HYBrid ACtivated Sludge

- For rapid, simple upgrading of existing activated sludge plants
- Enables existing plants to treat double the load and/or achieve tighter standards (ammonia / N removal)
- Proven in UK (Ashbourne, 2012)
- Proven up to 100 MLD / 400,000 PE
- Full scale plants operating since 1999
Global Water Intelligence: Wastewater Project of the Year, 2014, Highly Commended

CIWEM W Mids. Innovations Showcase Winner – Best Value Innovation 2012

Winner, Best Process Technology

Water & Energy Exchange (WEX) Global Innovation Awards, 2014

Awarded by MoW in gratitude on the completion of the project
Conventional Activated Sludge

Types of COD in Wastewater

Particulates → Hydrolysis (slow) → Macromolecules → Hydrolysis (slow) → Small molecules

Cell Wall

Assimilation (fast)

Biomass

Growth

Oxidation → CO₂

Bacterial Cell
HYBACS®: How does it work?

**HYBACS: Hybrid Activated Sludge**

Particulates → Hydrolysis (accelerated) → Macromolecules → Hydrolysis (accelerated) → High concentration of Small molecules

- Cell Wall
- Assimilation (fast)

Biomass

- Growth
- Oxidation → CO₂

Bacterial Cell
HYBACS: Typical Configuration

HYBACS: HYBrid ACtivated Sludge

SMART units

Anoxic Aeration Tank

Clarifier
Hydrolysis in the SMART unit enables:

- Increased performance of aeration tanks
- Better sludge settlement
- Improved phosphorus removal
HYBACS: Powered by the SMART™ Unit

**Media Cassettes**
the media cassettes form the biological engine room of the SMART™ unit. The standard SMART™ unit, model 302, consists of twelve cassettes each comprising fifteen mesh plates. The plates are located using precision moulded spacer couplings which, in turn, are supported on high quality steel tie bars.

**Rotating Assembly**
the rotating assembly forms the core of the SMART™ unit, carrying the mesh media cassettes. The assembly is rigorously and robustly engineered to ensure long term reliable operation, whilst ensuring ease of maintenance should the need arise in the years ahead.

**GRP cover**
the SMART™ unit is supplied with a protective GRP cover. Normally supplied in Bluewater Bio corporate colours, client colours can normally be incorporated.

**Gear Drive**
Bluewater Bio has chosen Sumitomo as its engineering partner for the SMART™ unit gearbox. Sumitomo’s Buddy Box has numerous advantages, not least of which are its rugged shaft-mounted design and global product support.

**Air Sparge System**
air sparge system operates for a few minutes each day to clear excess biomass from the mesh cassettes.

**Tank**
steel tank, includes air sparge system, D.O. probes, inlet and outlet connections, outlet weirs and local cabling.

**D.O. Transmitter**
a luminescent D.O. probe is supplied as part of the SMART™ control system.

**SMART™ Unit Control Panels**
a number of control panel options are available, from a basic field panel up to full colour touchscreen HMI with data logging and remote diagnostics.
SMART™ Units

2 weeks

Standard, modular reactors

- Installed offline (no process interruption during construction)
- Rapid deployment
- Existing assets can be retained
- Simple to commission
- Each unit (4.5m long x 2.3m wide) pre-treats:
  - Up to 3,000 m$^3$/d
  - Equivalent to 6,000 - 10,000 PE
- Lease / rental options available
Case Study: Tubli WPCC, Bahrain

How do you increase the capacity of a plant which is highly overloaded and has limited space?

Image © Google – CNES / Astrium, DigitalGlobe, taken 17 April 2014
Case Study: Tubli WPCC, Bahrain

- 2 aeration lanes upgraded from 40 to 100 MLD
- 4 clarifiers upgraded from 17 to 33 MLD each
- Contract value: US$ 20m (MBR alternative tendered for > US$ 100m)
- Performance targets of <3 mg/l ammonia, <10 mg/l TN have been achieved consistently
- Existing structures retained and minimal additional land take
HYBACS: Tubli WPCC – Sludge Settlement

HYBACS SLUDGE SETTLEMENT FILM

Tubli, Bahrain
9th December, 2013
HYBACS advantages:
- Large, dense flocs with few filaments
- Settlement velocities up to 12 m/h
- SVI typically 40-50 ml/g
- Tubli clarifiers achieving <10 mg/l SS at 1.5 m$^3$/m$^2$.h and 7 kg/m$^2$.h
HYBACS: Proven Data, Performance & Technology

Before HYBACS

After HYBACS
**HYBACS at Tubli: Proven Performance**

- Passed the Performance Test with no failures, despite very high influent COD loads
- HYBACS sludge is highly settleable
- Substantial power savings
- Simple, compact upgrade, maintaining full treatment during construction

### Performance Test Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Guaranteed value</th>
<th>Expected value</th>
<th>Actual performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (ML/d)</td>
<td>100</td>
<td>100</td>
<td>101</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>-</td>
<td>60</td>
<td>27</td>
</tr>
<tr>
<td>SS (mg/l)</td>
<td>20</td>
<td>15</td>
<td>9.5</td>
</tr>
<tr>
<td>Ammonia (mg/l)</td>
<td>35</td>
<td>3</td>
<td>0.58</td>
</tr>
<tr>
<td>Total nitrogen (mg/l)</td>
<td>-</td>
<td>15</td>
<td>9.0</td>
</tr>
<tr>
<td>SSVI (ml/g)</td>
<td>-</td>
<td>80</td>
<td>46</td>
</tr>
<tr>
<td>Power usage (MWh/d)</td>
<td>29.7</td>
<td>25</td>
<td>21</td>
</tr>
</tbody>
</table>

“The HYBACS plant performance and consistency have exceeded all our expectations”, Project Manager, Ministry of Works
HYBACS: Severn Trent, Ashbourne, UK

- Chicken processor doubled discharge, increasing PE load from 25,000 to 35,000
- Four solutions compared namely:
  - new oxidation ditch
  - roughing filters
  - SAF plant
  - HYBACS
HYBACS: Ashbourne – Project Drivers

**HYBACS® at Ashbourne**
“from concept to commission”

**PROJECT DRIVERS**

**PLANT OPERATING AT 95% CAPACITY**

- Growth - 40% increase in future flows to works
- Mainly trade effluent
- 25,000 to 35,000 population equivalent increase

**OPTIONEERING THE SOLUTION**

**EXCELLENT RESULTS FROM HYBACS PILOT PLANT AT COLESHILL STW**

- Four alternatives 'on the table'
- CAPEX, OPEX and Carbon were key factors in Business Case
- Due diligence with technical and commercial analysis
- Long term trial of HYBACS within STW

**HYBACS - PREFERRED SOLUTION**

**SMART UNIT UNDER CONSTRUCTION**

- One Supply Chain partnership
- Severn Trent Water - R&D and Service Delivery
- MWH Global - Principal Contractor
- Bluewater Bio - specialist supply chain HYBACS provider

**LEAN CONSTRUCTION**

**SAFELY AND SWIFTLY INSTALLED**

- Off-site construction reduces H&S risks
- All units installed in two weeks
- Programmes reduced through up-front civils work
- Permitted development

**BENEFITS**

**LEADING EDGE TECHNOLOGY**

- 50% CAPEX reduction compared to updating existing plant
- Power consumption costs associated with aeration reduced by 30%
- Minimum increase in embodied and operational carbon

**ADDING VALUE**

**MWH EXPERTISE**

- Quality Assurance
- Reusing MSWA specification
- CE Marking
- Sharing knowledge

**PROCESS FLOW - ASHBOURNE STW**
## HYBACS: Ashbourne – Optioneering

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>HYBACS</th>
<th>Additional oxidation ditch</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost&lt;sup&gt;1&lt;/sup&gt;</td>
<td>£ k</td>
<td>1031</td>
<td>1438</td>
<td>28%</td>
</tr>
<tr>
<td>Operating Cost&lt;sup&gt;1&lt;/sup&gt;</td>
<td>£ k/year</td>
<td>23</td>
<td>114</td>
<td>80%</td>
</tr>
<tr>
<td>Duration of site work&lt;sup&gt;2&lt;/sup&gt;</td>
<td>weeks</td>
<td>8-10</td>
<td>24-40</td>
<td>70%</td>
</tr>
<tr>
<td>Embodied Carbon&lt;sup&gt;2&lt;/sup&gt;</td>
<td>t CO₂e</td>
<td>91</td>
<td>955</td>
<td>90%</td>
</tr>
<tr>
<td>Operational Carbon&lt;sup&gt;2&lt;/sup&gt;</td>
<td>t CO₂e/year</td>
<td>31</td>
<td>94</td>
<td>67%</td>
</tr>
</tbody>
</table>

**Notes:**

1. Severn Trent estimates, OPEX includes power, labour & business rates
2. Bluewater Bio estimates, using Environment Agency calculator
HYBACS: IDI, Princeton Meadows, USA

**Background:**

The HYBACS system utilizes an innovative nutrient removal hybrid activated-sludge process. The process consists of two biological stages.  
1. The first stage comprises SMART™ units, with attached biomass.  
2. The second stage is an activated sludge process, with suspended biomass.

**SMART™ Units** – The plates are manufactured from mesh with a porosity of 95%, which produces a biological environment containing aerobic, anoxic and anaerobic regions. This supports a large quantity of attached biomass with substantial diversity and activity, ensuring high treatment capacity.
## HYBACS vs Competition

Comparison of options for upgrading an existing activated sludge plant:

<table>
<thead>
<tr>
<th>Feature</th>
<th>HYBACS</th>
<th>MBBR</th>
<th>Build more lanes and clarifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective for biological N removal</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Effective for biological P removal</td>
<td>✔</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Upgrade without affecting existing works operation</td>
<td>✔</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td>Minimal civil works needed</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>Short construction period</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Compact footprint</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>Enhanced sludge settlement</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Reduced aeration power</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
HYBACS: Future-Proofing Activated Sludge

- HYBACS is ideal for upgrading existing activated sludge plants for:
  - increased capacity, and/or
  - tighter standards
- Accelerated hydrolysis enables up to a 2.5-fold uplift in capacity
- Simple off-line installation, with minimal footprint
- Existing assets can be retained, reducing capital costs and project duration
- Easy to commission, operate and maintain
  - 9 staff: Manager, 3 SCADA operators, 1 Mech Eng, 1 Elec Eng, 2 Labourers, 1 Safety
  - As easy to operate as an activated sludge plant
- Sludge is highly settleable