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Energy Efficiency in STP Design considering current effluent standards and possible changes

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Content

- Introduction of P2mberlin
- Effluent Standard: TSE Reuse
- Case Studies Jordan-Full STP
- Case Studies Germany-Biological Reactor

Berliner Wasserbetriebe

Water Supply and Waste Water Disposal for the Capital of Germany

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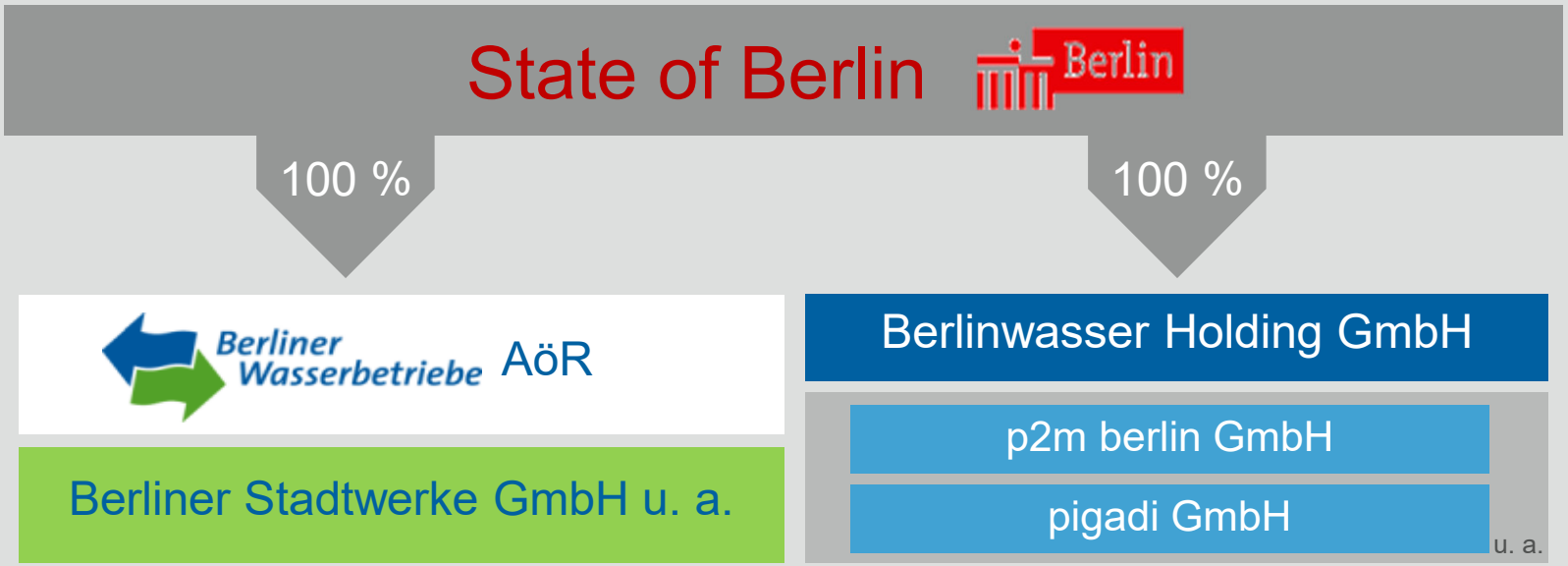

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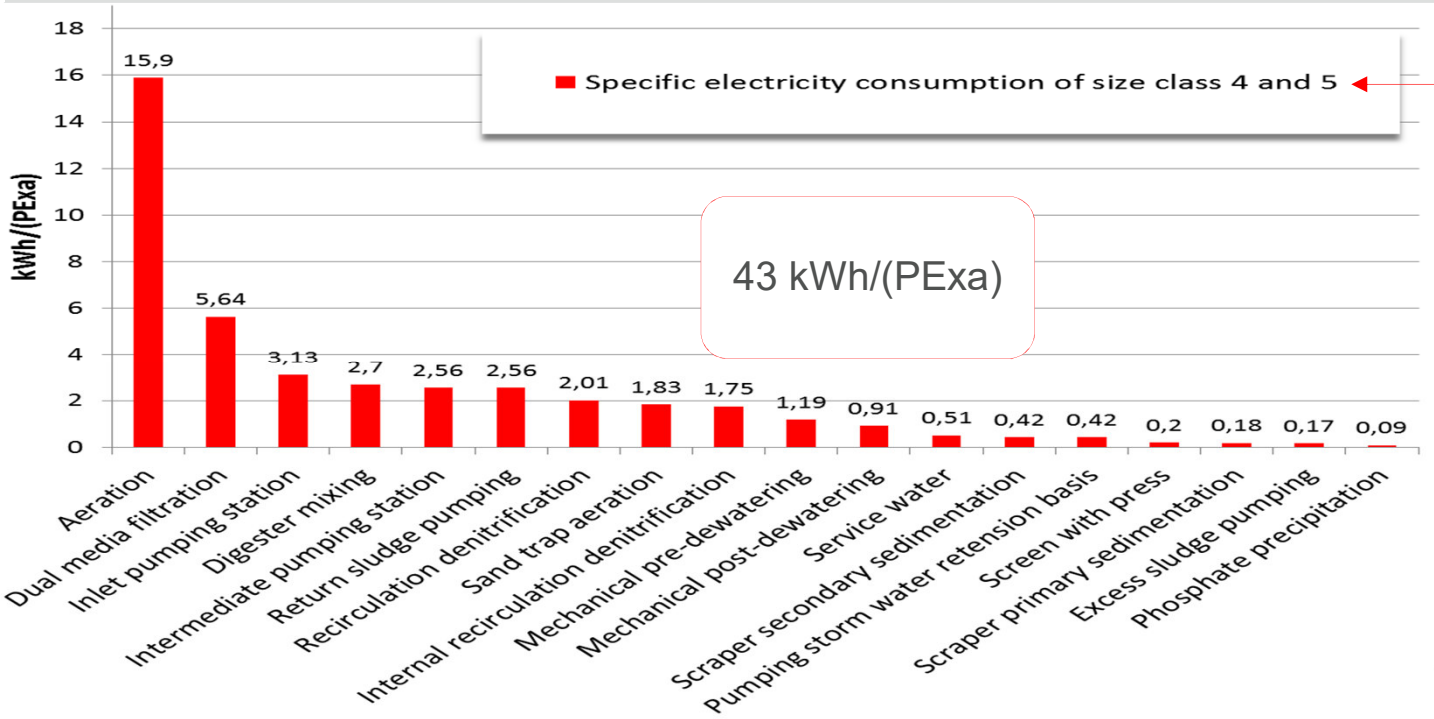
p2m berlin GmbH
Engineering Company of Berlinwasser Group

We offer expertise in the fields of:

- Wastewater Treatment
- Drinking Water Supply
- Stormwater Management
- Sewer Systems
- Sludge Management
- Project Management
- Landscaping
- International Consulting

Effluent Standard: TSE reuse



Full Nitrification, Denitrification and P-Elimination

In case of aerob stab. + 8 kWh/(PExa)

Source: UBA, 2008

Effluent Standard: TSE reuse

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Treated **S**ewage **E**ffluent:

- + nutrients (N, P)
- - carbon
- + disinfection

Oxygen uptake biol. reactor

$OV_h = OV_C - OV_D + OV_N$

65 % 35 %

Theoretical Optimization potential: 5.5 kWh/PExa

by separation TSE flow from full stream.

Energy Optimization of STP in Jordan

Case study on 3 STPs

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General:

- Objective: Efficiency increase and CO_2 emissions reduction while maintaining or improving the treatment quality
- The following 3 Wastewater Treatment Plants were evaluated:
  - As Salt (1981/1994, Q_d=7,600 m³/d, 76,000 PE, C, N, aerob stabilization, effluent standard: to Wadi)
  - Mu'ta Al Mazar (2014, Q_d=7,060 m³/d, 68,000 PE, C, N/DN, P, disinfection, aerobic stabilization, Drying Beds, effluent standard: reuse agriculture (A))
  - Aqaba (2005, Q_d=12,000 m³/d, 180,000 PE, C, N/DN, P, aerobic stabilization, effluent standard: reuse industry or agriculture (B))
- Effluent Standards vary depending on the different water use application

ORIENT

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Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

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Jordan Domestic Wastewater Standards 893/2006 (extract):

Discharge to	water bodies and wadis	irrigation purposes		
		(A)	(B)	(C)
BOD_5 [mg/l]	60	30	200	300
COD [mg/l]	150	100	500	500
DO [mg/l]	>1	>2	-	-
TSS [mg/l]	60	50	150	150
Turbidity [NTU]		10	-	-
pH [unit]	6-9	6-9	6-9	6-9
NO_3 [mg/l]	80	30	45	45
N_{Total} [mg/l]	70	45	70	70
E.coli [MPN or CFU/100ml]	1000	100	1000	-
Intestinal helminth eggs [egg/l]	</=1	</=1	</=1	</=1

(A)TSE for cooked vegetables, playing ground, sideways in populated areas
(B)TSE for fruit and forestry trees, crops and industrial products
(C)TSE for fodder crops

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As Salt:

- Findings: plant overloaded, equipment outdated and partially not operational, Surface aerator, no SCADA system
- Energy consumption (2014)
  - 22.5 kWh/(PExa) – (plus Diesel Generator) << 43+8!
  - 0.6 kWh/m³
- Recommendations: energy efficient replacements, installation of sensors and SCADA system (automation), adaptation of treatment parameters
- Energy efficient WWTP expansion or replacement incl. sludge management

Energy Optimization of STP in Jordan
Case study on 3 STPs

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Mu'ta Mazar:

- Findings: plant heavily under loaded (20% - only 1 line under operation), aeration equipment inappropriate (surface aerator), equipment partially not operational
- Energy consumption (2015)
  - 135.8 kWh/(PExa) >> 43+8 !!
  - 3.6 kWh/m³
- Recommendations: adapt treatment to load, replacement of aeration system (preferably fine-bubble pressure aeration), adaptation of treatment parameters
- Mid-term objective integration of sludge management

Energy Optimization of STP in Jordan
Case study on 3 STPs

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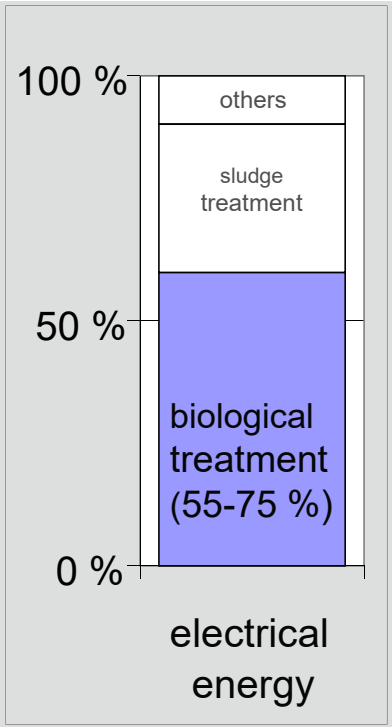
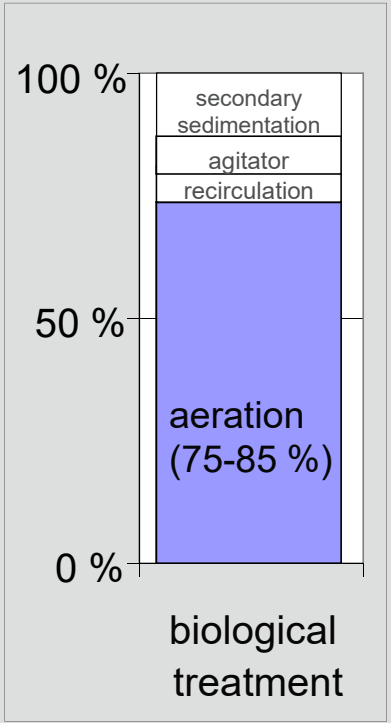
Aqaba:

- Findings: plant overloaded, surface aerator, no online aeration sensors, drum aerators without frequency converters, sophisticated SCADA system existent
- Energy consumption (2015)
  - 24 kWh/(PExa) << 43+8!!
  - 1.0 kWh/m³
- Recommendations: expansion of WWTP with energy efficient aeration system (preferably fine-bubble pressure aeration) and sludge management, adaptation of treatment parameters, scheduled replacements by energy efficient equipment

Energy Optimization of STP in Germany





- Long-term Study (8 Years) for 6 STPs in Berlin
- Biological reactor is the main energy consuming treatment step in the STP ⇒ aeration
- Potential of energy saving is 10 to 15 %

Energy Optimization of STP in Germany

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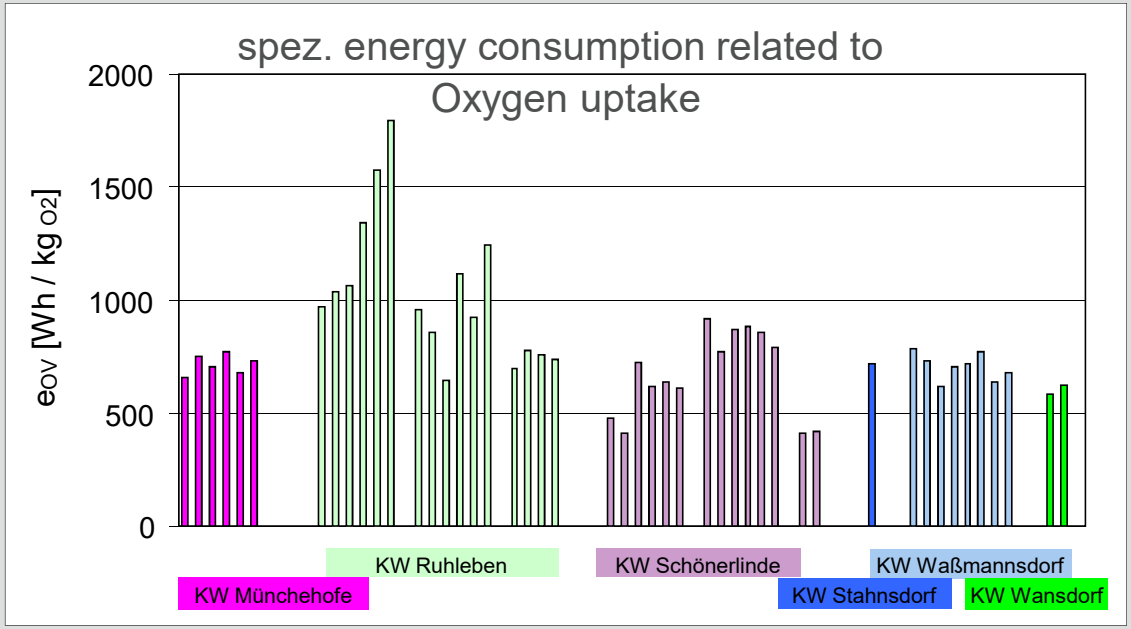

- Benchmark according to DWA: 450kWh/kg O_2
- Main optimization potential:
  - Production of compressed air
  - Selection of aerator type and position in tank
  - Air control according to load curve

Energy Optimization of STP in Germany

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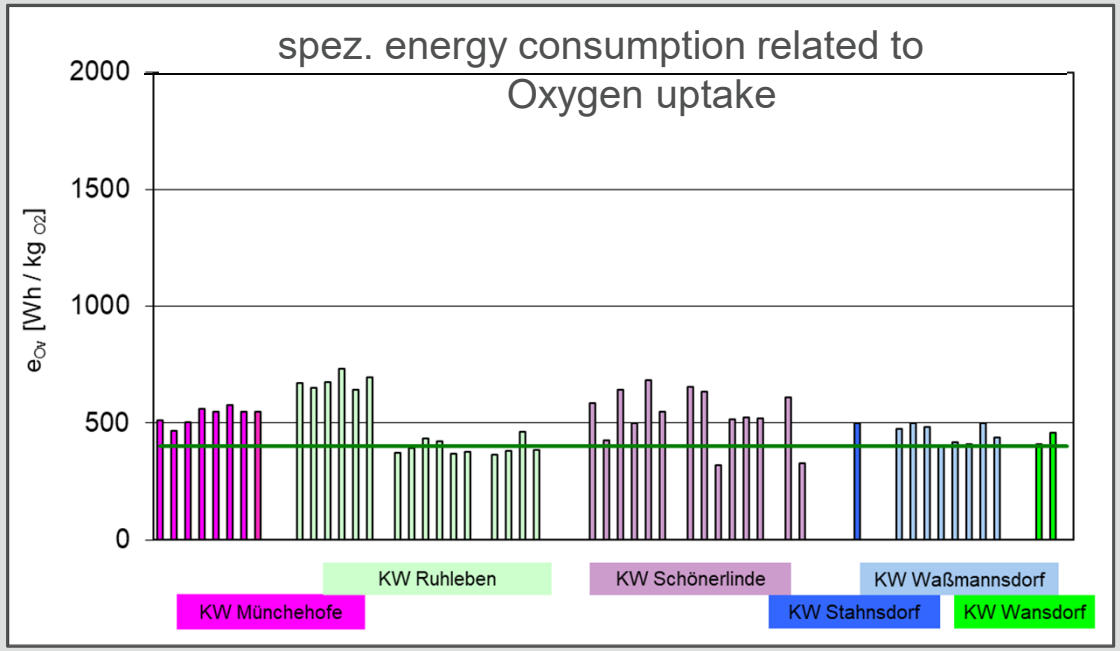

- 9 – 20 %: O_2 – concentration on demand (no fixed value)
- 5 – 10 %: continuously efficiency control of aerator (pressure) and regular cleaning
- 5 – 10 %: Turbo blower versus Rotary Piston Blower

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Conclusion

- Energy Saving Potential of STPs is high
- STP must be adopted to PE Forecast and sewer situation
- Use of effluent of STP defines the STP design
- Maintenance of Equipment and Instrumentation generate energy savings
- Regular operational checks (audits) generate savings
- Replacement of equipment: CAPEX and OPEX

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Vielen Dank Thank you 谢谢 Merci شكراً