AquatecOLIVIA – Treatment and processing of Residues from Olive Processing

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Summary

High organic content process water from olive oil manufacturing (OMW - olive mill wastewater) represents one of the most important environmental problems in the Mediterranean region.

Technologically and economically suitable solutions for the disposal of OMW have not been available until now.

The AquaTecOLIVIA technology was developed with special attention to the unique characteristics of olive processing residues and has a modular design that enables it to be adapted for individual disposal and processing requirements within the respective economic constraints.

The core element of the technology is a multiple-stage anaerobic biological process. In this process, biogas obtained from the organic wastewater content is converted into electrical and thermal energy (regenerative energy). In addition, high quality fertilizer and other valuable substances can be obtained from the residues. The purified wastewater can be used as process water or for the irrigation of agricultural land.

Aquatec 3w GmbH offers comprehensive consulting and planning services and at the customer's request also provides full turnkey installed systems, as well as support with the project financing process and the operation of the system.

The first installation based on the AquaTecOLIVIA process has been in operation in Greece on the island of Crete since the 1999/2000 season.

1 Problems and Potential of Wastewater from Olive Oil Extraction

During production of olive oil OMW, a high organic content wastewater, is generated as a liquid byproduct of mechanical extraction. With a chemical oxygen demand (COD) of 50 to 150 g/l, this wastewater has one hundred times the contamination potential of communal wastewater, whereby the production processes employed in the manufacture of the oil have a significant impact on the amount and composition of the OMW.

OMW is produced during the olive harvesting season, roughly from November to March. During peak season there is little time that could be dedicated to the development of modern residue disposal and processing methods.

Evaporation ponds reduce the problem only marginally, and OMW is not suited for application on fields. Although its contents are a good fertilizer, negative affects on soil quality and ground water cannot be ruled out.

Wastewater from olive processing contains valuable organic and mineral components that are extracted from the soil by the olive trees. One cubic meter of wastewater contains 50-80 kg of organic constituents and 20-30 kg of minerals, as well as 60-80 kWh of energy.

2 Disposal and Processing Concept

The energetic and material potential of waste and wastewater are used to finance the costs of disposal.

The underlying technical concept is based on an understanding of the material and energy cycles – both in the manufacturing process as well as in nature. Only in this way can the value that the waste and wastewater represents be recognized and utilized in other production processes or ecological systems.

The overall concept supports the olive processing structures that are often characteristic of small and medium-sized operations, and offers support through appropriate technical solutions and services to companies and communities in handling their waste and wastewater management needs.

Aquatec 3w GmbH offers concepts and technologies that allow the modular integration of technological components matched to individual project requirements. These designs can accommodate centralized or decentralized disposal structures and, depending on the requirements, either partial or full processing of the wastewater. For even more effective utilization of the installed systems, the simultaneous treatment of other organic wastes and wastewater is possible as well. This increases the production of regenerative energy, which in turn improves the overall effectiveness of the disposal structure. Wastewater from dairy operations, as well as the fruit or meat processing industry is a good example of other organic wastewater suited for simultaneous treatment.

3 Process Concept

The AquatecOLIVIA technology consists of three processing lines:

- ➔ Wastewater purification
- ➔ Sludge treatment
- ➔ Biogas processing

Wastewater purification

In a mechanical-biological pretreatment stage, the wastewater is separated into dissolved and undissolved constituents, which reduces the organic load by 40-60%. As an option, the remaining olive oil can also be separated in the wastewater of 0.5 - 1.5 Vol.-%.

Because the wastewater is generated for a short period of only a few months, economic considerations call for an intermediate storage solution. Existing pond or storage systems can be integrated into the solution.

In a special anaerobic stage, up to 95% of the dissolved or undissolved constituents are removed from the wastewater and converted to biogas. The wastewater is treated subsequently in an anaerobic or membrane filtration stage to ensure the necessary discharge quality. This subsequent treatment can also be handled in an existing communal water treatment plant. The purified wastewater can be used for irrigation of agricultural land or as industrial process water, or fed into surface waters.

Sludge treatment

During pretreatment the undissolved constituents of the wastewater are separated as sludge (OMW sludge) by sedimentation and, depending on the project concept, subsequently processed for energy or fertilizer.

Where recovery of energy is the primary objective, the sludge is converted to biogas in the methane stage and subsequently dewatered and dried. One cubic meter of OMW sludge yields energy equivalent to 140 - 200 kWh of electrical power.

For the production of fertilizing material, the OMW sludge is stabilized aerobically and solar-dried after pretreatment. The fertilizer (in the form of a powder or granulate) can be mixed with nitrogen and phosphorous sources, resulting in a purely plant-based potassium fertilizer with a high content of humus-building material. One cubic meter of wastewater yields 40 - 60 kg of fertilizer.

Biogas processing

Approximately 30 m³ of biogas can be produced from each m³ of OMW (COD approx. 100 g/l), from which roughly 70 kWh/m³ of electrical and 150 kWh of thermal energy or, where a co-generation plant is not used and the biogas is used only thermally, 210 KWh of thermal energy can be generated.

Selected sample parameters for three systems with varying capacities:

	Typ I	Typ II	Typ III
OMW capacity[m³/a]	6.000	18.000	35.000
Pretreatment stage I			
Average admission [m³/d]	70	200	390
Operating time		90 days	
Methane stage II			
Average admission [m³/d]	17	50	95
Operating time		300 days	
Products			
Max. biogas production [m³/a]	150.000	459.000	889.000
Max. electr. power. [kWh/a]	315.000	964.000	1.867.000
Fertilizer production [t/a]	215	650	1.300

Cold can also be produced using a heat pump. The energy requirements of the system itself are fully covered, and surplus energy can be marketed.

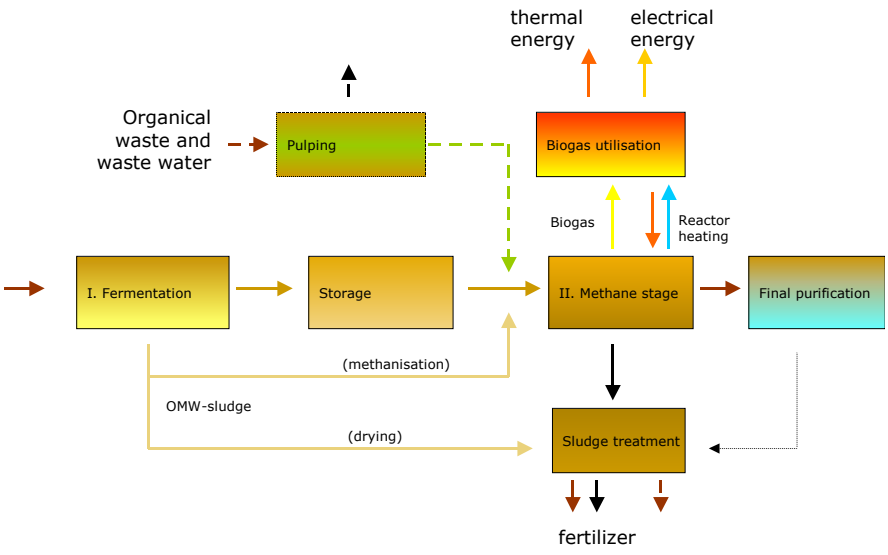
Surplus thermal energy can be reused in the form of hot water or steam, or cold for cooling systems.

Simultaneous treatment of other organic waste or wastewater

Other high organic content waste or wastewater such as in meat, vegetable, or fruit processing operations, are often generated in the disposal areas of the oil mills and can be removed and handled in a treatment system that uses the AquaTecOLIVIA technology. Simultaneous treatment of other wastes improves the overall utilization of the system and offers the opportunity to generate additional revenue and reduce system-specific costs.

4 Data and Parameters

The values shown are intended as reference values only – depending on the production process used, the admission values (COD) fluctuate from 50,000 to 150,000 mg/l; the stated discharge values for final purification correspond to the achievable discharge values with a complete purification. Based on individual project requirements, purification goals must be weighed against economic expense and a meaningful balance must be struck.



Wastewater parameter	Admission	Discharge	
		Methane stage	Final purification
Chemical oxygen demand COD [mg/l]	100.000	3.500	50
Biological oxygen demand BOD_5 [mg/l]	60.000	400	20
Dry substance salary TS %	10	0,6	0,2
pH	4,0...6,0	7,0	7,0

Economic Data

Capital and Operating Expenses

The capital expenditure and operating costs are determined largely by the purification goal. Cofermentation (simultaneous treatment) of other organic wastes and high organic content wastewater leads to a more effective utilization of the capital expenditure, as well as to higher profits from the material and energetic exploitation of the residues. The continued use of existing central or decentral storage capacities can significantly reduce the capital expense. The costs for transport – normally in tanker trucks and only rarely over pressure lines – have a substantial influence on the overall cost. For each individual project, therefore, an economical disposal radius must be defined and a decision reached as to whether a larger centralized system or several decentralized systems would be more cost-effective. Treatment of the wastewater can be decentralized; for cost reasons, however, materials should be centrally processed for multiple systems. The smallest economically feasible treatment system has a capacity sufficient for the disposal of wastewater from the production of approximately 1500 t of olive oil.

Capital and operating expenses (excluding transport costs) for systems with complete purification and reprocessing amount to approximately:

- Capital expenditure 100…170 € per m³/y OMW treatment capacity
- Operating costs 3,50…5,50 € per m³ OMW
- Payback period : Building engineering: 25 a, Technical equipment: 12 a, Power generator: 7 a

Revenues from the recovery of biogas and the refinement of material residues are estimated at 2.00 to 5.00 € per m³ OMW.

Project Financing

The capital financing for project management, planning, and construction of the system is comprised of equity, self-performance by the project carrier, subsidies, and debt.

System operating expenses (labor, incidental expenses, debt service, etc.) are covered through revenues from long-term disposal contracts with the companies requiring disposal services and revenues from the marketing of the products.

The total costs; i.e., capital expenditure, operating costs, and debt servicing, amount to approximately 3 to 6 Euro-cents per liter of olive oil, calculated based on assumed investment aids of 40%. Units costs for the disposal and processing of additional residues from other industries could be even lower.

5 Project Management

In addition to the process engineering design, proper project management is critical to the success of a project; it controls deadlines and cash flows and supports the builder in the implementation of the project.

Project Flow

These projects normally comprise the following phases:

1. Feasibility study
2. Formation of a project carrier for centralized disposal and processing projects
3. Project financing
4. Design planning and approval
5. Project implementation and installation of a turnkey system
6. Operation of the system

The project lead time from receipt of order to turnkey-installed delivery is approximately 12 to 16 months.

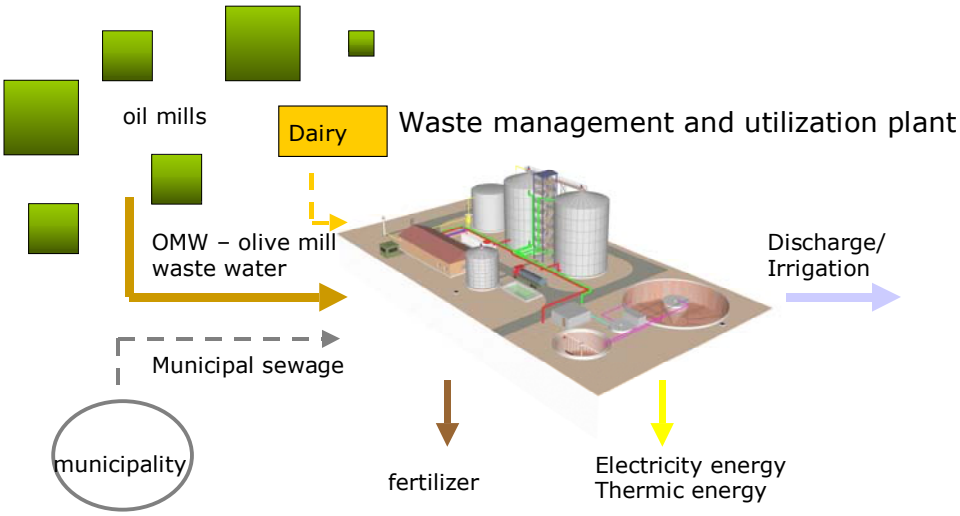
Feasibility Study

The feasibility study represents a fundamental element in the economic and technological evaluation of the project on location and forms the decision basis for project design and financing. The scope of the study includes treatment of the following topics:

- Identification of key local rules and constraints, and existing systems
- Development of a treatment and disposal concept
- Concept for the processing of byproducts
- Profitability analysis.

Project Carrier

The project carrier is responsible for the project financing and the conclusion of contracts (building contract, disposal contracts, power supply contracts, operating agreement, etc.).
For smaller-scale projects this function can usually be handled by the operator or the builder; for centralized disposal



and processing projects, the project carrier can take the form of a public-private partnership (ppp), a purely private, or also a public establishment. In so-called ppp-companies the interests of the communities (environmental protection), of the oil mills (polluters), and perhaps also of private investors can be combined. The operation of the system and the daily disposal and processing operations can be managed independently by the project carrier or transferred to a separate operating company.

Consulting is offered on the formation of the project carrier or operating company.

Regardless of the method with which the project is achieved, the lasting success of any project depends on the goodwill and active support of all involved parties.

Recycling Center

The integration of the treatment system in other disposal and processing installations already in existence or yet to be built, such as communal purification plants, composting installations, etc., has a positive affect on costs -- for example through

- Greater operating cost efficiencies
- Joint project financing and project management, specifically also more access to subsidies
- Shared service and administration capacities
- A communal purification plant can be expanded as a final treatment stage for the AquatecOLIVIA technology
- Joint marketing strategies.

6 Service Portfolio Aquatec 3w GmbH

We offer individual services or complete packages tailored to customer requirements:

Individual services

- Feasibility study
- Project management
- Design and approval planning
- Implementation planning, tendering process
- Supervision of construction
- Supplier of system components
- Technical support in the operation of the system and training of personnel

Complete service package for turnkey system

All services are performed by a general contractor and conclude with the delivery of a functionally efficient system.

Complete service package for disposal services

This all-around service package is based on long-term disposal contracts. We participate in the project financing, the project management, the installation and operation of the system, and the processing of usable substances.

7 Data from the Pilot Plant on Crete

Within the scope of the European Union LIFE-Umwelt (LIFE-Environment) program, a demonstration system based on the AquatecOLIVIA process was erected in 1999 on the island of Crete and has been operated successfully since then. The system operates roughly 5 months out of the year and purifies the wastewater from an oil mill that produces approximately 400 tons per year of olive oil (three-phase decanter). The level of purification achieved is over 95%.

Technical Details

- Reactor capacity: 2 x 100 m³
- Intermediate storage: 600 m³
- Operating temperature: 25...30°C Fermentation stage I
  36°C Methane stage II
- Biogas production: 60-120 m³/d
- Gas processing: 47 kW biogas burner
- Solids production: 60 -70 kg_{TS}/d

Chemical Parameters

- Admission concentration: 50...100 g/l COD
- Discharge concentration, methane stage: 3...4 g/l COD
- Discharge concentration, final purification (by-pass): 500 mg/l COD

Expansion of the systems to accommodate additional oil mills in the Apokorounou region is now in planning.

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