ENOPUR®
Energy optimised sludge treatment systems
Conversion of residues into an energy source

WABAG

sustainable solutions. for a better life.

Sludge stabilisation systems

Integral part of state-of-the-art WWTPs

Around the world, mechanical/biological treatment is the most frequently used process for dealing with municipal wastewater. Modern treatment plants are highly efficient and their discharges are virtually solids-free. Sewage sludge is created as a resultant by-product and this possesses considerable potential for use as a source of energy and nutrients.

However, a prerequisite for the employment of sewage sludge is correct treatment, which above all reduces or removes the high water content (>95%), the pollutant load, pathogen bacteria and malodorous substances.

Using the range of mature technologies and experience derived from the numerous plants that we have built and operated, these tasks can be fulfilled easily and the potential of the sludge as a resource exploited.

As an important part of environmentally compatible wastewater disposal, modern sludge treatment processes are currently subject to a **variety of demands**:

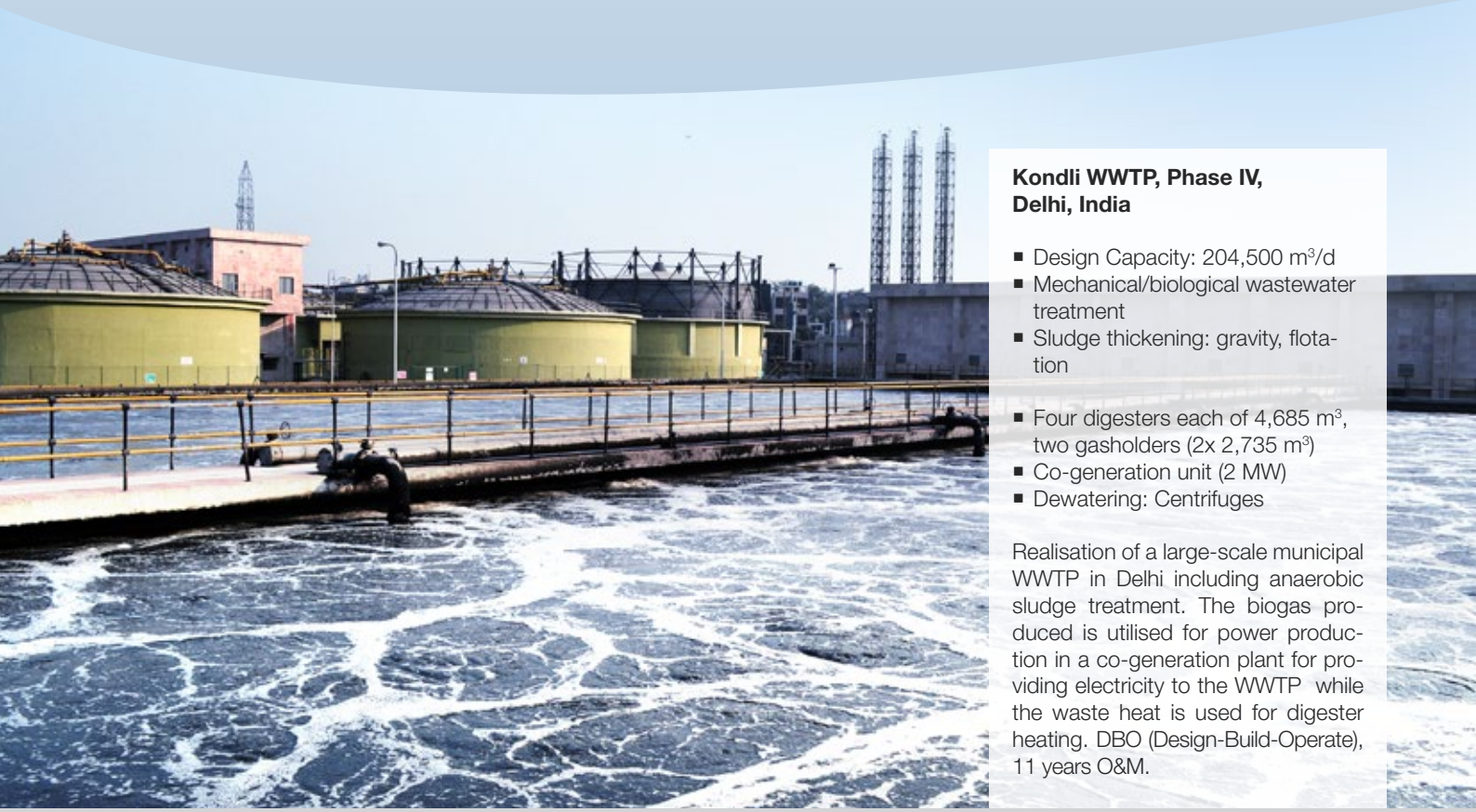
- Efficiency with regard to investment and operating costs
- Energy efficiency with low consumption and the use of own reserves
- Minimisation of the sludge volume
- High sewage sludge quality
- Landfilling with low environmental impact

Two classic processes are available for correct sludge treatment:

Aerobic sludge stabilisation takes place in open sludge tanks with the injection of air. Sufficient space constitutes the prerequisite for its use. Aeration and agitation mean that the energy requirement is higher than in the case of anaerobic stabilisation.

Anaerobic sludge stabilisation – the advantageous solution. Anaerobic sludge stabilisation constitutes the best solution for sewage plants with medium to large design capacity (from approx. 20,000 PE) with regard to cost and energy efficiency and environmental protection. Moreover, combustible biogas results from controlled digestion and this can be used for energetic purposes.

Depending on the individual demands made on a plant, an optimum result can also derive from **dual stabilisation**, which involves a combination of both processes.



Kondli WWTP, Phase IV, Delhi, India

- Design Capacity: 204,500 m^3/d
- Mechanical/biological wastewater treatment
- Sludge thickening: gravity, flotation
- Four digesters each of 4,685 m^3, two gasholders (2x 2,735 m^3)
- Co-generation unit (2 MW)
- Dewatering: Centrifuges

Realisation of a large-scale municipal WWTP in Delhi including anaerobic sludge treatment. The biogas produced is utilised for power production in a co-generation plant for providing electricity to the WWTP while the waste heat is used for digester heating. DBO (Design-Build-Operate), 11 years O&M.

ENOPUR-AD™ - Anaerobic sludge stabilisation

Main advantages

Sewage sludge – waste or alternative energy source?

The increase in both energy demand and CO_2 emissions represent a global problem that requires urgent solution. And if sewage sludge were to be stored untreated on landfills this would further exacerbate the greenhouse effect, as pollutant landfill gas would be emitted into the atmosphere over decades. Above all, the emissions of methane are of special relevance as this is 25 times more active as a greenhouse gas than carbon dioxide.

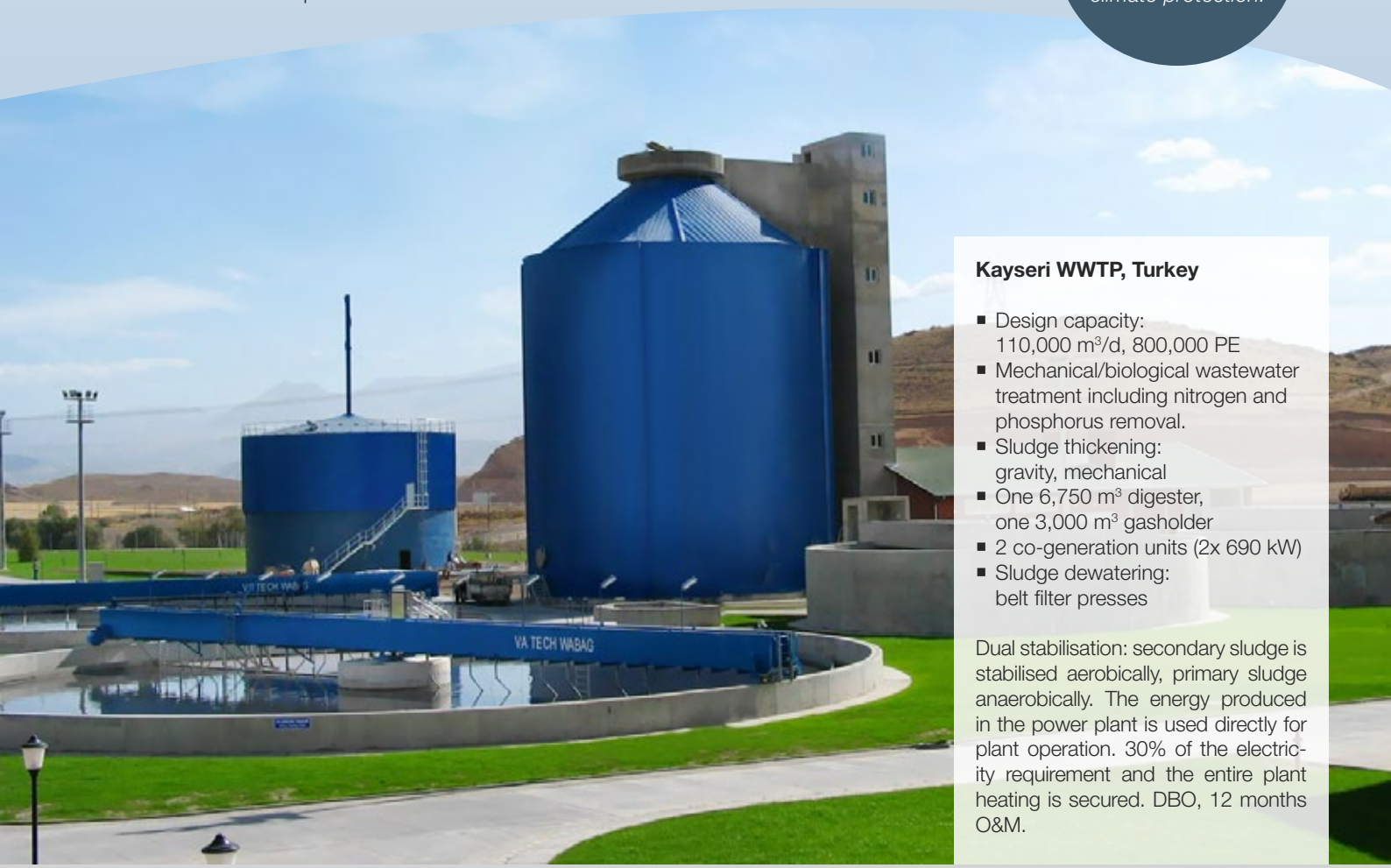
Anaerobic sludge treatment offers an alternative solution with a range of ecological and economic advantages.

- A reduction in organic content of ~50% and its conversion into combustible biogas.
- The production of renewable energy
- The possibility of the independent supply of the treatment plants with energy
- Reduced operating costs
- A stable and reliable process
- A smaller footprint
- A reduction in the volume of malodorous substances
- Sludge hygienisation (including bacteria reduction)
- Climate protection through an improvement in the CO_2 balance of the treatment plant

What makes WABAG a preferred partner?

- Comprehensive experience in the design, construction and operation of complete WWTPs including anaerobic sludge digestion systems (around 100 plants built since 1990).
- Proven process know-how and expertise as well as an understanding of entire systems.
- Experience as plant operator: based on DBO as well as O&M outsourcing schemes.
- Special capabilities with regard to the retrofitting and upgrading of existing plants.
- Provision of complete solutions, life cycle partnership.
- Top quality completion standards.
- In-house R&D centres guarantee the continuous optimisation of current systems as well as the development of innovative technologies (e.g. the BIOZONE-AD® process).).

Anaerobic sludge treatment makes a significant contribution to climate protection.



Kayseri WWTP, Turkey

- Design capacity: 110,000 m^3/d, 800,000 PE
- Mechanical/biological wastewater treatment including nitrogen and phosphorus removal.
- Sludge thickening: gravity, mechanical
- One 6,750 m^3 digester, one 3,000 m^3 gasholder
- 2 co-generation units (2x 690 kW)
- Sludge dewatering: belt filter presses

Dual stabilisation: secondary sludge is stabilised aerobically, primary sludge anaerobically. The energy produced in the power plant is used directly for plant operation. 30% of the electricity requirement and the entire plant heating is secured. DBO, 12 months O&M.

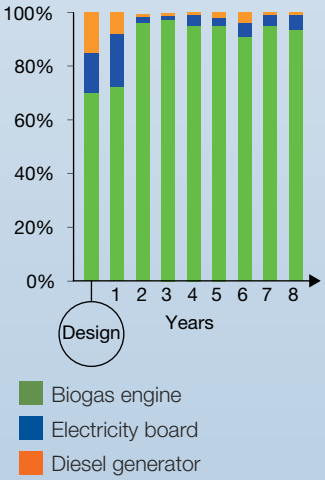
Complete solutions

ENOPUR® = State-of-the-art plants

Becoming energy self-sufficient

- ✓ ***Volume reduction***
- ✓ ***Biological stability***
- ✓ ***Bacteria reduction***
- ✓ ***Reduction in malodorous substances***
- ✓ ***Biogas production***
- ✓ ***Improved dewatering characteristics***

Kodungaiyur
Power consumption pattern in % of share



Sludge thickening as pre-treatment

Thickening prior to stabilisation results in a significant reduction in sludge volume and subsequently a cut in the hydraulic load in the digester, improved gas yield and a higher heat temperature.

The anaerobic sludge digestion process

The selected temperature range and the resultant retention time of the sludge in the digester are the most important intake parameters for the design of anaerobic stabilisation.

Classic stabilisation takes place in digesters, which represent a type of bioreactor. In roughly 20 days, the sludge is subjected to controlled digestion in an air-free atmosphere and the organic content is converted into water and biogas. The digester gas (biogas) thus released, which consists of a mixture of 50-70% methane, 30-40% CO_2, 0-1% steam and trace elements, is combustible and can be used for energy generation purposes.

Sludge stabilisation can occur within differing temperature bands and be completed in one or two stages. In general, WABAG employs mesophile stabilisation at 30-37°C and this requires around 20 days. A further solution is comprised by thermophile stabilisation at >53°C, which reduces the process period to less than 15 days.

Three important points have to be taken into account for an optimum process:

- Sludge circulation by means of agitators or pumps or (bio)gas injection
- Avoidance of floating sludge layers
- Digester heating preferably through waste heat from energy generation

98%
energy-neutral

Kodungaiyur Phase I WWTP, Chennai, India

- Design capacity: 110,000 m^3/d
- Mechanical/biological wastewater treatment
- Sludge thickening: mechanical
- Two 6,750 m^3 digesters
- One co-generation unit: 1MW
- Sludge dewatering with centrifuges

Realisation of a new wastewater treatment plant with anaerobic sludge treatment. The biogas is used for electricity generation and the resulting power for the supply of the sewage treatment plant. DBO, 10 years O&M.

The Kodungiyur STP treats roughly 20% of the total sewage generated in Chennai. In a city that suffers from acute power shortage, WABAG developed and operates a biogas generation plant that produces power to meet cent percent of the plant's operational requirements.

Producing green energy

Putting biogas to work

Renewable energy. The possibilities offered by biogas utilisation.

The calorific value of the gas produced in the digesters during anaerobic stabilisation amounts to approximately 6.5 kWh/m³. This corresponds with more than half of the calorific value of natural gas (~10 kWh/m³). If the biogas is employed for energy generation purposes, electrical and thermal energy can be obtained for the in-house supply of treatment plants or feeding into the public grid.

- Generation of electrical energy and waste heat in a combined heat and power plant: ~35-40% electrical energy, ~60% thermal energy.

  1 m³ biogas = 6.5 kWh = 2.3 kWh electrical + 4.2 kWh thermal energy

- Direct employment in gas engines

- Thermal utilisation through the generation of steam or hot water

Efficient utilisation means that a largely independent energy supply can be guaranteed with regard to the provision of the treatment plant with electricity for purposes such as the aeration of the activated sludge tanks, digester and building heating, and the hot water supply.

Large treatment plants can cover up to 100% of their energy needs through in-house generation.

Biogas cleaning

Depending on the composition of the wastewater, desulphurisation, dewatering or the removal of siloxane may be required prior to energetic use. WABAG employs various processes such as adsorption, biogas scrubbing or air injection for this purpose.

An example: Sludge treatment Tehran Southern WWTP, Iran:

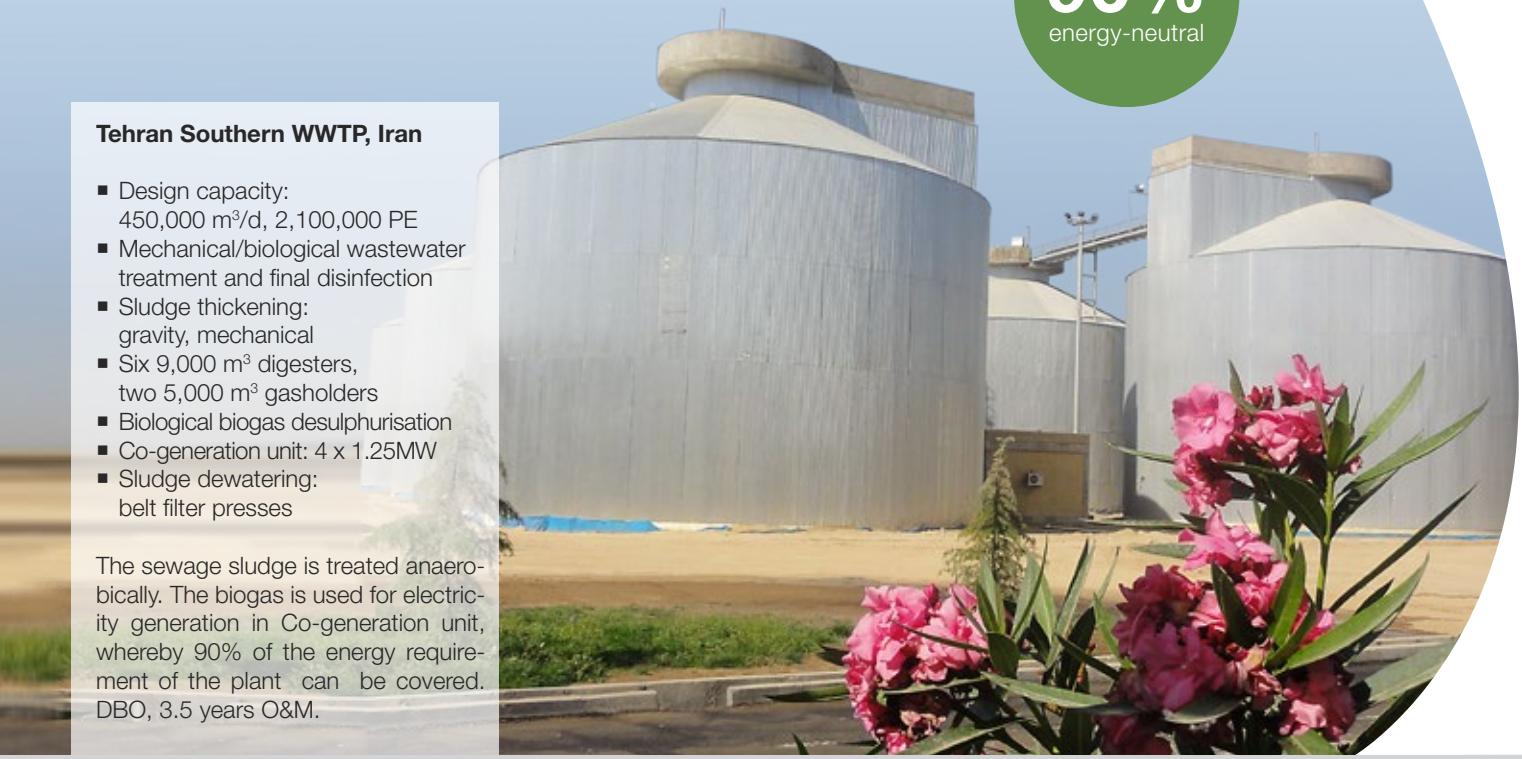
Digester volume:
54,000 m³

Biogas production:
30,000 m³/day

Energy production:
111,000 kWh term./day
74,000 kWh el/day

This corresponds with the energy content of ~ 20,000 m³ natural gas /day

90%
energy-neutral



Tehran Southern WWTP, Iran

- Design capacity: 450,000 m³/d, 2,100,000 PE
- Mechanical/biological wastewater treatment and final disinfection
- Sludge thickening: gravity, mechanical
- Six 9,000 m³ digesters, two 5,000 m³ gasholders
- Biological biogas desulphurisation
- Co-generation unit: 4 x 1.25MW
- Sludge dewatering: belt filter presses

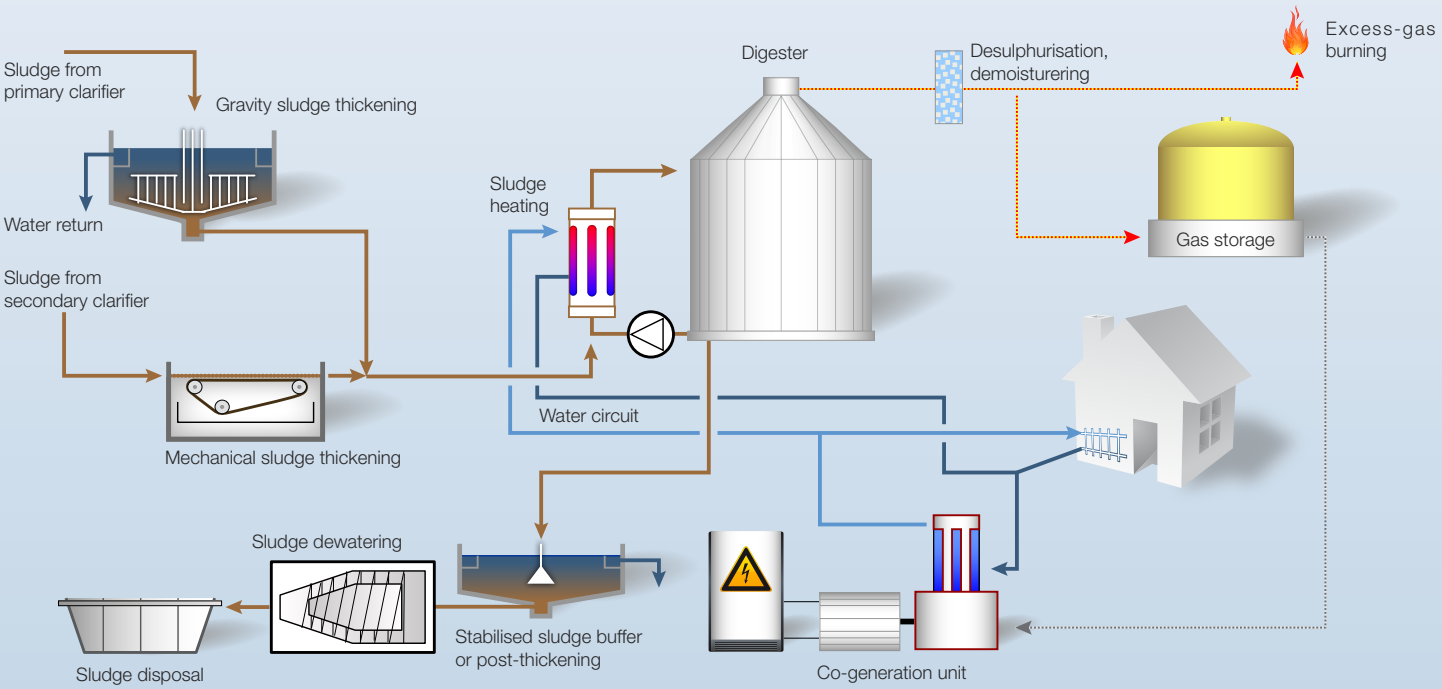
The sewage sludge is treated anaerobically. The biogas is used for electricity generation in Co-generation unit, whereby 90% of the energy requirement of the plant can be covered. DBO, 3.5 years O&M.

The perfect design

Individual solutions

designed by WABAG

Example of process diagram of an anaerobic sludge treatment with biogas utilisation

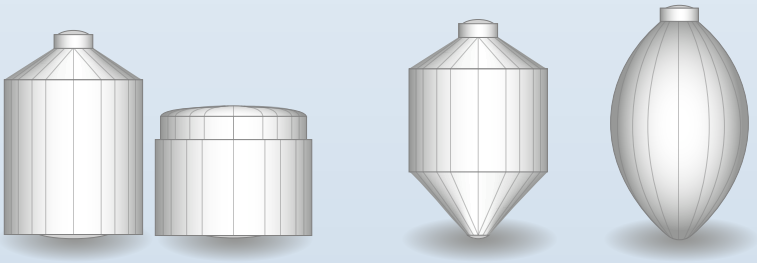


Classic digester (Weifang WWTP, P.R. China, 100,000 m³/d)

On the basis of the specific general conditions, WABAG creates ideal plant designs with regard to effectiveness, cost efficiency and environment-friendliness using all its comprehensive experience as an international plant builder.

The main components of a modern sludge treatment plant and the related variations

Thickening: gravity, mechanical
Digester designs: flat, classic, egg-shaped



Homogenisation: agitators, pumps, gas injection
Biogas desulphurisation: adsorption, biogas scrubbing, air injection
Biogas utilisation: cogeneration plants, boilers, gas engines
Dewatering: belt filter presses, chamber filter presses, centrifuges
Drying: fluidised bed drying, drying beds, belt drying, solar sludge drying
Utilisation/disposal: fertilizer, agriculture, joint combustion, mono-combustion, landfill

Homogenisation: gas injection

Co-generation unit

Sludge dewatering (belt filter press)

Solar sludge drying

Biogas desulphurisation, gas storage, excess gas burning
(Adana West WWTP, Turkey, 250,000 m^3/d)

Complete solutions

Optimum post-treatment

for closed cycle sludge management

Post-treatment: post thickening, sludge dewatering, drying and incineration

During post-treatment, the sludge should be dewatered to the greatest possible extent. This results in a further reduction in sludge volume and thus eases the load on downstream process phases.

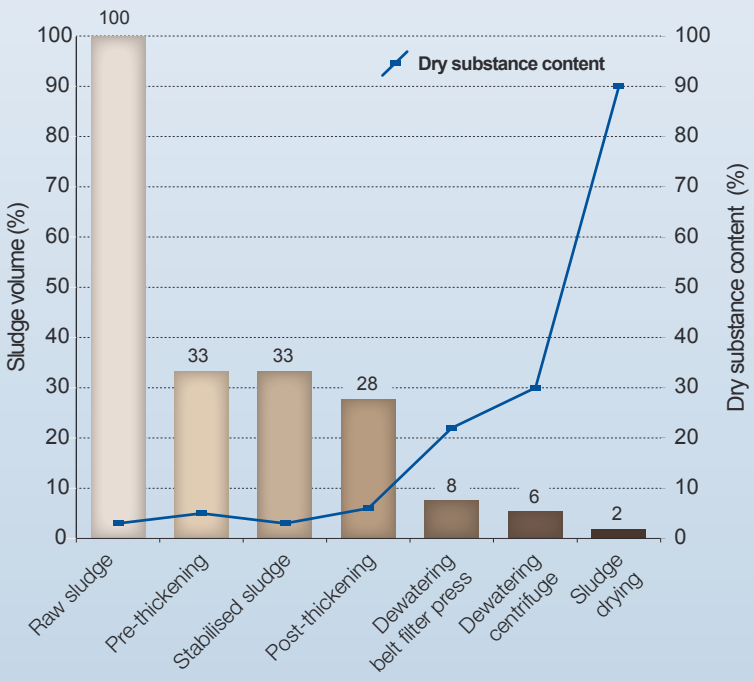
Depending on the sludge characteristics and the process used, stabilised sewage sludge demonstrates a dry substance content of 2-4%. All in all, stabilisation results in a roughly 30% reduction in solids. If post-thickening is employed, the dry substance concentration increases to 4-7%.

When the sewage sludge is subsequently dewatered in centrifuges or filter presses, a dry substance content of 20-35% can be achieved. With additional drying, e.g. with solar drying units or in a fluidised bed, a dry substance content of up to 95% is attained. This facilitates further thermal utilisation of the sludge as a supplementary fuel or in agriculture.

Sludge hygienisation

Stabilised sewage sludge contains high concentrations of nitrogen and phosphorus and can therefore be used as an agricultural fertiliser. This is subject to the sludge being entirely safe form a hygiene perspective, stable and suitable for transport. Several processes such as hot drying at a temperature of >80°C, a cut in the water content to <10%, or lime conditioning up to a pH value of min. 12 are available for a reduction in potential environmental impact, health risks and optimised degradability. As a result, pathogenic bacteria and viruses are destroyed resp. inactivated.

Reduction in the sludge volume - increase in solid content (dry substance content)



Adana West WWTP, Turkey

- Design capacity: 250,000 m³/d, 1,150,000 PE
- Mechanical/biological wastewater treatment
- Sludge thickening: gravity
- Six 9,000m³ digesters, two 3,100 m³ gasholders
- Biological gas desulphurisation
- Co-generation unit (880 kW)
- Sludge dewatering: belt filter presses

The sewage sludge is treated anaerobically. Half of the biogas is used for energy generation, whereby some 50% of the plant's electricity requirement and all of its heating needs are secured. DBO, 5 years O&M.

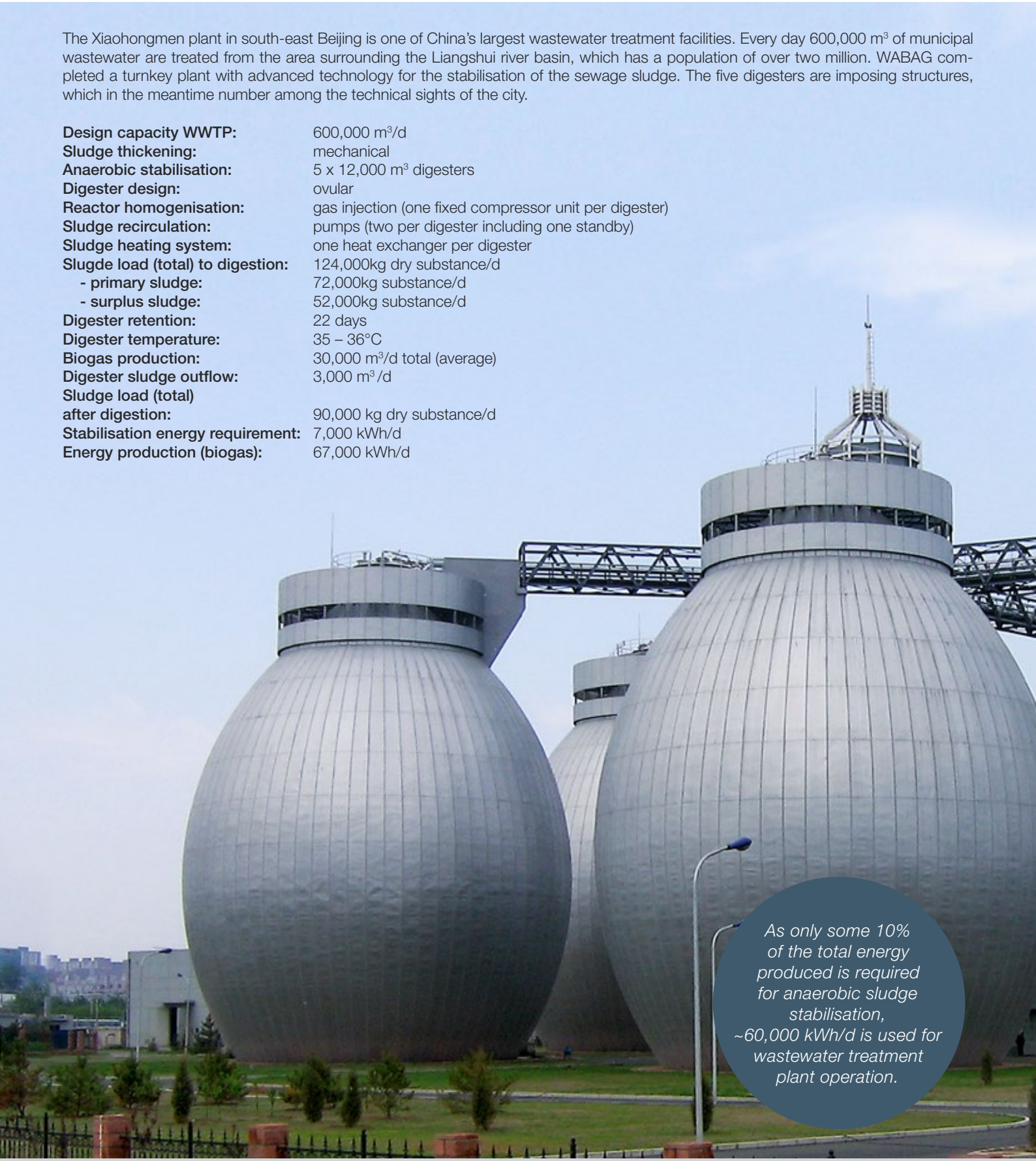
WABAG References

A model project

the Xiaohongmen treatment plant, Beijing, P.R. China

The Xiaohongmen plant in south-east Beijing is one of China's largest wastewater treatment facilities. Every day 600,000 m^3 of municipal wastewater are treated from the area surrounding the Liangshui river basin, which has a population of over two million. WABAG completed a turnkey plant with advanced technology for the stabilisation of the sewage sludge. The five digesters are imposing structures, which in the meantime number among the technical sights of the city.

Design capacity WWTP:	600,000 m^3/d
Sludge thickening:	mechanical
Anaerobic stabilisation:	5 x 12,000 m^3 digesters
Digester design:	ovular
Reactor homogenisation:	gas injection (one fixed compressor unit per digester)
Sludge recirculation:	pumps (two per digester including one standby)
Sludge heating system:	one heat exchanger per digester
Slugde load (total) to digestion:	124,000kg dry substance/d
- primary sludge:	72,000kg substance/d
- surplus sludge:	52,000kg substance/d
Digester retention:	22 days
Digester temperature:	35 – 36°C
Biogas production:	30,000 m^3/d total (average)
Digester sludge outflow:	3,000 m^3 /d
Sludge load (total) after digestion:	90,000 kg dry substance/d
Stabilisation energy requirement:	7,000 kWh/d
Energy production (biogas):	67,000 kWh/d



As only some 10% of the total energy produced is required for anaerobic sludge stabilisation, ~60,000 kWh/d is used for wastewater treatment plant operation.

sustainable solutions. for a better life.

WABAG

WABAG offers sustainable solutions for:

- Drinking water treatment
- Industrial and process water treatment
- Sea and brackish water desalination
- Water reclamation
- Municipal wastewater treatment
- Industrial wastewater treatment
- Sludge treatment

WABAG is one of the world's most innovative water treatment companies with know-how in specific technologies and in-house developed processes such as:

Fine sieving	MICROPUR®
Biofiltration	BIOPUR®
Moving bed biology	FLUOPUR®
Activated sludge processes	Hybrid™, MICROPUR-CAS®
Sequencing Batch Reactor (SBR)	CYCLOPUR®
Membrane bioreactor	MARAPUR®, MICROPUR-MBR®
Membrane filtration	RO, MF, UF, NF CERAMOPUR®, CERAMOZONE®
Denitrification	BIODEN®, ENR®
Oxidation processes	ADOX®, BIOZONE®
Adsorption processes	CARBOPUR®, PACOPUR®
Anammox	DAMOPUR™
Thermal desalination	MED, TVC, MVC, MSF

- Deep bed filtration in various designs
- Energy-optimised sludge treatment — ENOPUR®

The WABAG Group represents a leading multinational pla-yer with companies and offices in more than 25 countries and a focus on emerging markets in Europe, Africa, Middle East and Asia.

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