Advanced solutions for sludge treatment
Conversion of residues into an energy source
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.

**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.**

With our range of mature processes and plants these tasks can be fulfilled easily and in addition the potential of the sludge 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

**Main treatment plant, Oran/Algeria**

- Design capacity: 270,100 m³/d, 1,526,000 PE
- Mechanical/biological wastewater treatment and final disinfection.
- Sludge thickening: gravity, mechanical
- Four digesters each of 9,600 m³, one 6,800 m³ gasholder
- Dewatering: belt filter presses
- Turnkey realisation of the main treatment plant in Oran.

The sewage sludge is stabilised anaerobically and the biogas is used for thermal purposes and the heat employed for the digesters. DBO (Design-Build-Operate), two years of operational management.
Sewage sludge – waste or alternative energy source?

The increase in both energy demand and CO₂ 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 CO₂ balance of the treatment plant

Anaerobic sludge treatment makes a significant contribution to climate protection.

Your competent partner
We offer experience, know-how and innovation

WABAG has comprehensive experience in the design, construction and operation of plants using both aerobic and anaerobic sewage sludge stabilisation. During the past twenty years, the company has installed some eighty anaerobic stabilisation plants in various regions of the world.

WABAG’s services extend from basic and detailed design, engineering, supply, installation and start-up to long-term operational management. This applies to both new plants and the enlargement and modernisation of existing capacity.

Furthermore, WABAG has developed the innovative BIOZONE-AD® process for sludge disintegration, which employs the oxidation potential of ozone for even more effective anaerobic stabilisation.

Anaerobic sludge treatment makes a significant contribution to climate protection.

Kayseri treatment plant, Turkey

- Design capacity: 110,000 m³/d, 800,000 PE
- Mechanical/biological wastewater treatment including nitrogen and phosphorus removal.
- Sludge thickening: gravity, mechanical
- One 6,750 m³ digester, one 3,000 m³ 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, twelve months of operational management.
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% CO₂, 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

Kodungaiyur Phase I treatment plant, Chennai/India

- Design capacity: 110,000 m³/d
- Mechanical/biological wastewater treatment
- Sludge thickening: mechanical
- Two 6,750 m³ 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, ten years of operational management.
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.
  
  \[ 1 \text{ m}^3 \text{ biogas} = 6.5 \text{ kWh} = 2.3 \text{ kWh electrical} + 4.2 \text{ kWh thermal energy} \]

- 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 Xiaohongmen, China:**

- Digester volume: 60,000 m³
- Biogas production: 30,000 m³ biogas/day
- Energy production: 120,000 kWh therm./day
  - 70,000 kWh kWh el/day

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

Energy savings (electricity):

- EUR 7,000/d plus thermal energy

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**Teheran South treatment plant, 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: five years of operational management.
Innovative 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. 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 from 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.

Adana West treatment plant, 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, five years of operational management.
Our innovation: BIOZONE-AD®
Sludge disintegration using ozone

WABAG has developed the innovative BIOZONE-AD® process for an even higher level of sewage sludge stabilisation. This process supplements standard anaerobic sludge stabilisation with an additional phase and involves the injection of pre-digested sludge with ozone, which results in the further oxidative decomposition of the sludge and thus increases its suitability for biological use. This “reactivated” sludge is returned to the digesters and intensifies the degradation process. The organic dry substance is further reduced and at the same time, biogas production is increased.

Components

The BIOZONE-AD® process consists largely of one or two digestion stages and components consisting of an ozone generator and a reaction tank. Ozone is transported into the reaction tank via an external injection system and simultaneously secures circulation.

Easily degradable organic compounds result from disintegration and these are either thickened, returned to the digester directly, or in the case of serial operation, transported to the second digestion stage. The substances released through oxidation are metabolised and additional biogas is formed. The sewage sludge releases up to 40% more biogas, which means that proportionally more energy can be generated.

Degradation of micro-pollutants

The introduction of ozone into the sewage sludge not only results in higher dry substance reduction and biogas yield, but also to excellent hygienisation. In addition, micro-pollutants (e.g., polycyclic aromatic hydrocarbons) are degraded. This can be of relevance for agricultural use when parameters such as that for benzo(a)pyrene exceeds the statutory limits.

The process is ideal for the upgrading of overloaded plants.

Process advantages

- Extended stabilisation – increase in the degradation of organic dry substance by up to 40%
- Increase in biogas production by up to 40%
- Reduced sludge quantities and disposal costs
- Enhanced dewatering – up to 15% improvement in dewatering behaviour
- Improved sludge quality – degradation of micro-pollutants
- Lower operating costs
The perfect design

**Individual solutions**
designed by WABAG

**Typical process diagram of an anaerobic sludge treatment with biogas utilisation**

- **Sludge from primary clarifier**
- **Gravity sludge thickening**
- **Water return**
- **Sludge from secondary clarifier**
- **Mechanical sludge thickening**
- **Digester**
- **Sludge heating**
- **Water circuit**
- **Gas storage**
- **Desulphurisation, dewatering**
- **Gas storage**
- **Excess-gas burning**

**Classic digester (Wei fang 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:        | ovular             |
|                         | classic            |
|                         | flat               |

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
Utilisation/disposal: fertilizer, agriculture, joint combustion, mono-combustion, landfill

Biogas desulphurisation, gas storage, excess gas burning.
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 m³ 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 treatment plant capacity: 600,000 m³/d
Sludge thickening: mechanical
Anaerobic stabilisation: five 12,000 m³ 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
Sludge load (total) to digestion: 124,000 kg dry substance/d
- primary sludge: 72,000 kg substance/d
- surplus sludge: 52,000 kg substance/d
Digester retention: 22 days
Digester temperature: 35 – 36°C
Biogas production: 30,000 m³/d total (average)
Digester sludge outflow: 3,000 m³/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.
## Selected reference plants

<table>
<thead>
<tr>
<th>Project</th>
<th>Treatment plant capacity (m³/d)</th>
<th>Digester volumes (m³)</th>
<th>Biogas utilisation</th>
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<tbody>
<tr>
<td>Adana East, Turkey</td>
<td>210,000</td>
<td>2 x 9,000</td>
<td>Co-generation unit, 803 kW</td>
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<tr>
<td>Adana West, Turkey</td>
<td>250,000</td>
<td>6 x 9,000</td>
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<td>Kayseri, Turkey</td>
<td>110,000</td>
<td>1 x 6,570</td>
<td>Co-generation unit, 2 x 690 kW</td>
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<td>Baraki, Algiers, Algeria WWTP</td>
<td>150,000</td>
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<td>Thermal</td>
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<td>Oran, Algeria WWTP</td>
<td>270,100</td>
<td>4 x 9,600</td>
<td>Thermal</td>
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<td>Xiaohongmen, Beijing, PR China</td>
<td>600,000</td>
<td>5 x 12,000</td>
<td>Gas engine, 2.1 MW</td>
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<td>Kondli, Delhi, India</td>
<td>204,500</td>
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<td>Co-generation unit, 2 MW</td>
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<td>Kondungaiyur, Chennai, India</td>
<td>110,000</td>
<td>2 x 6,074</td>
<td>Co-generation unit, 1 MW</td>
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<td>Perungudi, Tamil Nadu, India</td>
<td>54,000</td>
<td>2 x 2,200</td>
<td>Co-generation unit, 1 MW</td>
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<tr>
<td>Tehran South, Iran</td>
<td>450,000</td>
<td>6 x 9,000</td>
<td>Co-generation unit, 5 MW</td>
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</tbody>
</table>
WABAG is an international supplier of systems for:

- Drinking water treatment
- Industrial and process water treatment
- Water reclamation
- Sea and brackish water desalination
- 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:

- Biofiltration
- Moving bed biology
- Activated sludge processes
- Membrane bioreactor
- Membrane filtration
- Oxidation processes
- Thermal desalination
- Denitrification
- Adsorption
- Anaerobic biological processes
- Sludge digestion and disintegration

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The WABAG Group represents a leading multinational player with companies and offices in more than 20 countries and a focus on emerging markets in Europe, North Africa, Middle East, South East Asia, China and India.