The Salisbury Township WWTP in Gap, PA utilized a conventional activated sludge system prior to being retrofitted with an AquaPASS Phased Activated Sludge System in May 2008. The upgrade was necessary in order to comply with the Chesapeake Bay Initiative for local impaired waterways, requiring stringent permit limits on effluent Total Nitrogen and Total Phosphorus by 2010. The plant’s conventional system was not designed for nutrient removal and required only secondary limits of 20 mg/l BOD5, 30 mg/l TSS, 6 mg/l NH3-N, and 2 mg/l TP. Salisbury experienced constant upsets during peak wet weather flow conditions that required operator intervention to prevent solids from rising over the effluent weir. In addition, the conventional system could no longer handle the increased hydraulic loadings from the area’s rapid population growth of about 11.5% in the past nine years.

After evaluating alternative technologies, Salisbury and its consulting engineer ultimately selected the AquaPASS system for its ability to combine prominent features of both batch and continuous-flow processes into a singular treatment process. This offered Salisbury an efficient, time-managed process environment in existing tank geometry at a low lifecycle cost. Salisbury was the first treatment plant to install AquaPASS technology.

Salisbury’s AquaPASS system is designed to meet the new stringent Total Nitrogen and Total Phosphorus effluent limits required by the Chesapeake Bay Initiative, 6.9 mg/l and 0.86 mg/l respectively. The system is also designed to provide 140% more treatment capacity in the same footprint as the previous conventional activated sludge system.

Performance of Salisbury’s AquaPASS system was evaluated in May 2009 to verify its ability to meet the new 2010 permit requirements of the Chesapeake Bay Initiative. Since its startup in May 2008, the AquaPASS system has been in compliance with the 2010 permit limits with Total N and Total P effluent values below design conditions. In addition, effluent BOD5, TSS and NH3-N have been reduced by more than 98%!

<table>
<thead>
<tr>
<th>Average Operating Data (2010 - July 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>BOD5 mg/l</td>
</tr>
<tr>
<td>TSS mg/l</td>
</tr>
<tr>
<td>TKN mg/l</td>
</tr>
<tr>
<td>NH3-N mg/l</td>
</tr>
<tr>
<td>Total N* mg/l</td>
</tr>
<tr>
<td>Total P mg/l</td>
</tr>
</tbody>
</table>

Note: *Nitrite was <0.3 mg/l and Nitrate was <1.9 mg/l.
Aqua-Aerobic Systems has led the industry in time-managed, biological technology since 1984. In 2004, Aqua-Aerobic applied its expertise in time-managed technology in a unique flow-through regime to provide superior nutrient removal performance in a singular, space-saving, and energy-efficient solution for activated sludge applications. The AquaPASS system utilizes the Aqua MixAir® system to enhance the performance benefits of a batch reactor into an efficient, compact, and reliable solution for activated sludge applications.

System Features and Advantages

- **Flexible tank design**, allowing equipment options and final clarifiers (provided separately) to make this process ideal for retrofitting existing systems.
- **Staged aeration** via the Aqua MixAir® system offers power savings.
- **Time-based aeration intervals** promote exceptional nitrate reduction.
- **Internal, low pressure sludge recycle** reduces energy consumption.
- **Phase separator optimizes biological nutrient removal**.
- **Total Phosphorus < 0.5 mg/l**
- **Total Nitrogen < 3 mg/l**
- **Phase separator optimizes biological nutrient removal**.
- **Internal, low pressure sludge recycle reduces energy consumption**.
- **Time-based anoxic intervals** promote exceptional nitrate reduction.

Aqua MixAir® System

The AquaPASS system utilizes the Aqua MixAir® system by providing separate mixing with AquaDDM® direct-drive mixers and Aqua-Aerobic diffused aeration. This system has the capability to cyclically operate the aeration and mixing to promote anoxic/anoxic and anoxic/aerobic environments with low energy consumption. In addition, the Aqua MixAir system can achieve and recover as low as one litre of return sludge, promote biological phosphorus removal, and control certain forms of filamentous bacteria.

AquaPASS® Stages of Operation

**Anoxic**

- Utlmated sewage is introduced into the anoxic reactor.
- Concentrated, biological solids are removed from the Pre-Anoxic reactor.
- Volatile Fatty Acid (VFA) formation is enhanced under anoxic conditions.
- Turbulent and efficient recting keeps long-term removals rate > 90% of the reactor’s hydraulic retention time (HRT).
- Elevated VFA-enriched mixed liquor is conveyed to the Staged Anoxic/Aerobic reactor.

**Staged Aeration**

- Anaerobically conditioned bi- solids are received into the Staged Anoxic/Aerobic reactor.
- Multi-variable dissolved oxygen (D.O.) control for management of discrete aerobic and anoxic intervals that can be further enhanced with the addition of the IntelliPro system.
- Aerobic stages enable operator-defined D.O. levels to be controlled.
- Anoxic stages produce a completely mixed biomass at near zero D.O. levels.
- Process management of anaerobic events via time or instrument feedback.
- Efficient oxygen delivery via proportional aeration management.

**Final Clarification**

- Enhanced solids concentration is promoted in a low-energy consumption environment.
- Supernatant is returned to Staged Aeration.
- Concentrated sludge is conveyed to the Anaerobic stage.

**Pre-Anoxic**

- Sludge from the Phase Separator is conditioned for further nitrite reduction.
- Aggressive mixing in absence of O.D. prepares bio-solids prior to anaerobic treatment.
- The elevated solids concentration results in reduced pumping requirements.
- Variable frequency control of the pumps maintains retention times in anaerobic and anoxic stages.
- Densefied sludge is conveyed to the Anaerobic stage.

**Phase Separator**

- Receives RAS from the Final clarifiers.
- Enhanced solids concentration is promoted in a low-energy consumption environment.
- Supernatant is returned to Staged Aeration.
- Concentrated sludge is conveyed to Pre-Anoxic reactor.

**Effluent**

- The effluent is discharged into the receiving body of water or reused according to the user's specific effluent objectives.

**IntelliPro® Process Monitoring and Control System**

The IntelliPro system is a personal computer (PC)-based program that interfaces with the AquaSBR system's programmable logic controller (PLC). A network connection to assist operators in optimizing the treatment process of the plant while reducing operating costs.

System Advantages

- **Real-time, online monitoring and control**
- **Active Control Mode** allows auto responses to upsets and provides operator intervention for problem solving.
- **Real-time and historical graphical trending of process parameters**
- **Remote troubleshooting** provides real-time assistance to eliminate operational interruptions and upsets.
- **Enhanced control and monitoring of enhanced nutrient removal processes**
- **Online System and performance monitoring**
- **Remote troubleshooting and maintenance support**

AquaSBR: AquaSBR System Overview of a 4-Stage AquaPASS® System.

**Stage Separator**

- The phase separator thickeners return activated sludge (RAS) from the final clarifiers to optimize process environments. Particularly phosphorus removal. Because the phase separator produces thickened sludge 20-50% more concentrated than return activated sludge, the cost associated with sludge thickening, dewatering, and transportation is decreased.

- Concentrated, denitrified biological solids are removed from the Pre-Anoxic reactor.
- Fully automated process control system with operational flexibility.
- Superior process environment suited for cold weather climates.
- Low life cycle cost with annual energy savings up to 50% compared to similar activated sludge processes due to reduced recycle flow requirements.

- Anoxic stages produce a completely mixed biomass at near zero dissolved oxygen levels.
- Process management of anaerobic events via time or instrument feedback.
- Efficient oxygen delivery via proportional aeration management.

- Process monitoring and control system’s programmable logic controller (PLC) via a network connection to assist operators in optimizing the treatment process of the plant and further reducing operating costs.
Aqua-Aerobic Systems has led the industry in time-managed, biological technology since 1984. In 2004, Aqua-Aerobic applied its experience to wastewater treatment systems that use the Aqua MixAir® system. This system has led the industry in time-managed, biological technology since 1984. In 2004, Aqua-Aerobic applied its experience to wastewater treatment systems that use the Aqua MixAir® system.

**AquaPASS System**

AquaPASS, the company’s flagship product, has led the way in developing integrated wastewater treatment systems that meet the highest standards of environmental performance and operational efficiency. AquaPASS systems are designed to be simple, yet sophisticated, providing a wide range of treatment options to meet specific site requirements.

The AquaPASS system incorporates the unique flexibility of a time-managed process configured in a flow-through activated sludge design. The system employs time-based aerobic and anaerobic phasing via the Aqua MixAir system to maximize oxygen and nutrient removal objectives. Independent aeration and mixing allows necessary nitrification, denitrification, as well as phosphorus removal to occur within a single basin. This concept also increases overall power consumption of the system. The AquaPASS system utilizes four (4) treatment steps: Anaerobic, Staged Aeration (multiple discrete aerobic/anoxic events), Pre-Anoxic, and Phase Separator. The stages can be designed to optimize conditions based on wastewater characteristics to meet specific effluent objectives.

**System Features and Advantages**

- **Flexible tank design:** Allows equipment options and footprint variations to provide a perfect fit for any project.
- **Staged aeration:** Via the Aqua MixAir® system offers power savings.
- **Time-based aeration:** Minimizes power consumption, providing cost and energy savings.
- **Low energy consumption:** In addition, the Aqua MixAir® system offers low energy consumption.
- **Mixing and Aeration:** The capability to cyclically operate the aeration and mixing processes separately with Aqua-Aerobic direct-drive mixers and Aqua-Aerobic diffused aeration. This system has been designed to achieve and recover alkalinity through denitrification, prevent nitrogen gas disruption in the settling phase, promote anoxic/aerobic and anaerobic environments with reduced energy consumption.
- **Fuller tank design:** Offers power savings.
- **Flexible equipment:** Tailored equipment options and final clarifiers (provisioned separately) make this process ideal for retrofitting existing systems.
- **Efficient flow:** The cycle is optimized for the entire wastewater treatment process to meet critical nutrient removal objectives. Independent aeration and mixing allows necessary nitrification, denitrification, as well as phosphorus removal to occur within a single basin. This concept also increases overall power consumption of the system. The AquaPASS system utilizes four (4) treatment steps: Anaerobic, Staged Aeration (multiple discrete aerobic/anoxic events), Pre-Anoxic, and Phase Separator. The stages can be designed to optimize conditions based on wastewater characteristics to meet specific effluent objectives.

**Aqua MixAir® System**

The AquaMixAir® system utilizes the Aqua MixAir® system by providing separate mixing with AquaDDM® direct-drive mixers and Aqua-Aerobic diffused aeration. This system has the capability to cyclically operate the aeration and mixing to promote anoxic/aerobic and anaerobic environments with low energy consumption. In addition, the Aqua MixAir system can achieve and recover energy through denitrification, provide nitrogen gas disruption in the settling phase, promote biological phosphorus removal, and control certain forms of filamentous bacteria.

**Phase Separator**

The phase separator thickeners return activated sludge (RAS) from the final clarifiers to optimize process environments, particularly phosphorus removal. Because the phase separator produces thickened sludge 20-50% more concentrated than return activated sludge, the cost associated with sludge thickening, dewatering, and transportation is decreased.

- **Sludge from the Phase Separator is conditioned for further nitrogen reduction.**
- **Aggressive mixing in a sludge pump prevents clogging.**
- **The aerated solids concentration results in reduced pumping requirements.**
- **Variable frequency control of the pumps maintains retention time in aerobic and anaerobic stages.**
- **Densified sludge is conveyed to the Anaerobic stage.**

**Stages of Operation**

The AquaPASS system incorporates the unique flexibility of a time-managed process configured in a flow-through activated sludge design. The system employs time-based aerobic and anaerobic phasing via the Aqua MixAir system to maximize oxygen and nutrient removal objectives. Independent aeration and mixing allows necessary nitrification, denitrification, as well as phosphorus removal to occur within a single basin. This concept also increases overall power consumption of the system. The AquaPASS system utilizes four (4) treatment steps: Anaerobic, Staged Aeration (multiple discrete aerobic/anoxic events), Pre-Anoxic, and Phase Separator. The stages can be designed to optimize conditions based on wastewater characteristics to meet specific effluent objectives.

**Anaerobic**

- **Ultimate sewage is introduced into the anaerobic reactor.**
- **Concentrated biological solids are transferred from the Pre-Anoxic reactor.**
- **Volatile Fatty Acid (VFA) concentration in anaerobic conditions.**
- **Turbulent and efficient mixing keeps particles dispersed in the reactor.**
- **The reactor’s hydraulic retention time (HRT).**
- **Enhanced VFA-enriched mixed liquor is conveyed to the Staged Aeration/Anoxic reactor.**

**Staged Aeration**

- **Anaerobically conditioned bio-solids are received into the Staged Aeration reactor.**
- **Multi-variable dissolved oxygen (D.O.) control for management of discrete aerobic and anaerobic intervals that can be further enhanced with the addition of the IntelliPro system.**
- **Anaerobic stages can be operated at D.O. levels to be controlled.**
- **Anoxic stages produce a completely mixed sludge at near-zero D.O. levels.**
- **Process management of anaerobic events via time or instrument feedback.**
- **Efficient oxygen delivery via proportional aeration management.**

**Pre-Anoxic**

- **Receive RAS from the final clarifiers.**
- **Enriched solids concentration is provided in a low-energy consumption environment.**
- **Supernatant is returned to Staged Aeration.**
- **Concentrated sludge is conveyed to Pre-Anoxic reactor.**

**Phase Separator**

- **Concentrated, denitrified biological solids are transferred from the Pre-Anoxic reactor.**
- **Extended hydraulic retention time (HRT).**
- **Enhanced VFA-enriched mixed liquor is conveyed to the Staged Aeration/Anoxic reactor.**

System Advantages

- **Real-time, online monitoring and control.**
- **‘Active Control Mode’ which automatically receives, interprets, and proactively adjusts to basin instrument and process variables including biological nutrient removal, chemical addition and energy consumption.**
- **Reduce the operator’s sampling time.**
- **Real-time and historical graphical trending of process parameters.**
- **Remote troubleshooting provides on-demand troubleshooting assistance.**

IntelliPro System

The IntelliPro system is a personal computer (PC) based program that interfaces with the AquaSBR system’s programmable logic controller (PLC) via a network connection to assist operators in optimizing the treatment process of the plant and further reducing operating costs.
AquaPASS®

Typical Applications

- Ideal for municipal or industrial large scale projects
- Enhanced biological nutrient removal
  - Total Nitrogen < 3 mg/l
  - Total Phosphorus < 0.5 mg/l
- Water reuse and reclamation
- New plant construction
- Retrofit existing activated sludge systems
- Convert isolation ditches
- Easily integrated into an Aqua-Aerobic membrane system

PLANT PROFILE - Salisbury Township WWTP, PA

The Salisbury Township WWTP in Gap, PA utilized a conventional activated sludge system prior to being retrofitted with an AquaPASS Phased Activated Sludge System in May 2008. The upgrade was necessary in order to comply with the Chesapeake Bay Initiative for local impaired waterways, requiring stringent permit limits on effluent Total Nitrogen and Total Phosphorus by 2010. The plant's conventional system was not designed for nutrient removal and required only secondary limits of 20 mg/l BOD, 30 mg/l TSS, 6 mg/l NH₃-N, and 2 mg/l TP. Salisbury experienced constant upsets during peak wet weather flow conditions that required operator intervention to prevent solids from rising over the effluent weir. In addition, the conventional system could no longer handle the increased hydraulic loadings from the area's rapid population growth of about 11.5% in the past nine years.

After evaluating alternative technologies, Salisbury and its consulting engineer ultimately selected the AquaPASS system for its ability to combine prominent features of both batch and continuous-flow processes into a singular treatment process. This allowed Salisbury to efficiently manage processes in existing tank geometry at a low lifecycle cost. Salisbury was the first treatment plant to install AquaPASS technology.

Salisbury's AquaPASS system is designed to meet the new stringent Total Nitrogen and Total Phosphorus effluent limits required by the Chesapeake Bay Initiative, 6.9 mg/l and 0.86 mg/l respectively. The system is also designed to provide 140% more treatment capacity in the same footprint as the previous conventional activated sludge system.

Performance of Salisbury's AquaPASS system was evaluated in May 2009 to verify its ability to meet the new 2010 permit requirements of the Chesapeake Bay Initiative. Since its startup in May 2008, the AquaPASS system has been in compliance with the 2010 permit levels with Total N and Total P effluent below design conditions. In addition, effluent BOD₅, TSS, and NH₃-N have been reduced by more than 98%!

AquaPASS®

PHASED ACTIVATED SLUDGE SYSTEM

Providing TOTAL Water Management Solutions

Visit our website at www.aqua-aerobic.com to learn more about the AquaPASS® Phased Activated Sludge System and our complete line of products and services:

- Aeration & Mixing
- Biological Processes
- Filtration
- Membrane Systems
- Controls & Monitoring Systems
- Aftermarket Products and Services

Salisbury's AquaPASS system is designed to meet the new stringent Total Nitrogen and Total Phosphorus effluent limits required by the Chesapeake Bay Initiative, 6.9 mg/l and 0.86 mg/l respectively. The system is also designed to provide 140% more treatment capacity in the same footprint as the previous conventional activated sludge system.

Average Operating Data (2010 - July 2012)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design</th>
<th>Actual</th>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Flow mgd</td>
<td>0.58</td>
<td>0.23</td>
<td></td>
<td>0.58</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>Peak Flow mgd</td>
<td>1.16</td>
<td>0.45</td>
<td></td>
<td>1.16</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>BOD mg/l</td>
<td>250</td>
<td>15</td>
<td>&lt; 3</td>
<td>15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TSS mg/l</td>
<td>215</td>
<td>30</td>
<td>&lt; 5</td>
<td>30</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>TKN mg/l</td>
<td>35</td>
<td>&lt; 5.8</td>
<td>&lt; 5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>NH₃-N mg/l</td>
<td>40</td>
<td>&lt; 0.6</td>
<td>&lt; 0.6</td>
<td>40</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total N* mg/l</td>
<td>&lt; 4.5</td>
<td>&lt; 2.6</td>
<td>&lt; 2.6</td>
<td>&lt; 4.5</td>
<td>&lt; 2.6</td>
<td>&lt; 2.6</td>
</tr>
<tr>
<td>Total P mg/l</td>
<td>6</td>
<td>&lt; 0.4</td>
<td>&lt; 0.4</td>
<td>6</td>
<td>0.86</td>
<td>0.86</td>
</tr>
</tbody>
</table>

*Nitrite was < 0.3 mg/l and Nitrate was < 1.9 mg/l.

Aqua-AEROCO SYSTEMS, INC.

AquaPASS®

Ideal for municipal or industrial large scale projects
Enhanced biological nutrient removal
- Total Nitrogen < 3 mg/l
- Total Phosphorus < 0.5 mg/l
Water reuse and reclamation
New plant construction
Retrofit existing activated sludge systems
Convert isolation ditches
Easily integrated into an Aqua-Aerobic membrane system

Typical Applications

- Ideal for municipal or industrial large scale projects
- Enhanced biological nutrient removal
  - Total Nitrogen < 3 mg/l
  - Total Phosphorus < 0.5 mg/l
- Water reuse and reclamation
- New plant construction
- Retrofit existing activated sludge systems
- Convert isolation ditches
- Easily integrated into an Aqua-Aerobic membrane system
The information contained herein relative to data, dimensions and recommendations as to size, power and assembly are for purpose of estimation only. These values should not be assumed to be universally applicable to specific design problems. Particular designs, installations and plants may call for specific requirements. Consult Aqua-Aerobic Systems, Inc. for exact recommendations or specific needs. Patents Apply.

© 2012 Aqua-Aerobic Systems, Inc.
6306 N. Alpine Rd  Loves Park, IL 61111-7655
p 815.654.2501  f 815.654.2508
www.aqua-aerobic.com
solutions@aqua-aerobic.com

Providing TOTAL Water Management Solutions
Visit our website at www.aqua-aerobic.com to learn more about the AquaPASS® Phased Activated Sludge System and our complete line of products and services:

Aeration & Mixing
Biological Processes
Filtration
Membrane Systems
Controls & Monitoring Systems
Aftermarket Products and Services

The Salisbury Township WWTP in Gap, PA utilized a conventional activated sludge system prior to being retrofitted with an AquaPASS Phased Activated Sludge System in May 2008. The upgrade was necessary in order to comply with the Chesapeake Bay Initiative for local impaired waterways, requiring stringent total nitrogen and total phosphorus by 2010. The plant’s conventional system was not designed for nutrient removal and required only secondary limits of 20 mg/l BOD5, 30 mg/l TSS, 6 mg/l NH3-N, and 2 mg/l TP. Salisbury experienced constant upsets during peak wet weather flow conditions that required operator intervention to prevent solids from rising over the effluent weir. In addition, the conventional system could no longer handle the increased hydraulic loadings from the area’s rapid population growth of about 11.5% in the past nine years.

After evaluating alternative technologies, Salisbury and its consulting engineer ultimately selected the AquaPASS system for its ability to combine prominent features of both batch and continuous-flow processes into a singular treatment process. This offered Salisbury an efficient, time-managed process environment in existing tank geometry at a low lifecycle cost. Salisbury was the first treatment plant to install AquaPASS technology.

Salisbury’s AquaPASS system is designed to meet the new stringent total nitrogen and total phosphorus effluent limits required by the Chesapeake Bay Initiative, 6.9 mg/l and 0.86 mg/l respectively. The system is also designed to provide 140% more treatment capacity in the same footprint as the previous conventional activated sludge system.

Performance of Salisbury’s AquaPASS system was evaluated in May 2009 to verify its ability to meet the new 2010 permit requirements of the Chesapeake Bay Initiative. Since its startup in May 2008, the AquaPASS system has been in compliance with the 2010 permit limits with total nitrogen and total phosphorus effluent design conditions. In addition, effluent BOD5, TSS, and NH3-N have been reduced by more than 98%!