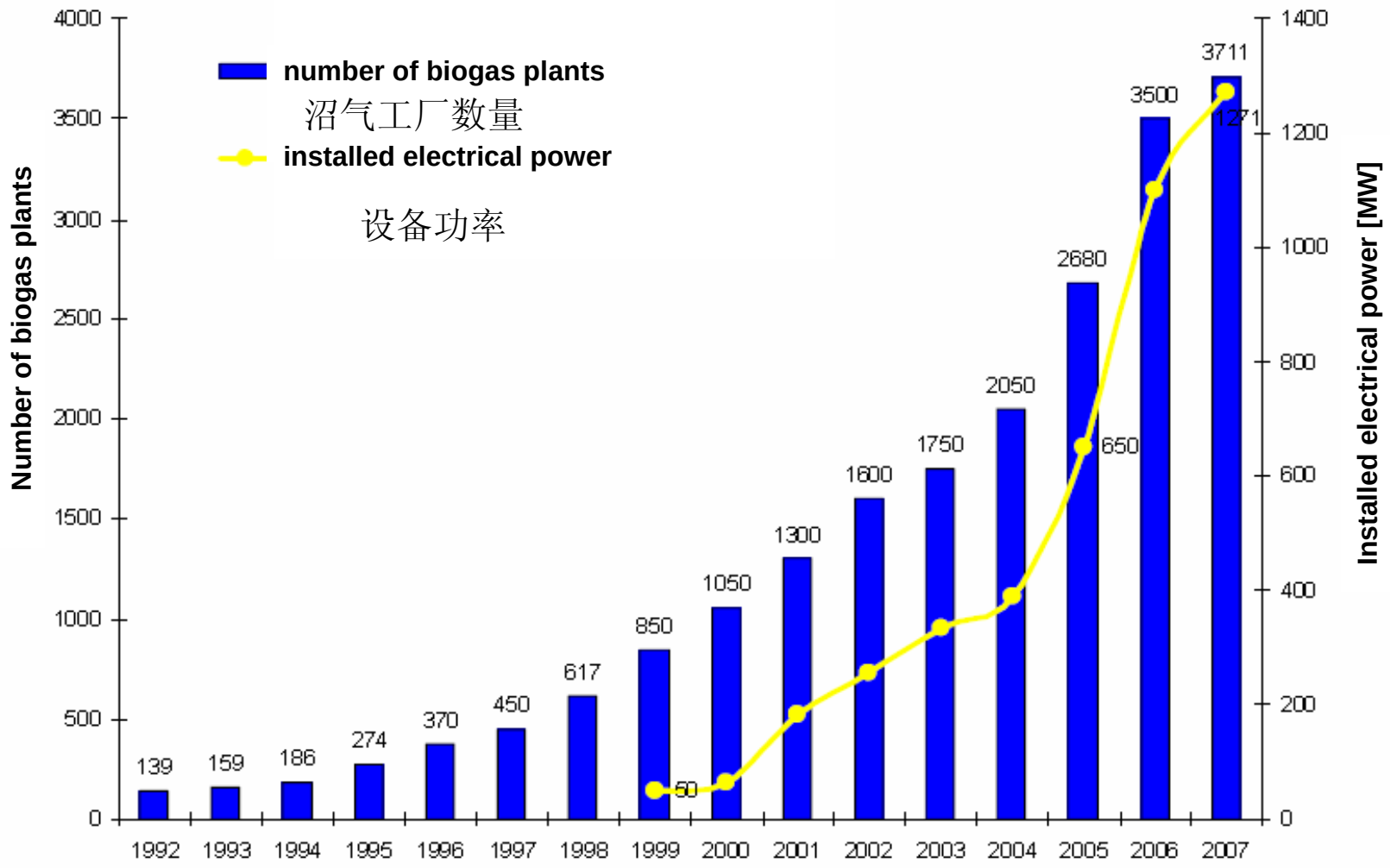

References – Examples
参考-举例

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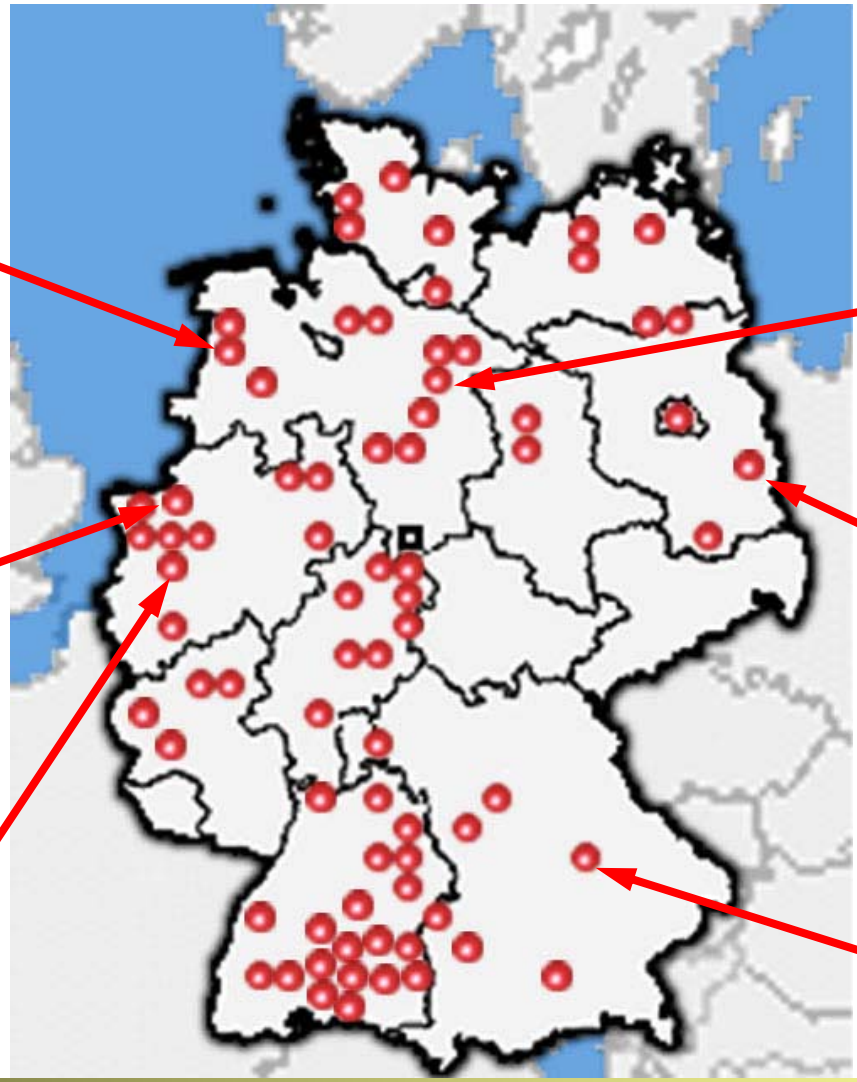
Central Biogas Plant
沼气工厂中心

Energy Crop Biogas Plant
沼气工厂能源作物

Kitchen Waste Digestion
厨房废弃物消化



Potato Residue Digestion
土豆残余物消化

Energy Crops with Cattle Manure
动物粪便能源作物

Biowaste Digestion
生物废物消化

Type of Digester
消化罐类型

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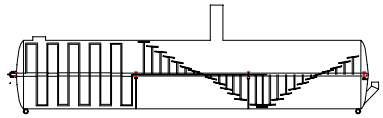
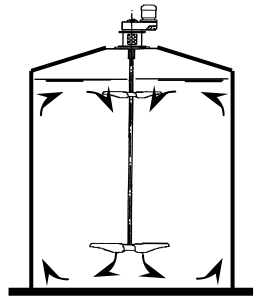
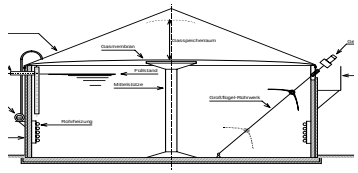
- Horizontal digester
  plug flow, vertical mixing
  bypass reduced by high viscosity
  卧式消化罐活塞流，高黏度产生的垂直混合



- High upright digester
  complete mixing, homogeneous
  temperature, bypass possible
  高直立消化罐
  完全混合，均质
  温度，绕流可能产生的混合

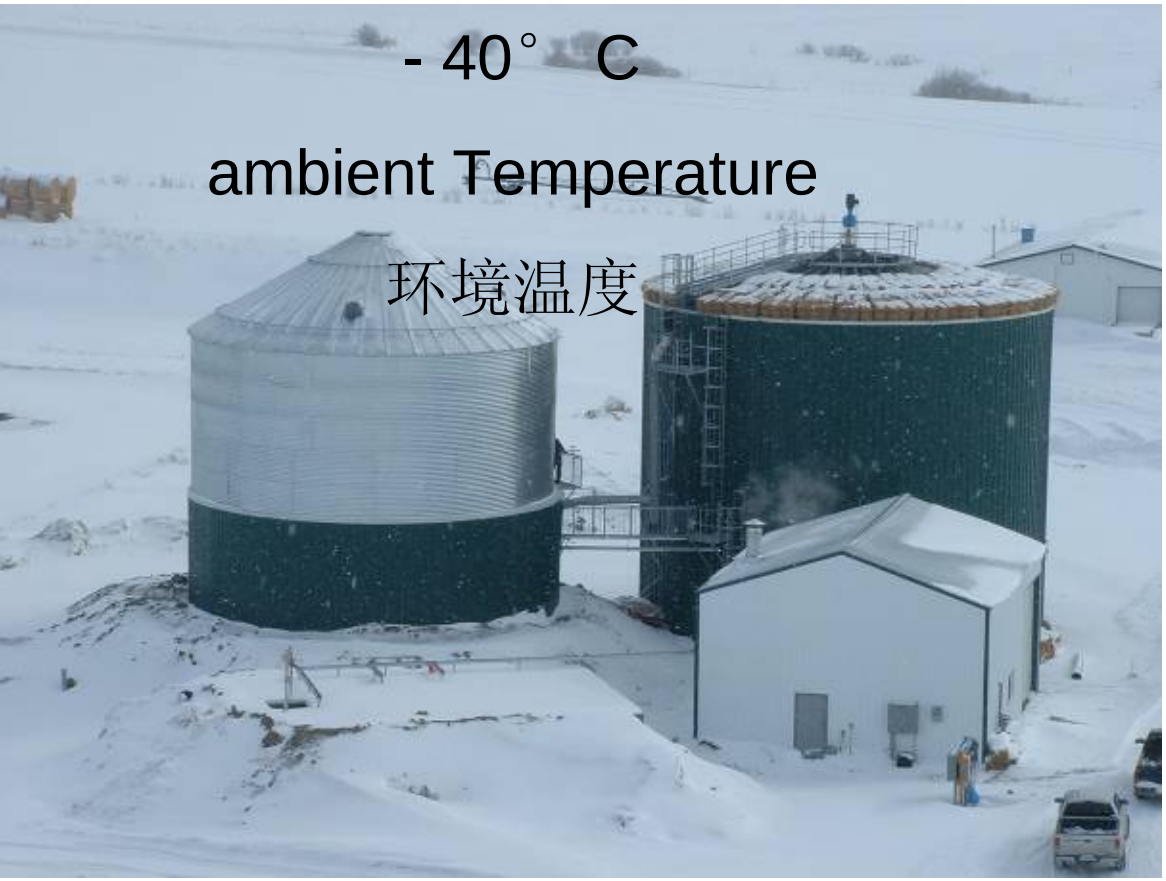


- Flat upright digester
  less mixed, zoning possible,
  bypass possible
  扁平直立消化罐
  较少混合，分区制
  绕流可能产生的混合




90,000 m³/a manure
90,000 m³/a 肥料
20,000 m³/a fats
20,000 m³/a 脂肪
WERLTE

Sakatoon, Saskatchewan, Canada
Sakatoon, Saskatchewan, 加拿大



- Built: 2003
- 建于2003年
- Substrate: pig manure, potatoes
- 底物基质： 动物粪便，土豆
- Digester: 2,000 m³, steel tank
- 消化池： 2,000 m³，钢罐
- CHP: 4 x 30 kW_e
- CHP: 4 x 30 kW_e
- Microgasturbines
- 微气涡轮机
- Designed for low outside temperature
- 为室外较低温度设计
  - special design: gas holder in a tank (left tank)
  - 特殊设计：储气装置放置在罐中（左边容器）
  - special building material for gas holder roof and insulation
  - 储气装置的顶是特殊材料，用于保温

France, Noyon
法国，Noyon

- Substrate: 40,000 t/year fluid and solid organic waste and sludge
- 底物基质： 40,000 t/year 液态和固态有机废物和污泥
- Digester: steel tank 3,479 m³
- 消化罐：钢桶 3,479 m³
- Gas engine: 716 kWe
- 气体发动机： 716 kWe
- Solid-fluid separation of the digestate
- 消化液的固液分离

Japan, Hokkaido
日本，Hokkaido

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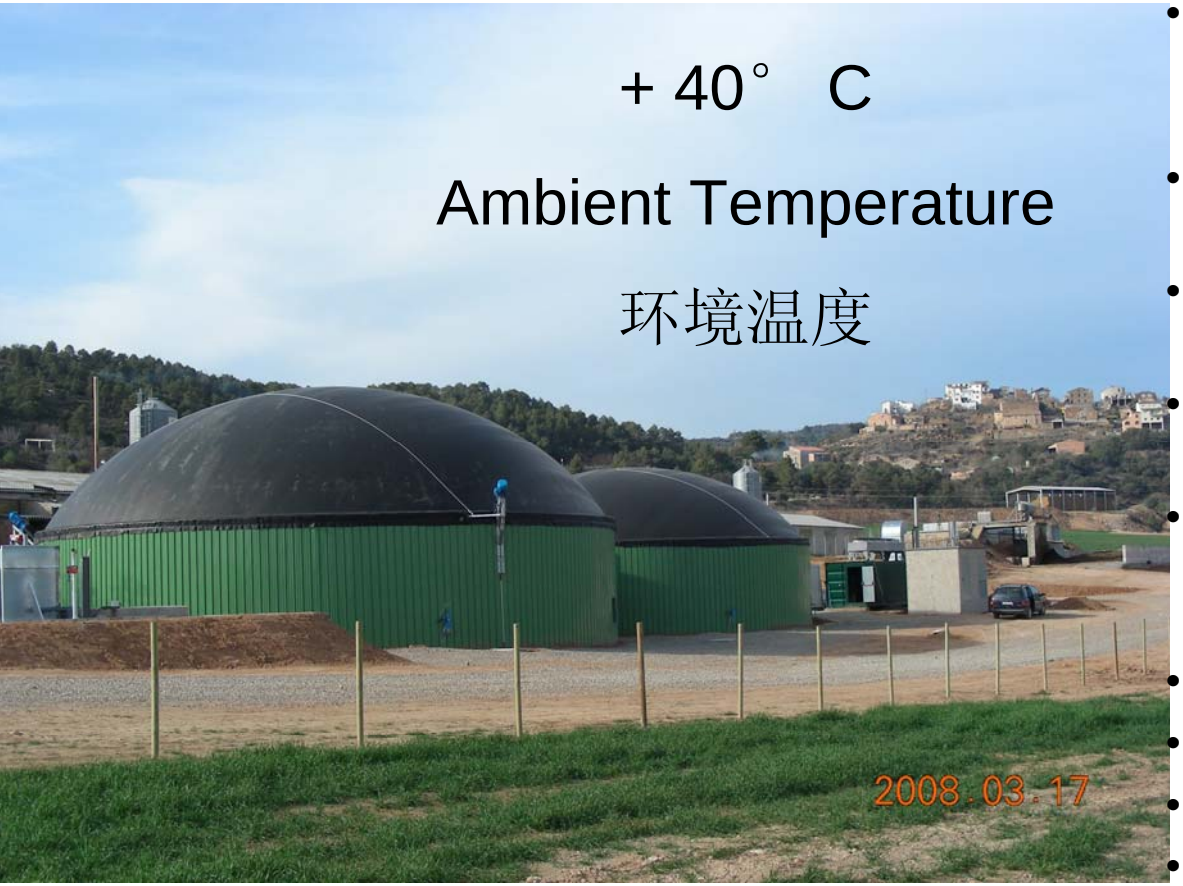
Seismic Zone IV

地震区IV

- Input: manure, co-fermentation
- 输入：粪便，混合发酵
- Digester: steel tank, glass coated, 1,500 m³
- 消化容器：钢桶，玻璃表面，1,500 m³
- Gas holder roof above 450 m³
- 储气器超过450 m³
- secondary digester + external gas holder
- 二级消化池+外部储气器
- Diesel gas engines: 3 x 65 kWe
- 柴油气燃气机： 3 x 65 kWe

Spain, Montargull
西班牙，Montargull



- Input: pig manure, FOG, slaughterhouse waste water sludge
- 输入：猪粪便，FOG，屠宰场废水污泥
- Digester (2.080 m³) and secondary digester with gas holder roof
- 消化池（ 2.080 m³）和带有储气器的二级消化池
- Special gas cooling system adopted to high ambient temperature
- 适应高温环境的特殊气体冷凝系统
- CHP: 364 kWe
- CHP:364 kWe
- Invest 820.000 €
- 投资 820.000 €

Compiling a biogas plant
沼气工厂的设计

Krieg & Fischer Ingenieure GmbH

Planning of a biogas plant

沼气工厂的设计

⇒ Type of input substrate
底物基质输入的形式

⇒ Amount of input substrate per year
每年底物基质输入的量

⇒ Local circumstances
当地环境

⇒ Heat usage
热量利用

⇒ Pre treatment, pasteurisation
预处理，巴斯德杀菌法

⇒ Automation level
自动操作水平

Compiling a biogas plant
沼气工厂的设计

Krieg & Fischer Ingenieure GmbH

Planning of a biogas plant

沼气工厂的设计

⇒ Calculation of biogas amount

沼气产量的计算

⇒ Size of digester

消化池型号

⇒ Size of engine

发动机型号

⇒ Flow sheet

流程图

⇒ Site layout

工地布置

⇒ Estimate of costs

费用评估


2002 7 5


2003 3 5


2002 12 3

Noyon: Delivery of solid waste in a reception pit
Noyon:固体废物传送方式

Compiling a biogas plant
沼气工厂的设计

Krieg & Fischer Ingenieure GmbH

Planning of a biogas plant

沼气工厂的设计

⇒ Type and condition of input substrate
底物基质输入的类型和条件

⇒ Amount of input substrate per year
每年底物基质输入量

⇒ Local circumstances
当地环境

⇒ Heat usage
热量使用

⇒ Pre treatment, pasteurisation
预处理，巴斯德杀菌法

⇒ Automation level
自动化水平

Compiling a biogas plant
沼气工厂的设计

Krieg & Fischer Ingenieure GmbH

Planning of a biogas plant

沼气工厂的设计

⇒ Calculation of biogas amount

沼气量的计算

⇒ Size of digester

消化池尺寸

⇒ Size of engine

发动机尺寸

⇒ Flow sheet

流程图

⇒ Site layout

工地布置

⇒ Estimate of costs

费用评估

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Biogas Production

沼气生产

谷物饲料	Corn Silage	1 Mg	30% TS	94% VS	700 l/kgVS	197 m³ Biogas
小麦饲料	Wheat Silage	1 Mg	30% TS	90% VS	600 l/kgVS	162 m³ Biogas
草饲料	Grass Silage	1 Mg	30% TS	89% VS	550 l/kgVS	145 m³ Biogas
牛粪便	Cattle Manure	1 Mg	8% TS	80% VS	200/500 l/kgVS	13/32 m³ Biogas
猪粪便	Pig Manure	1 Mg	6% TS	75% VS	350/500 l/kgVS	16/23 m³ Biogas
家禽粪便	Poultry Manure	1 Mg	24% TS	85% VS	300/550 l/kgVS	61/112 m³ Biogas
厨房垃圾	Kitchen Waste	1 Mg	20% TS	90% VS	700 l/kgVS	126 m³ Biogas
土豆残余物	Potato Residues	1 Mg	20% TS	95% VS	620 l/kgVS	118 m³ Biogas
脂肪	Fats	1 Mg	25% TS	95% VS	1.000 l/kgVS	238 m³ Biogas

Compiling a Biogas Plant
沼气工厂的设计

Krieg & Fischer Ingenieure GmbH

Input:	输入	
Potato Raw Material	土豆原材料	97.610 t/a
Starch	淀粉	4.495 t/a
Oil	油	636 t/a
Potato Sludge	土豆泥	6.583 t/a
Sum	总和	109.324 m³/a
Total Solids:	总固	
Potato Raw Material	土豆原材料	20,0 % Input
Starch	淀粉	60,0 % Input
Oil	油	100,0 % Input
Potato Sludge	土豆泥	30,0 % Input
Sum	总和	22,7 % Input
Volatile Solids:	挥发性固体	
Potato Raw Material	土豆原材料	90,0 % TS
Starch	淀粉	90,0 % TS
Oil	油	95,0 % TS
Potato Sludge	土豆泥	90,0 % TS
Hydraulic Retention Time	水力停留时间	**41,7 days**
Digester Volume (net)	消化池体积（干）	**12.500 m³**
Organic Load Rate	有机负荷率	**4,9 kgVS/m³/d**
Specific Gas Production Rate:	特殊气体产生率	
Potato Raw Material	土豆原材料	600 m³/t VS
Starch	淀粉	600 m³/t VS
Oil	油	1.000 m³/t VS
Potato Sludge	土豆泥	700 m³/t VS
Biogas Production:	生物气产生	
Potato Raw Material	土豆原材料	10.541.880 m³/a
Starch	淀粉	1.456.380 m³/a
Oil	油	604.200 m³/a
Potato Sludge	土豆泥	1.244.187 m³/a
Methane Content:	甲烷含量	
Potato Raw Material	土豆原材料	58 %
Starch	淀粉	60 %
Oil	油	65 %
Potato Sludge	土豆泥	62 %
Sum	总和	59 %
Calorific Value:	热量值	5,9 kWh/m³
Biogas Production:	生物气产生	13.846.647 m³/a
		1.581 m³/h
Biogas Power:	生物气能量	9.306 kW
Engine Power (installed) (3 Gas Engines)	发动机功率（已安装）	10.500 kW
Engine Power (electric)	发动机功率（电）	4.200 kW
Produced Energy (electric)	产生能量（电）	32.608.977 kWh/a
Engine Power (thermal)	发动机功率（热）	5.250 kW
Produced Energy (thermal)	产生能量（热）	40.761.222 kWh/a

Energy calculation overview

能量计算总结

Energy Calculation, Part 1

能量计算，第一部分

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Input:	输入	
Potato Raw Material	土豆原材料	97.610 t/a
Starch	淀粉	4.495 t/a
Oil	油	636 t/a
Potato Sludge	土豆泥	6.583 t/a
Sum	总和	109.324 m³/a

Total Solids:	总固	
Potato Raw Material	土豆原材料	20,0 % Input
Starch	淀粉	60,0 % Input
Oil	油	100,0 % Input
Potato Sludge	土豆泥	30,0 % Input
Sum	总和	22,7 % Input

Volatile Solids:	挥发性固体	
Potato Raw Material	土豆原材料	90,0 % TS
Starch	淀粉	90,0 % TS
Oil	油	95,0 % TS
Potato Sludge	土豆泥	90,0 % TS

Energy Calculation, Part 2

能量计算，第二部分

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Hydraulic Retention Time	水力停留时间	**41,7 days**
Digester Volume (net)	消化池体积（干）	**12.500 m³**
Organic Load Rate	有机负荷率	**4,9 kgVS/m³/d**
Specific Gas Production Rate:	特殊气体产生率	
Potato Raw Material	土豆原材料	600 m³/t VS
Starch	淀粉	600 m³/t VS
Oil	油	1.000 m³/t VS
Potato Sludge	土豆泥	700 m³/t VS
Biogas Production:	生物气产生	
Potato Raw Material	土豆原材料	10.541.880 m³/a
Starch	淀粉	1.456.380 m³/a
Oil	油	604.200 m³/a
Potato Sludge	土豆泥	1.244.187 m³/a

Energy Calculation, Part 3

能量计算，第三部分

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Methane Content:	甲烷含量	
Potato Raw Material	土豆原材料	58 %
Starch	淀粉	60 %
Oil	油	65 %
Potato Sludge	土豆泥	62 %
Sum	总和	59 %
Calorific Value:	热量值	5,9 kWh/m³
Biogas Production:	生物气产生	13.846.647 m³/a
		1.581 m³/h
Biogas Power:	生物气能量	9.306 kW
Engine Power (installed) (3 Gas Engines)		10.500 kW
Engine Power (electric)	发动机功率（已安装，3个气体发动机）	4.200 kW
Produced Energy (electric)	发动机功率（电）	32.608.977 kWh/a
Engine Power (thermal)	产生能量（电）	5.250 kW
Produced Energy (thermal)	发动机功率（热）	40.761.222 kWh/a
	产生能量（热）	

Mass balance - Without process water

物质平衡- 不含处理水部分

Methane: 55 %

Input		Pig manure	Pig dung	Water	Gras silage	Process water	Total
Input (t/a)		0	0	0	15.000	0	**15.000**
Input (t/d)		0,00	0,00	0,00	41,10	0,00	41,10
Total solids (%)		4,5%	30,0%	0,0%	30,0%	5,0%	**30,0%**
Total solids (t/a)		0,0	0,0	0,0	4500,0	0,0	4500,0
Total solids (t/d)		0,0	0,0	0,0	12,3	0,0	12,3
Volatile solids (% TS)		82,0%	82,0%	0,0%	89,0%	50,0%	**89,0%**
Volatile solids (t/a)		0	0	0	4.005	0	4.005
Volatile solids (t/d)		0,0	0,0	0,0	11,0	0,0	11
Water (t/a)		0	0	0	10.500	0	10.500
Water (t/d)		0	0	0	29	0	29
spec. Gas Production rate (m^3/t VS)		400	450	0	500	75	
(dry gas, Normal conditions 1,25 kg/m^3)							
Biogas							
Gas production (m^3/a)		0	0	0	2.002.500	0	2.002.500
Gas production (m^3/d)		0	0	0	5.486	0	5.486
Gas production (t/a)		0	0	0	2.503	0	2.503
Gas production (t/d)		0,00	0,00	0,00	6,86	0,00	6,86
Water content:	11%	0	0	0	275	0	275
Wet Gas 37°C (t/a)		0	0	0	2.778	0	2.778
Wet Gas 37°C (t/d)		0,00	0,00	0,00	7,61	0,00	7,61
Reactor effluent							
Total solids (t/a)							1.997
Total solids (t/d)							5
Volatile solids (t/a)							1.502
Volatile solids (t/d)							4
Water (t/a)							10.225
Water (t/d)							28
Output (t/a)							12.222
Total solids (%)							16,3%

Mass balance -With process water

物质平衡- 含处理水部分

Methane: 55 %

Input	输入	Pig manure	Pig dung	Water	Gras silage	Process water	Total
Input (t/a)	输入（t/a)	0	0	0	15.000	16.000	**31.000**
Input (t/d)	总固体（%）	0,00	0,00	0,00	41,10	43,84	84,93
Total solids (%)	总固体（t/a）	4,5%	30,0%	0,0%	30,0%	5,0%	**17,1%**
Total solids (t/a)	总固体（t/d)	0,0	0,0	0,0	4500,0	800,0	5300,0
Total solids (t/d)	挥发性固体（t/a)	0,0	0,0	0,0	12,3	2,2	14,5
Volatile solids (% TS)	挥发性固体（t/a)	82,0%	82,0%	0,0%	89,0%	50,0%	**83,1%**
Volatile solids (t/a)	水（t/a)	0	0	0	4.005	400	4.405
Volatile solids (t/d)	水（t/a)	0,0	0,0	0,0	11,0	1,1	12
Water (t/a)	特殊气体产生率(m ?t VS)	0	0	0	10.500	15.200	25.700
Water (t/d)	(干重，正常条件 1.25 kg/m)	0	0	0	29	42	70
spec. Gas Production rate (m^3/t VS)		400	450	0	500	75	
(dry gas, Normal conditions 1,25 kg/m^3)							
Biogas	生物气						
Gas production (m^3/a)	气体产生（m/a)	0	0	0	2.002.500	30.000	2.032.500
Gas production (m^3/d)	气体产生（m/d)	0	0	0	5.486	82	5.568
Gas production (t/a)	气体产生（t/a)	0	0	0	2.503	35	2.539
Gas production (t/d)	气体产生（t/d)	0,00	0,00	0,00	6,86	0,10	6,95
Water content:	水含量 11%	0	0	0	275	4	279
Wet Gas 37°C (t/a)	湿气（t/a)	0	0	0	2.778	39	2.818
Wet Gas 37°C (t/d)	湿气（t/d)	0,00	0,00	0,00	7,61	0,11	7,72
Reactor effluent	反应器出水						
Total solids (t/a)	总固体（t/a)						2.761
Total solids (t/d)	总固体（t/d)						8
Volatile solids (t/a)	挥发性固体(t/a)						1.866
Volatile solids (t/d)	挥发性固体（t/d)						5
Water (t/a)	水（t/a)						25.421
Water (t/d)	水(t/d)						70
Output (t/a)	出水 （t/a)						28.182
Total solids (%)	总固体（%）						9,8%

Biogas concept with upright digester
立式消化池的沼气

Krieg & Fischer Ingenieure GmbH

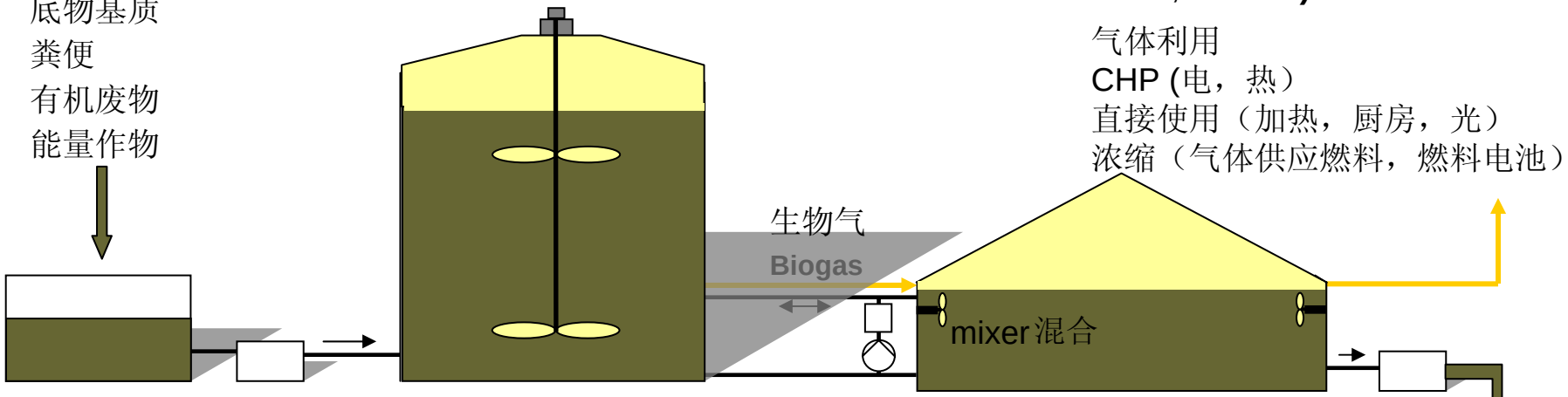
Substrate

manure
organic waste
energy crops
底物基质
粪便
有机废物
能量作物

混合器
mixer

Gas utilization
→CHP (power, heat)
→direct use (heating, cooking, light)
→upgrading (gas grid fuel, fuel cell)

气体利用
CHP (电，热)
直接使用（加热，厨房，光）
浓缩（气体供应燃料，燃料电池）



Storage Tank
储存容器

Upright digester
立式消化池

泵 Pump

Heat exchanger

Secondary digester
第二消化池

Digested substrate
→ storage and use as fertilizer
→ treatment
消化池底物
作为肥料进行储藏和使用
处理

Input device
→ piston pump, screw etc. (solids)
→ pump (fluids)
基质底物输入装置
活塞泵，螺丝等（固体）
泵（液体）

Tall Digester, Top Mounted Mixer
立式消化池，顶部混合装置

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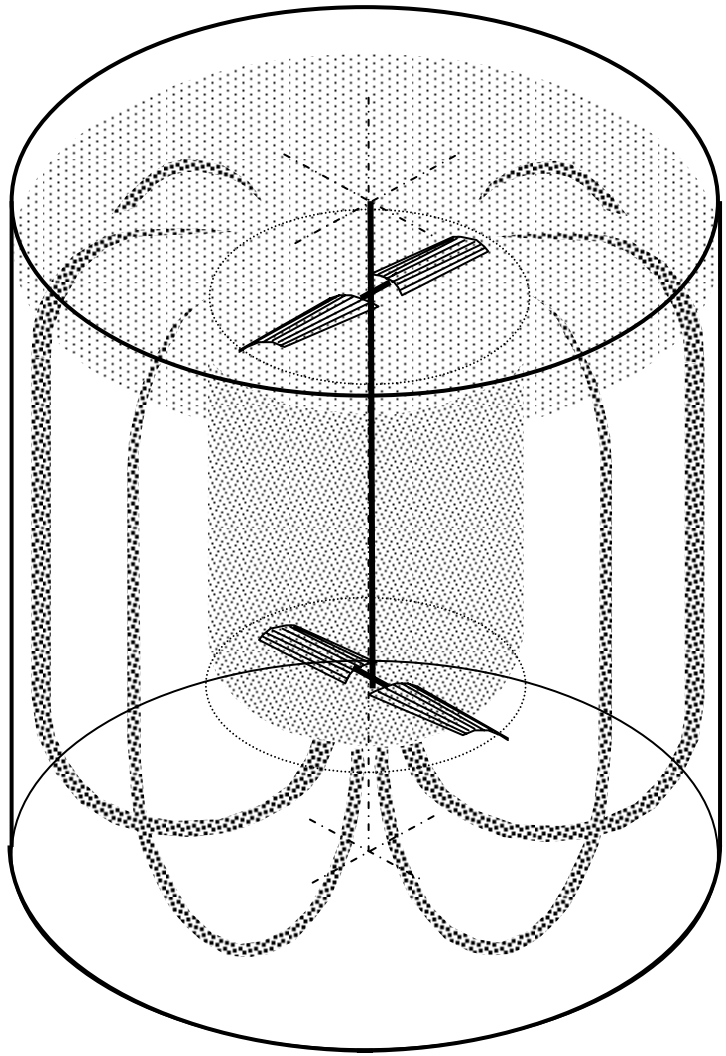
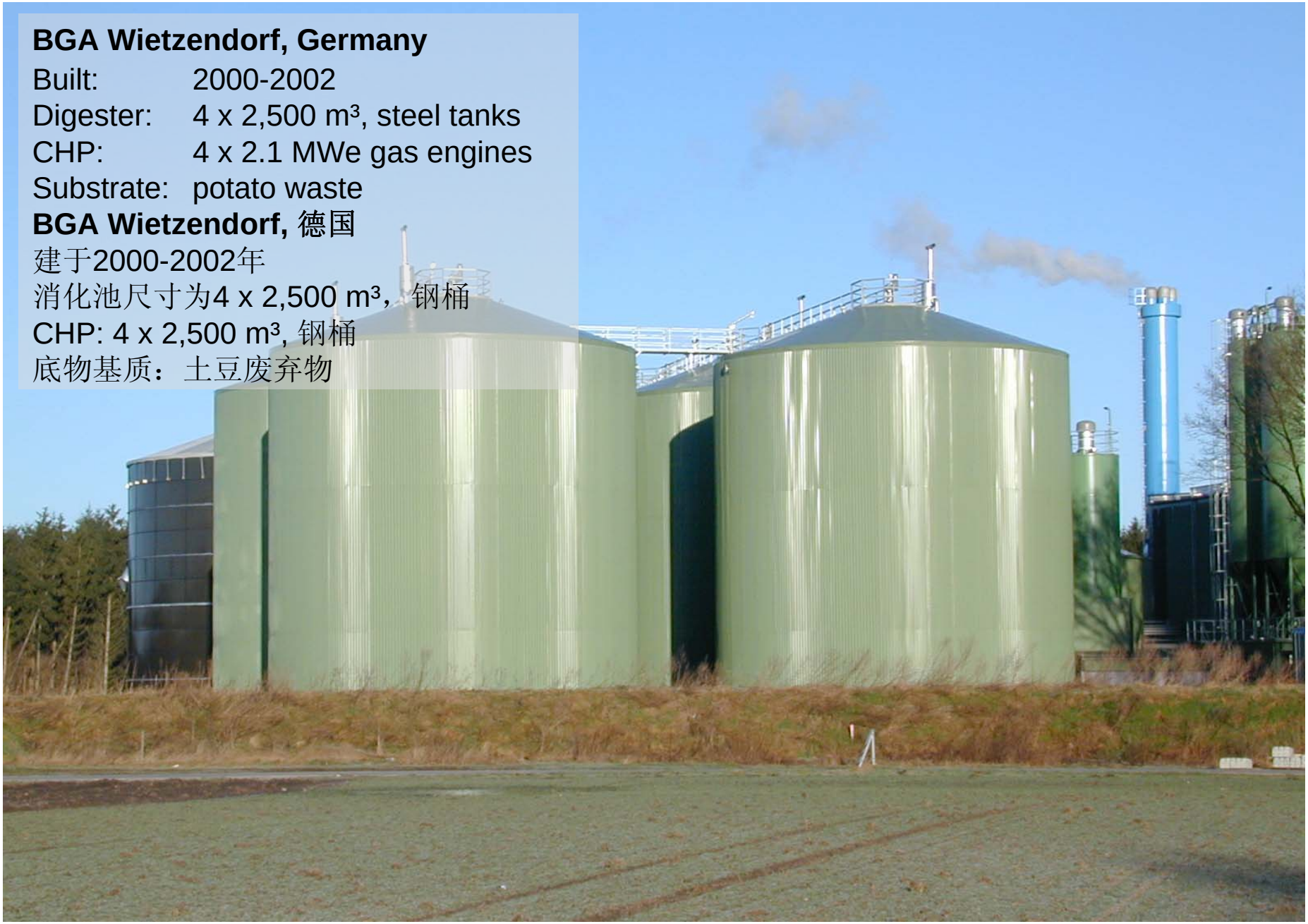
Operation Top Mounted Mixer
运行顶部混合装置

- Permanent=24 h/d
  转速 24 h/d
- 13-18 rds/m
  13-18 rds/m
- 11,5 – 30 KW
  11,5 – 30 KW
- Frequency inverter for low energy consumption
  变频器能耗低




BGA Wietzendorf, Germany
Built: 2000-2002
Digester: 4 x 2,500 m³, steel tanks
CHP: 4 x 2.1 MWe gas engines
Substrate: potato waste
BGA Wietzendorf, 德国
建于2000-2002年
消化池尺寸为4 x 2,500 m³，钢桶
CHP: 4 x 2,500 m³, 钢桶
底物基质：土豆废弃物

Top mounted mixer
顶部混合

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Biogas concept with flat digester
扁平消化池的沼气

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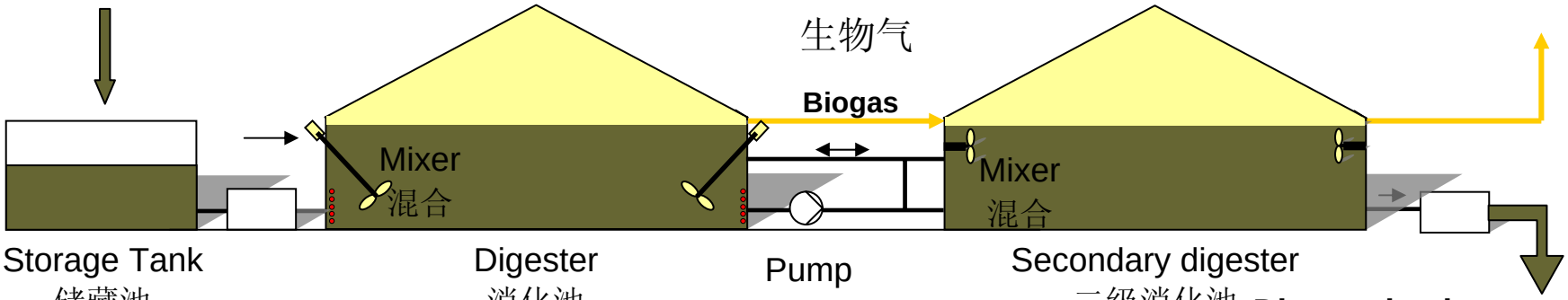
Substrate 底物基质

manure 粪便
organic waste 有机废物
energy crops 能源作物

Gas utilization 气体利用
→CHP (power, heat) CHP (电，热)
→direct use (heating, cooking, light) 直接使用（加热，厨房，光）
→upgrading (gas grid fuel, fuel cell) 浓缩（气体供应燃料，燃料电池）



Input device
→piston pump, screw etc. (solids)
→pump (fluids)
基质底物输入装置
活塞泵，螺丝等（固体）
泵（液体）

Digested substrate
→storage and use as fertilizer
→treatment
消化池底物
作为肥料进行储藏和使用
处理

BGA Porta, Spain
Built: 2006
Digester: 1,360 m³, concrete tank
CHP: 191 kWe dual fuel engine
Substrate: pig manure, waste

BGA Porta, 西班牙
建于2006年
消化池： 1,360 m³, 浓缩池
CHP: 191kWe二重燃料发动机
底物基质：猪粪便，废物

Flat digester, submerged mixer
扁平消化池，混合器

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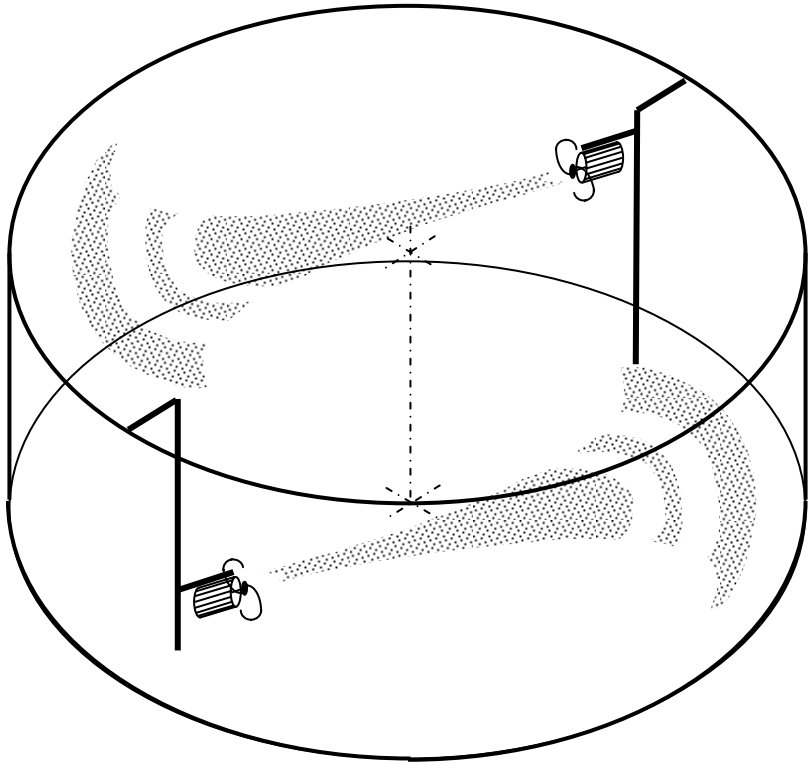

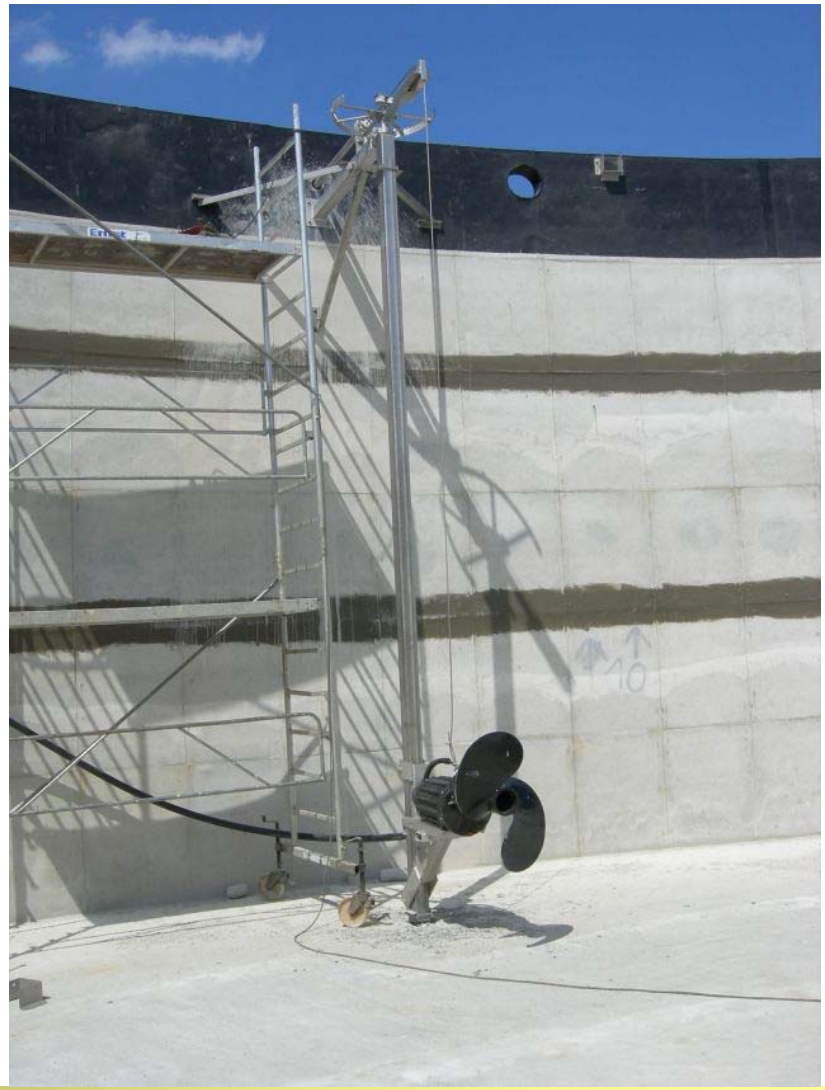

Biogas concept with a horizontal digester
卧式消化池的沼气

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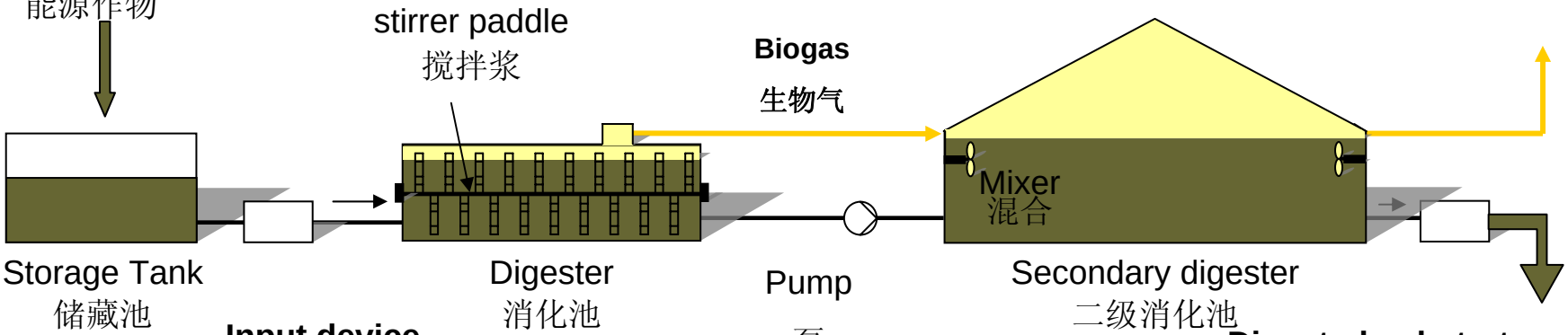
Substrate

manure
organic waste
energy crops
底物基质
粪便
有机废物
能源作物

Gas utilization
→CHP (power, heat)
→direct use (heating, cooking, light)
→upgrading (gas grid fuel, fuel cell)

气体利用
CHP (电，热）
直接使用（加热，厨房，光）
浓缩（气体供应燃料，燃料电池）



Input device
→ piston pump, screw etc. (solids)
活塞泵，，罗杆等**(固体)**

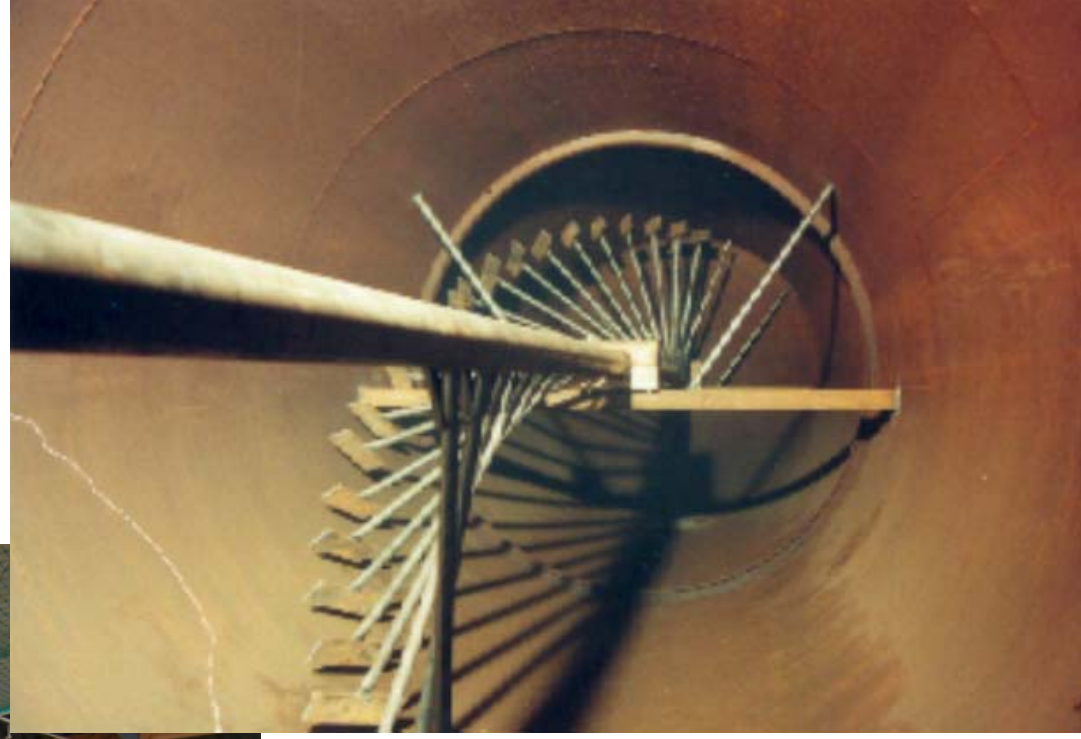
Digested substrate
→ storage and use as fertilizer
→ treatment
消化池底物作为肥料进行储藏和使用
处理

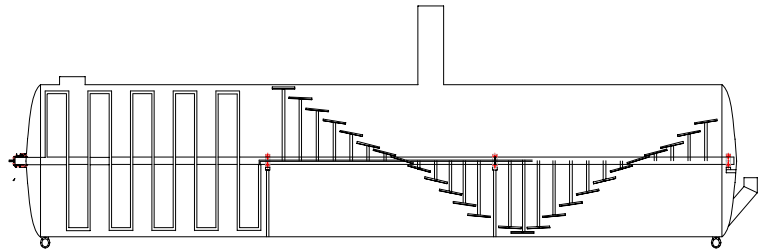
Stirring and mixing technology

搅拌和混合技术

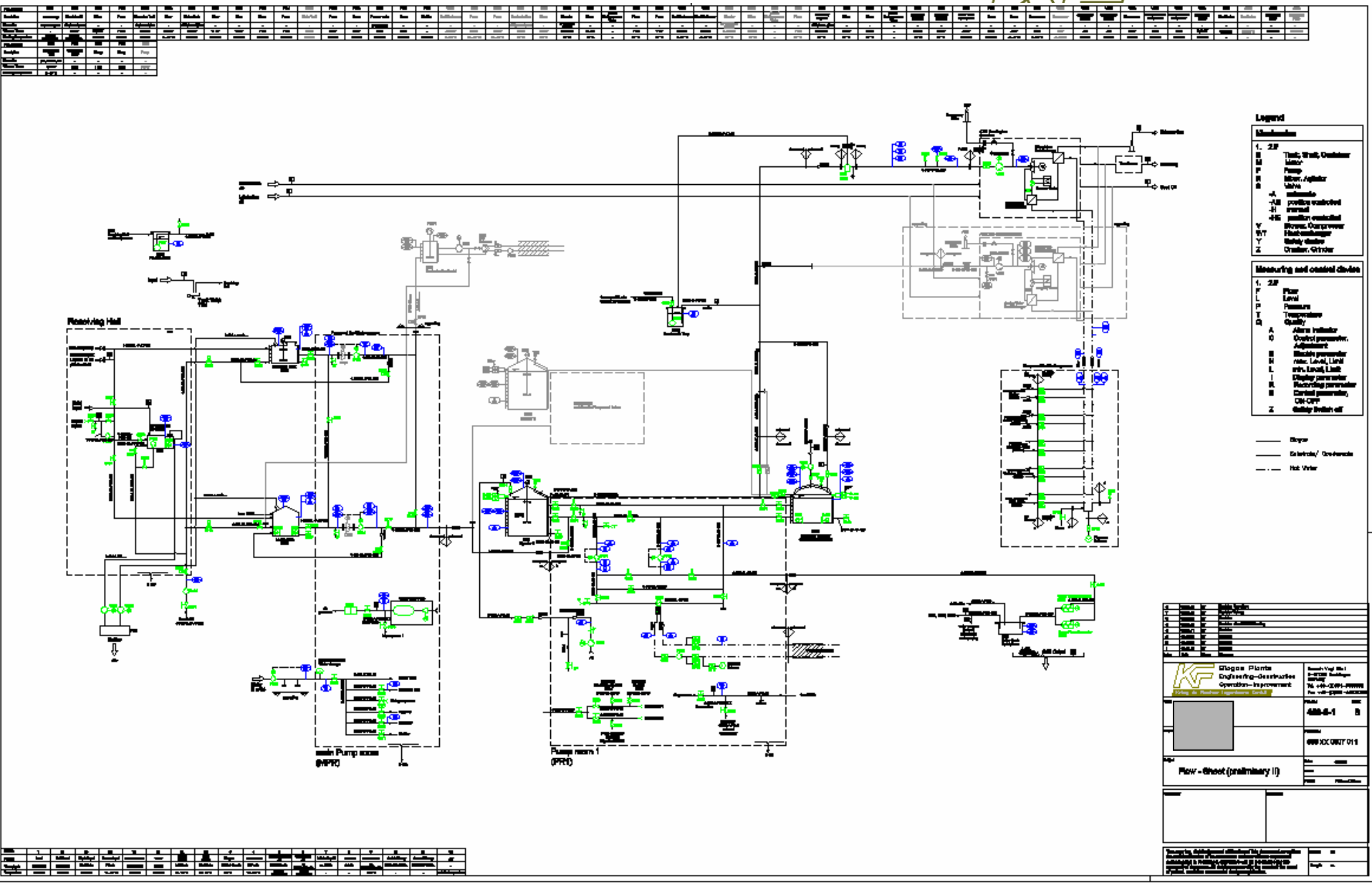
Horizontal digester

卧式消化池

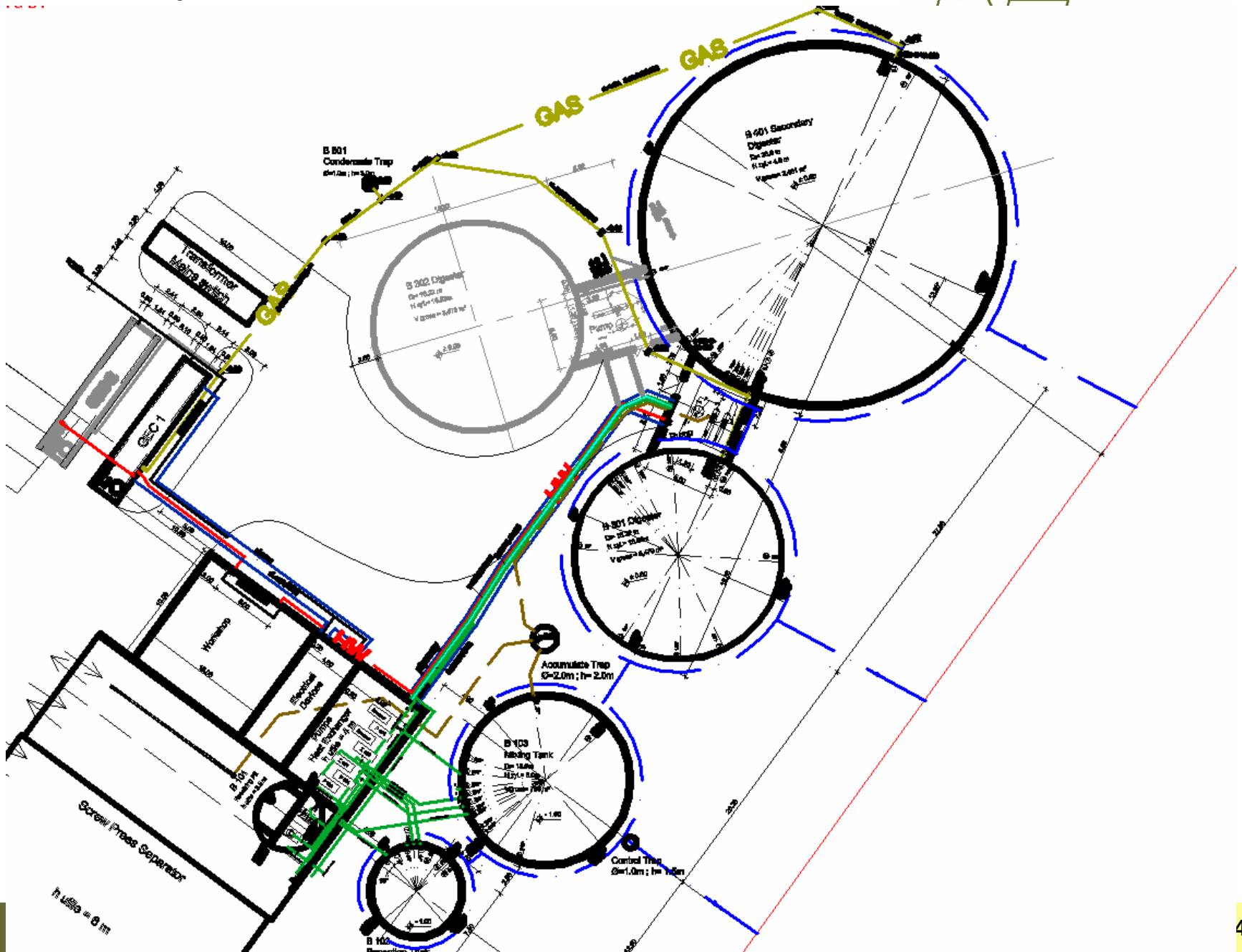


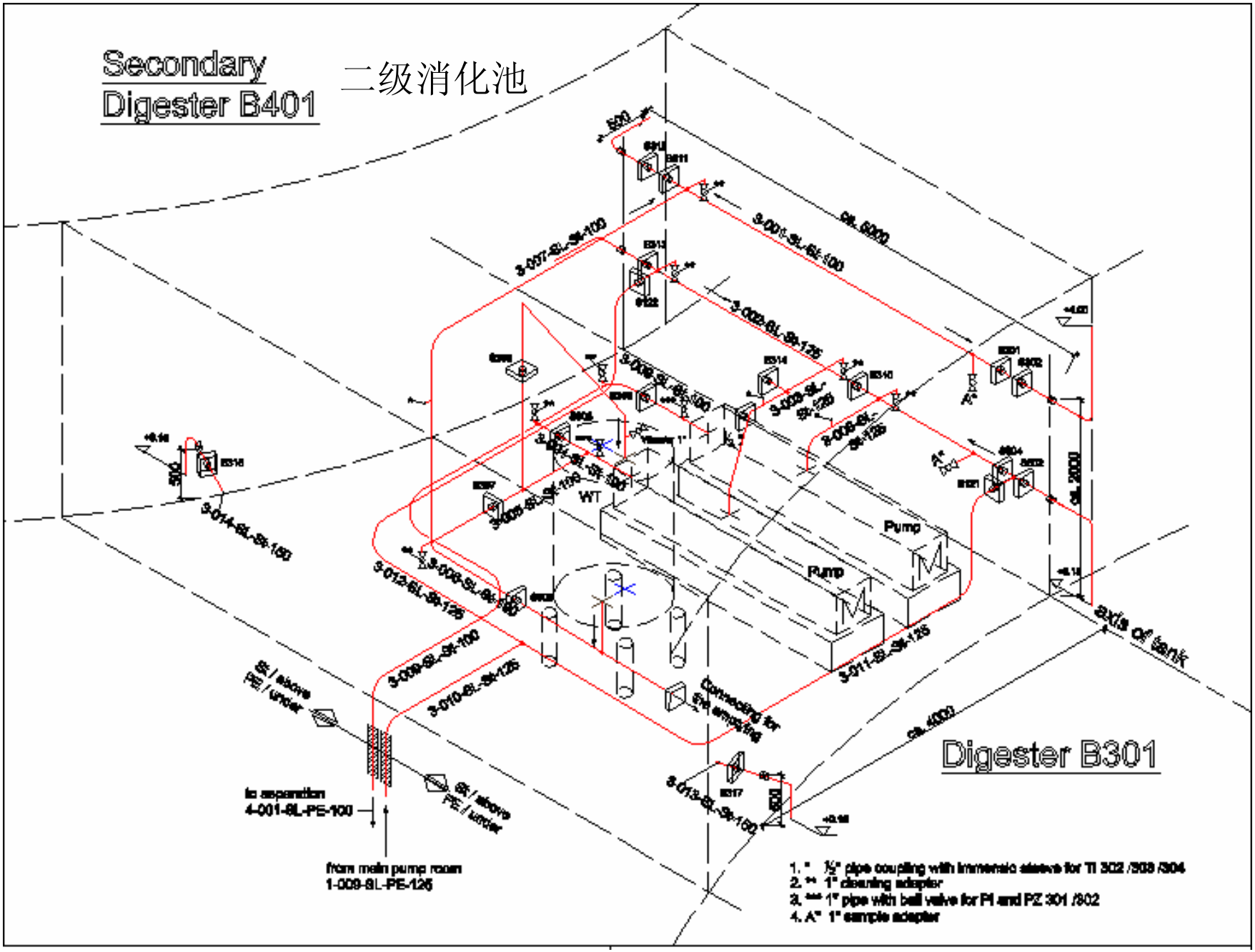


Flow Sheet 流程图



Site Layout 工地布置




Secondary
Digester B401
二级消化池
Digester B301
Pump
Pump
WT
axis of tank
from main pump room
1-009-SL-PE-125
to separation
4-001-SL-PE-100
1. * ½" pipe coupling with immersio sleeve for TI 302 /303 /304
2. ** 1" cleaning adapter
3. *** 1" pipe with ball valve for PI and PZ 301 /302
4. A" 1" sample adapter

Introduction into Planning and Construction
计划和构建介绍

- Important building materials
  concrete – steel
  construction work tanks

  重要的建造材料
  实体：钢
  施工工程箱
- Suitable material for equipment
  PVC, PE, Steel, stainless steel

  设备的合适材料：PVC, PE, 钢，不锈钢

  Technical principals
  pumps, valves

  技术概念 泵，阀门
- Special parts
  Process control units

  特殊部分 过程控制单元

Important building materials
重要建造材料

Where do we need tanks ?

哪里需要罐?

1. Digester, secondary digester

   消化池，二级消化池

2. Storage tanks

   储藏罐

3. Reception tanks

   接收罐

4. Mixing tanks

   混合罐

5. Gas holder

   储气器


90,000 m³/a Manure
90,000 m³/a 粪便
20,000 m³/a Fats
20,000 m³/a 脂肪
WERLTE

Important building materials
重要的建筑材料

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How to differentiate the tanks ?
怎么区分不同的罐?

1. By function
   根据作用
2. By material
   根据材料
   - Concrete (in situ; precast; pre-stressed)
     混凝土（现场，预浇铸，预混凝）
   - Steel (glass coated steel; stainless steel)
     钢材（玻璃镀层钢板，不锈钢钢板）
   - Others (fiberglass)
     其他（玻璃纤维）

Concrete or Steel Tank ?
混凝土罐还是钢罐？

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- Main argument is the price – if the design is done properly
  主要的问题是价格-如果设计合理
- Typical types of use
  使用的典型类型
  - Concrete tanks as storage tanks or flat digester: diameter up to 30 m; height up to 8 m
    混凝土罐作为贮藏罐或者扁平消化池
    直径为30 m, 高度为8 m
  - Concrete tanks as high digesters: up to 14 m by 14 m diameter (500 kW-plant)
    混凝土罐作为贮藏罐或者高消化池
    直径为14 m, 高度为14 m（500 KW工厂）
  - Steel tanks as high digester:
    钢罐作为高消化池
  - height more than 15 m by 15 m diameter (for example 18*18 m for a 1 MW-plant)
    高度超过15 m, 直径为15 m, (比如1MW工厂，18*18 m)

Comparison
比较

Digester made of concrete

混凝土消化池

- construction on site by local companies

  由当地公司现场建造

- concrete has to be protected at least in the gas phase

  在气相条件下必须保护混凝土材料

- cheaper < 2,500 m³ volume (in Germany)

  较便宜的< 2,500 m³ 体积 （在德国）

- tightness has to be tested after 28-56 days

  28-56天后测试强度

- renaturation difficult

  较难复原

Digester made of glass coated steel

玻璃镀层钢板消化池

- preproduction in the factory (only 3 - 4 companies worldwide)

  在工厂预生产 （全世界只有3-4家公司）

- corrosion protection by enameling

  防腐保护

- cheaper > 2,500 m³ volume

  较便宜> 2,500 m³ 体积

- tightness can be tested after 4 weeks;
  4周之后测试强度

- leakiness very few and easy to correct

  不易漏，易复原

- Recycable

  重复使用

Concrete tank under construction
正在建造中的混凝土罐

SCHORNBUSCH

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Concrete tank under construction: Excursion „concrete“
在建造中的混凝土罐：混凝土

- Concrete is a mixture of water, gravel and cement.

  混凝土是水，砾石和水泥的混合物
- By using reinforced concrete the good attributes of steel and the good attributes of concrete are combined

  钢筋混凝土具备钢筋和混凝土的好的性能
- Concrete: cheap, high compression strength

  混凝土：便宜，压缩强度较高
- Steel: high tensile strength

  钢筋：抗张强度较高
- Concrete is alkaline and protects the steel from corrosion

  混凝土是碱性的，因此保护钢筋免受腐蚀

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concrete digester

混凝土消化池

finished concrete construction

完成的混凝土罐

Concrete tank under construction: Concrete protection cover
正在建造中的混凝土罐：混凝土保护罐

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Concrete tank under construction: Insulation and steel cladding
正在建造中的混凝土罐：绝缘和钢铁覆层

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Concrete tank under construction: Ladders and plattforms

正在建造中的混凝土罐：梯子和平板窗体

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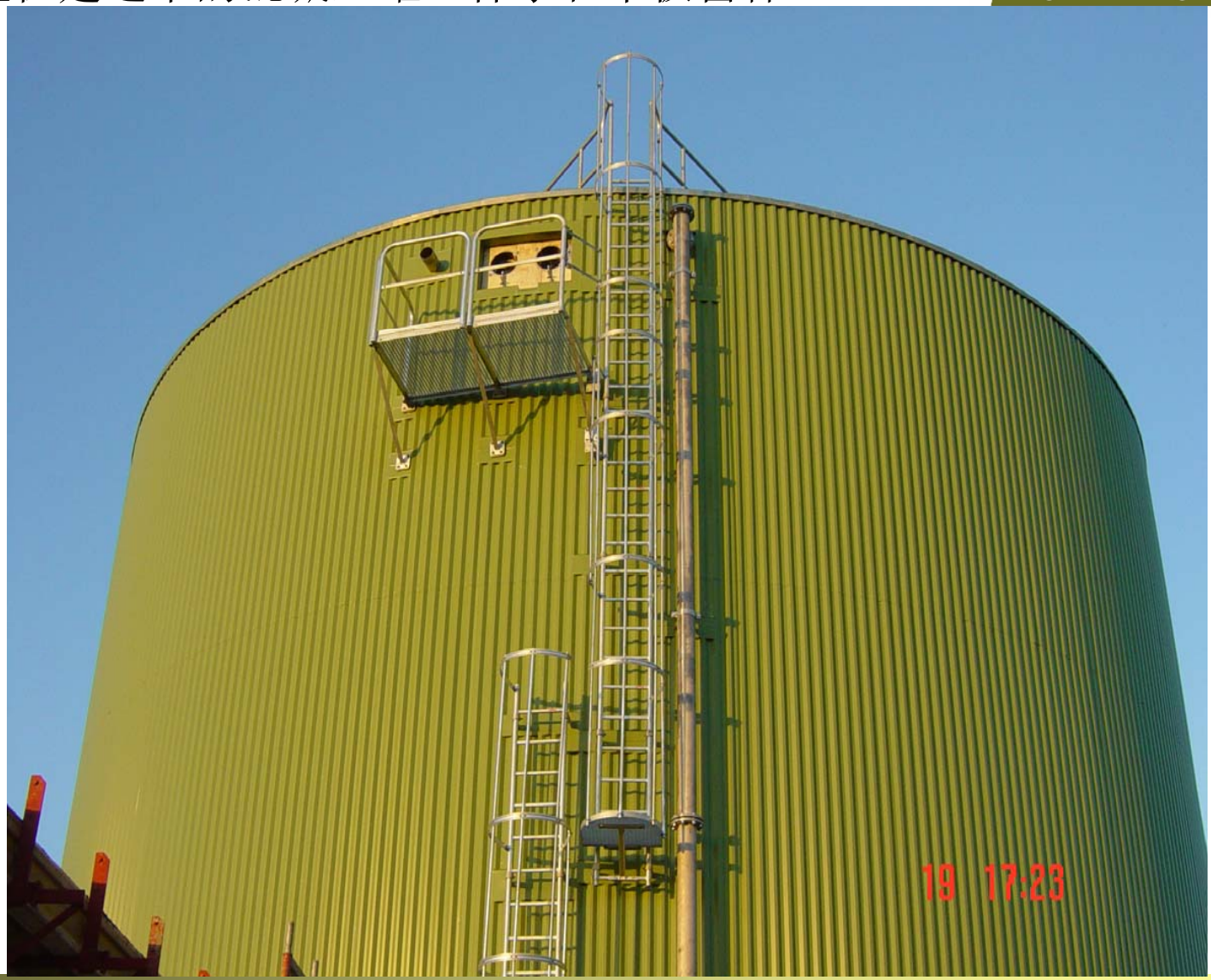

Steel tank under construction
正在建造中的钢罐

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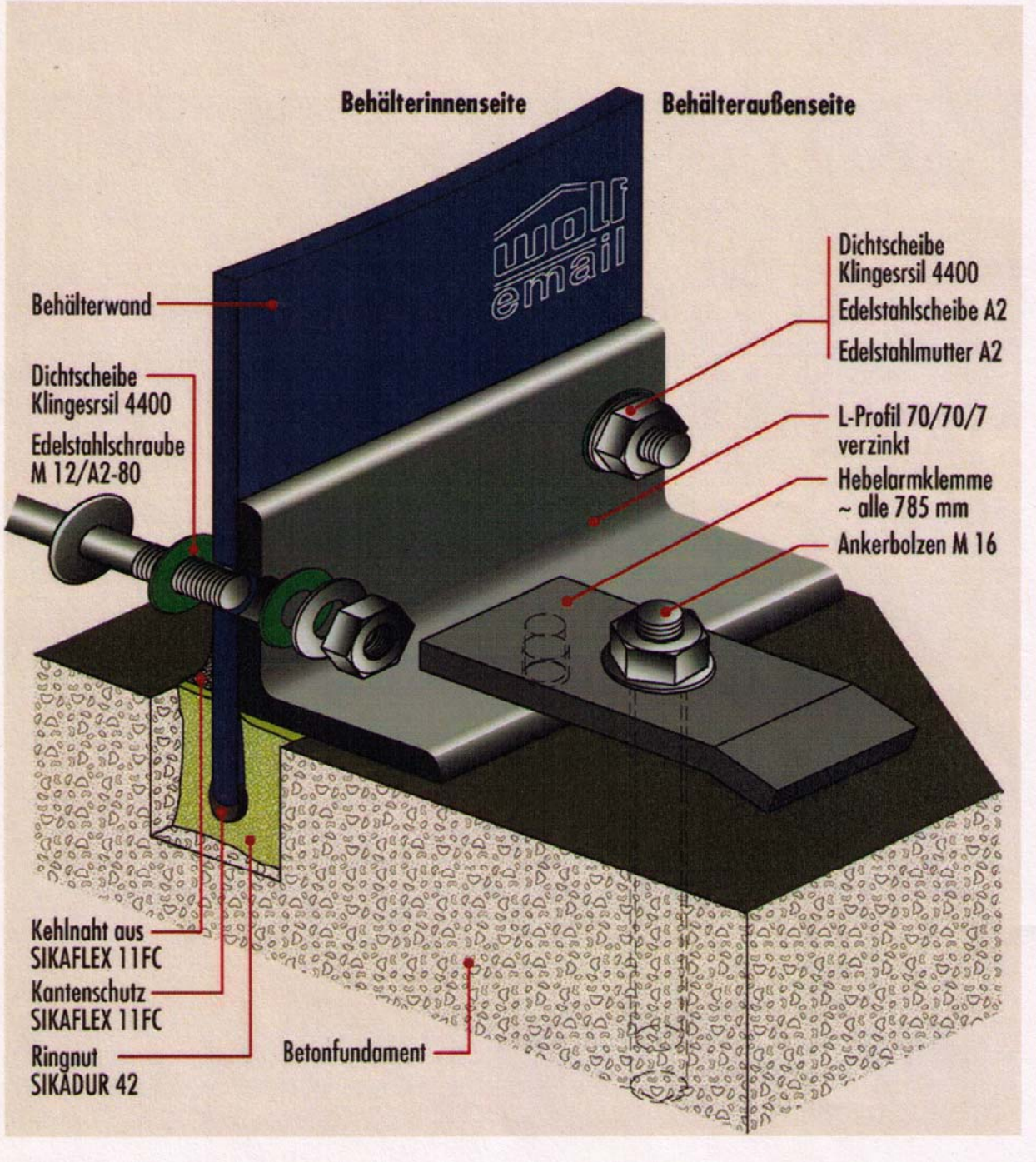
Definition of interfaces
分界面定义

- Hardcore layer, concrete blinding or concrete base produced by others
  核心层，混凝土膜层或者混凝土地基
- Concrete tank with required flanges for following trades
  带有所需凸轮的混凝土罐


INLAND EMPIRE

Steel tank under construction
正在建造中的钢罐

First ring
第一圈



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Steel tank under construction: Roof

正在建造中的钢罐：顶

Steel tank under construction:
Growing tank
正在建造中的钢罐：高度增加的罐

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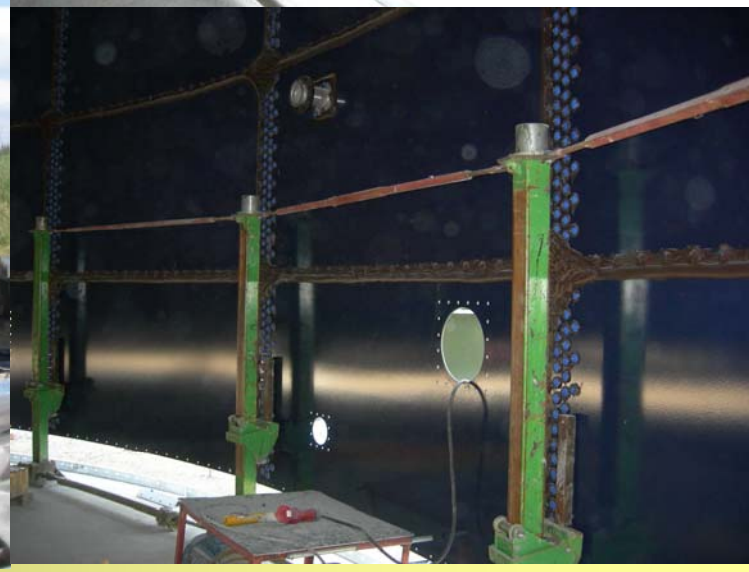

Steel tank under construction
正在建造中的钢罐

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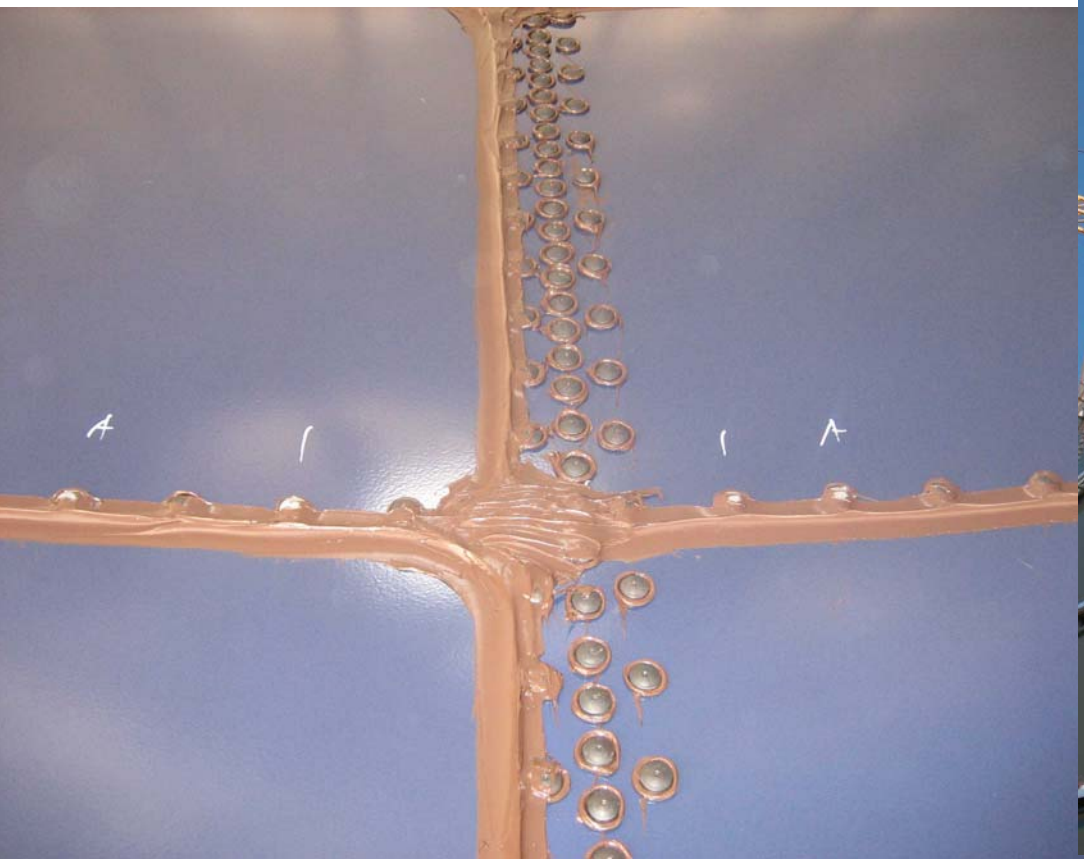

Steel tank under construction
正在建造中的钢罐

Equipment: ladders, inspection glass, flanges
设备：梯度，玻璃，凸缘

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Steel tank under construction:
正在建造中的钢罐

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Top mounted agitator

带有顶部的搅拌器

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High upright digester made of glass coated steel

由玻璃涂层钢板做成的高直立消化池

Conceptual Planning of integrated MLBGP Project Solutions
MLBGP项目解决方案的规划

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