THERMAL PROCESS SYSTEMS

EXCALIBAER

YOUR PROVEN SOLUTION FOR BIOSOLIDS MANAGEMENT

THE **EXPERIENCE** TO KNOW WHAT WORKS. THE **INNOVATION** TO MAKE IT WORK BETTER.

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About TPS

Thermal Process Systems was founded by experienced wastewater treatment professionals who understand the complex issues of biosolids processing and re-use.

Frustrated by the compromises that were necessary with existing systems and the inability of these processes to meet industry demand — we formed a company exclusively focused on biosolids management.

The team at Thermal Process Systems develops more reliable and efficient processes to produce high-quality biosolids. The result of this innovation is our patented ThermAer Process. Now, we are continuing our tradition of leading-edge development by introducing the ExCalibAer anaerobic optimization system.

As if our experience and technology weren't enough, Thermal Process Systems has established relationships with the most innovative and respected equipment manufacturers in the industry today. This unmatched combination offers you complete systems integration from retrofit to ground-up installation and control.

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ExCalibAer: Revolutionizing Anaerobic Digestion & Nutrient Removal

Transforming Challenges Into Opportunities

ExCalibAer™ is the cutting-edge solution for wastewater resource recovery facilities (WRRFs) seeking to maximize efficiency, sustainability, and energy production. By integrating advanced digestion stages with innovative nitrate recycling, ExCalibAer optimizes digestion by adding nutrient removal, turning challenges into opportunities.

The Science Behind ExCalibAer

ExCalibAer separates the anaerobic digestion process into three distinct but interconnected stages, each designed to optimize specific biological processes:

Acid Phase Digester/Feed Denitrification Tank (FDT):

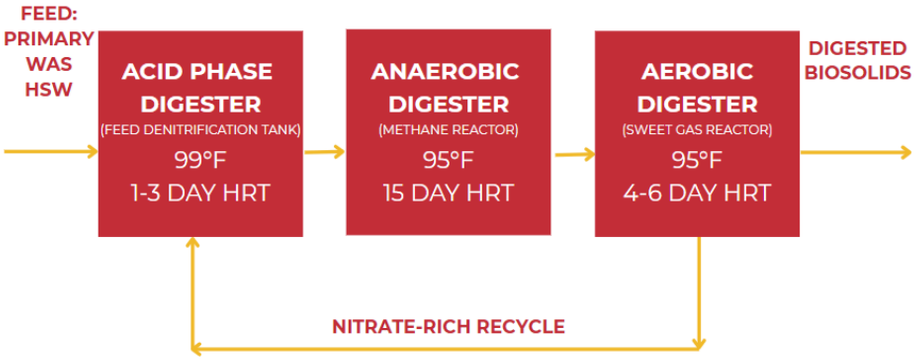
- *Function:* Hydrolysis and acidogenesis occur here, breaking down feed sludge into volatile fatty acids (VFAs). Material recycled from the aerobic digester undergoes denitrification for nitrogen removal.
- *Innovation:* Recycling nitrate-rich material from the final aerobic stage suppresses the production of hydrogen sulfide (H_2S) by promoting the nitrate pathway, a process that is 5.5 times more energy-efficient than the typical sulfate pathway. Denitrification also produces alkalinity which keeps the pH closer to neutral compared to classic acid digesters.
- *Result:* Enhanced VFA production, improved pH balance, and reduced concentrations of sulfate reducing bacteria for smoother downstream digestion.

Anaerobic Digester:

- *Function:* The VFAs are converted into methane-rich biogas in this anaerobic stage.
- *Optimization:* By maintaining ideal conditions (95°F, pH control without chemicals, balanced VFA concentrations), methanogens efficiently convert carbon into energy while minimizing the production of H_2S and ammonia.
- *Result:* Cleaner, higher-quality biogas and superior volatile solids destruction.

Aerobic Digester:

- *Function:* The aerobic digestion phase removes ammonia via nitrification, reducing alkalinity and conditioning biosolids for improved dewatering.
- *Closed Loop Innovation:* A portion of the digested material is recycled back to the Acid/FDT, enhancing system stability and efficiency.
- *Result:* Reduced ammonia and struvite formation, low-odor biosolids, and consistent nutrient removal.



Why Choose ExCalibAer™?

The Power of the Nitrate Pathway
Traditional anaerobic digestion sets the stage for the sulfate pathway, which produces corrosive hydrogen sulfide (H_2S) and consumes more carbon, leaving less available for methane production. ExCalibAer disrupts this process by introducing nitrate recycling:

- **Higher Methane Yield:** Nitrate recycling prioritizes methane production, increasing biogas energy potential by up to 25%.
- **Lower H_2S Production:** H_2S levels in biogas are reduced by up to 99%, improving safety, reducing odors, and lowering maintenance costs.

Enhanced Process Control
ExCalibAer incorporates advanced monitoring and control mechanisms, ensuring optimal conditions at every stage:

- **Continuous Monitoring:** Temperature, pH, and Oxidation-Reduction Potential (ORP) sensors ensure precise control.
- **Automated Adjustments:** Intelligent systems respond to fluctuations, maintaining stable digestion processes and reducing operator intervention.
- **Biological Controls:** The pH control provided by the recycle of aerobically digested material maintains phosphorus solubility, reducing concerns over struvite precipitation and the need for chemical adjustments.

Integrated Nutrient Management

- **Nitrogen Removal:** Through Nitrification-Denitrification steps within the reactors, ExCalibAer™ significantly reduces nitrogen loads in the liquid return stream from dewatering.
- **Phosphorus Recovery:** Phosphorus is kept soluble throughout the digestion process, making it available for economically feasible recovery and addressing nutrient recycling issues.

Key Benefits of ExCalibAer

Energy Efficiency

- **Biogas Quality:** Achieves Produces biogas with higher methane content and lower CO_2 and H_2S concentrations.
- **Energy Production:** Facilities experience up to 25% greater energy recovery compared to standard anaerobic systems.

Cost Savings

- **Reduced Chemical Costs:** Eliminates or significantly reduces the need for ferric salts, coagulants, and polymers.
- **Lower Hauling Costs:** Decreased biosolids volume reduces transportation and disposal expenses.

Operational Advantages

- **Stable Operations:** Recycling nitrate-rich material smooths feed variations and prevents digester upsets.
- **Increased Throughput:** Lower hydraulic retention times (HRTs) allow for higher capacity and reduced tankage needs.

Environmental Benefits

- **Sustainability:** Supports compliance with stringent nutrient discharge regulations by removing nitrogen and phosphorus.
- **Odor Control:** Produces low-odor biosolids with a natural, earthy smell.

Designed for Flexibility
ExCalibAer is easily Integrated into Existing Systems and designed to adapt to various facility configurations with minimal modifications:

- Utilizes existing tankage and infrastructure.
- Scalable to handle varying loads and feed compositions.
- Low-maintenance, automated systems reduce operator intervention.

The ExCalibAer Process in Detail

Step 1: Feed Denitrification Tank (FDT)

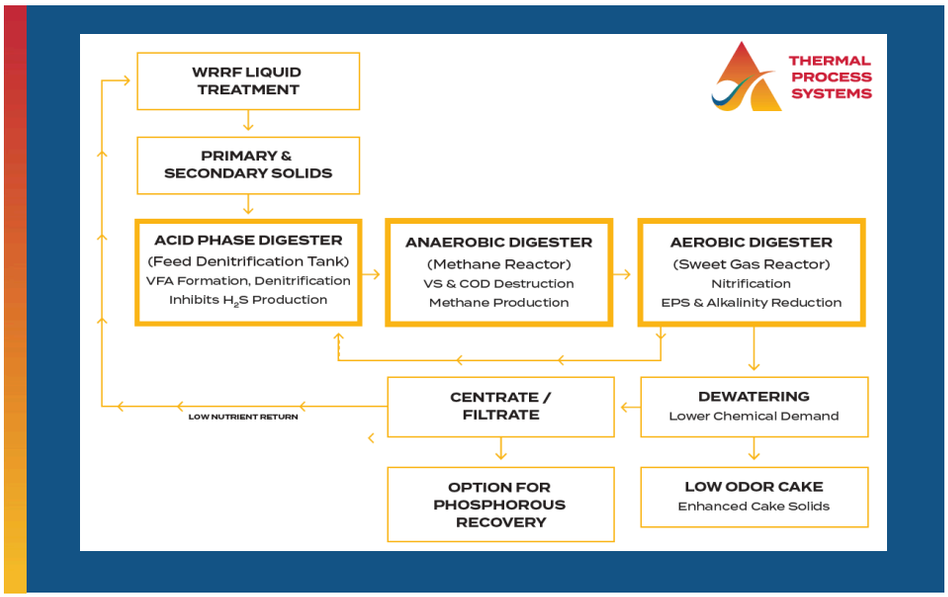
- **Hydrolysis & Acidogenesis:** Converts solids into VFAs, laying the groundwork for effective methane production.
- **Nitrate Recycling:** Introduces oxygen-rich nitrates, suppressing sulfate-reducing bacteria and minimizing H_2S.

Step 2: Methanogen Reactor (MR)

- **Methanogenesis:** Converts VFAs to biogas in a controlled environment, optimized for methane production.
- **Process Stability:** Advanced sensors maintain ideal conditions, ensuring high VS destruction and gas yield.

Step 3: Sweet Gas Reactor (SGR)

- **Nitrification:** Ammonia is converted to nitrate, preparing biosolids for dewatering while maintaining nutrient balance.
- **Recycling Loop:** A portion of digested material returns to the FDT, enhancing system performance and reducing chemical inputs.



Real-World Results!

Proven Success in Pilot Studies

- **Biogas Yield:** Increased by up to 25%, with methane concentrations exceeding standard anaerobic digestion benchmarks.
- **H_2S Reduction:** Consistently achieved reductions of 85–99%, extending equipment lifespan and reducing costs.
- **Volatile Solids Reduction (VSR):** Achieved up to 60% reduction, lowering biosolids volume and disposal needs.

Enhanced Dewatering

- **Improved Cake Solids:** Pilot testing demonstrated up to 20% higher cake solids with reduced polymer demand.
- **Low Odor:** Biosolids produced are nearly odorless, improving working conditions and reducing community complaints.

Ready to take your digesters to the next level?

ExCalibAer is more than a process—it's a revolution in anaerobic digestion. Whether you're seeking energy efficiency, cost savings, or compliance with environmental regulations, ExCalibAer is the solution you've been looking for.

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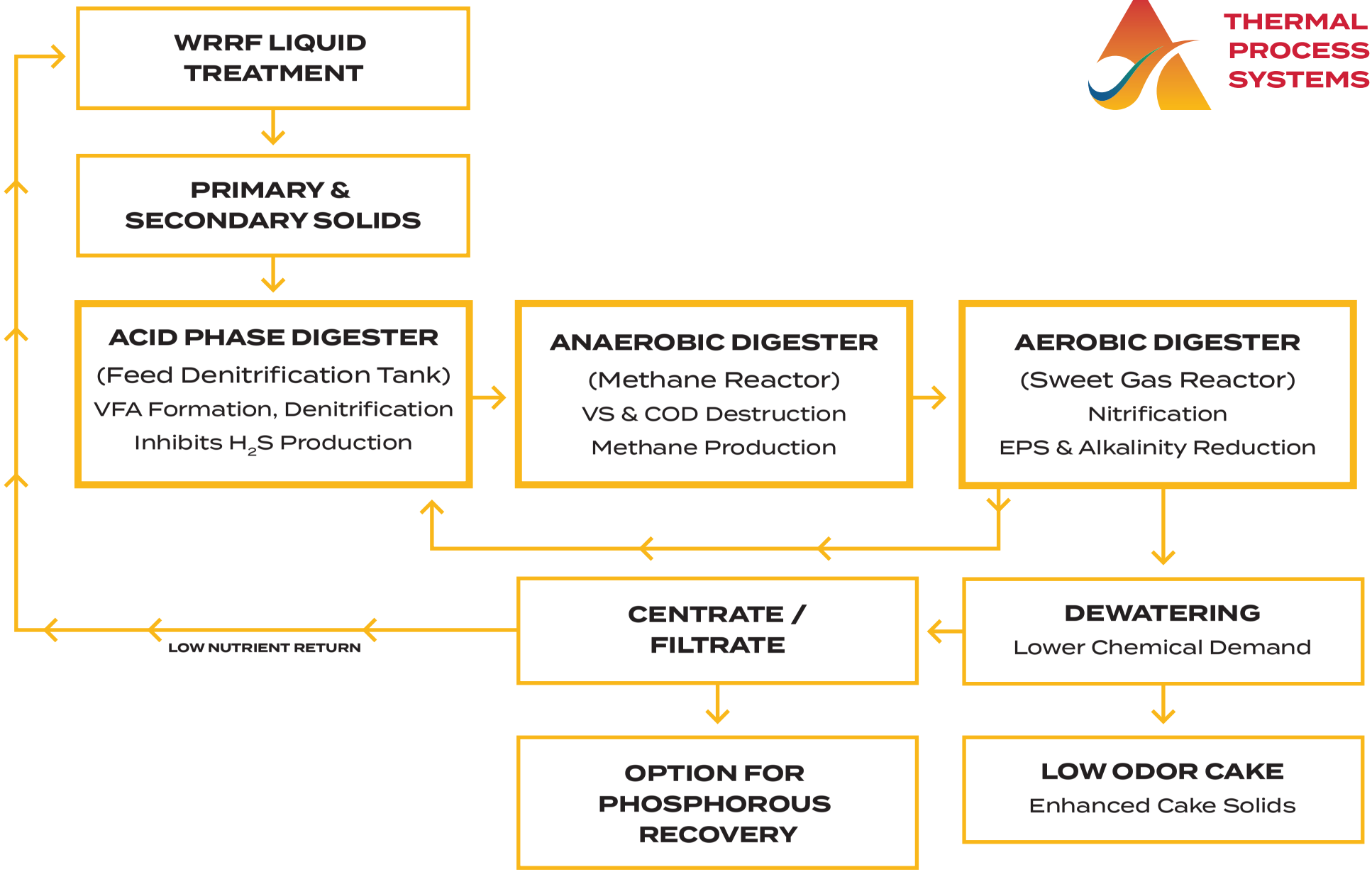

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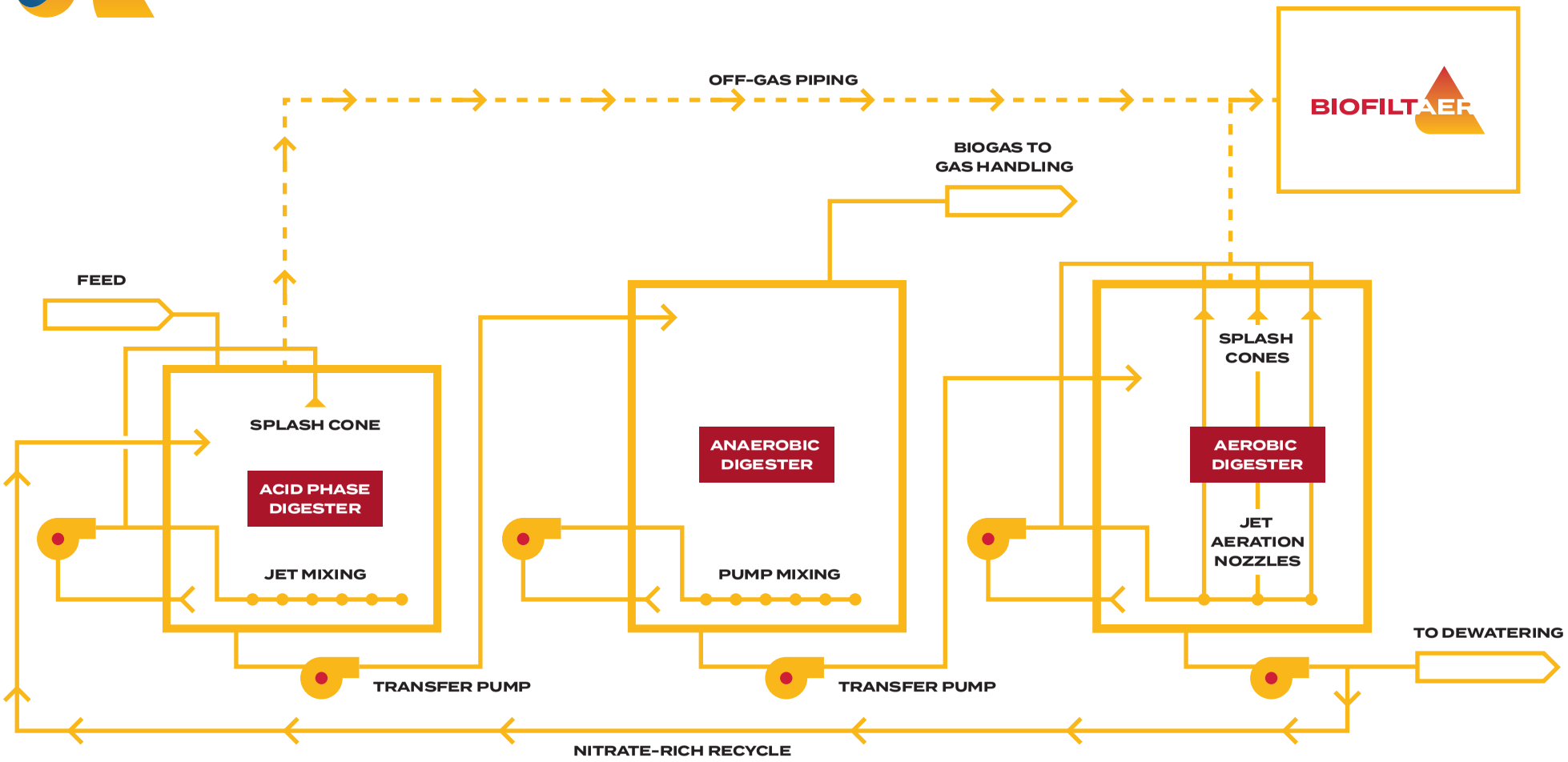

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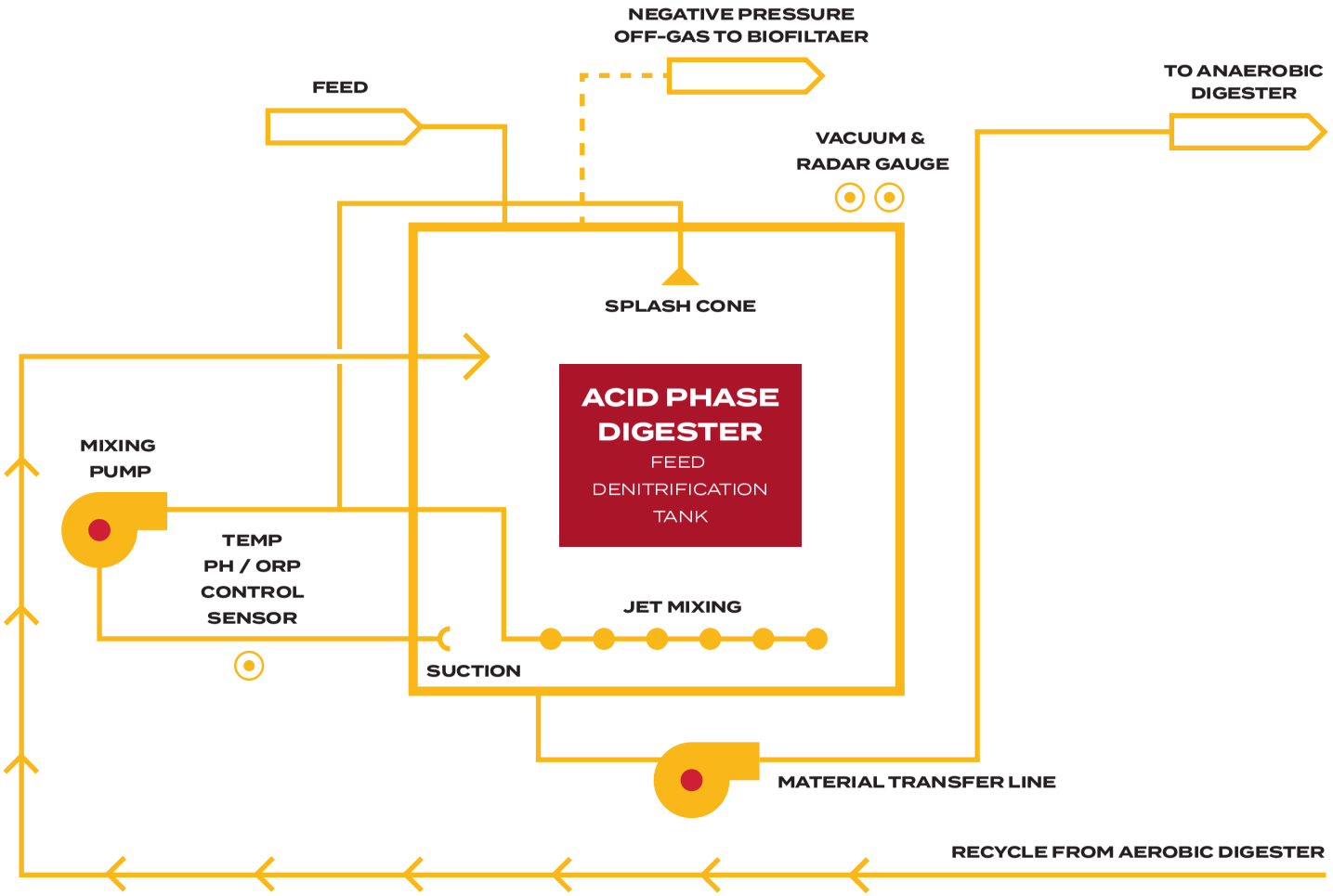

TYPICAL TANK - ACID PHASE DIGESTER

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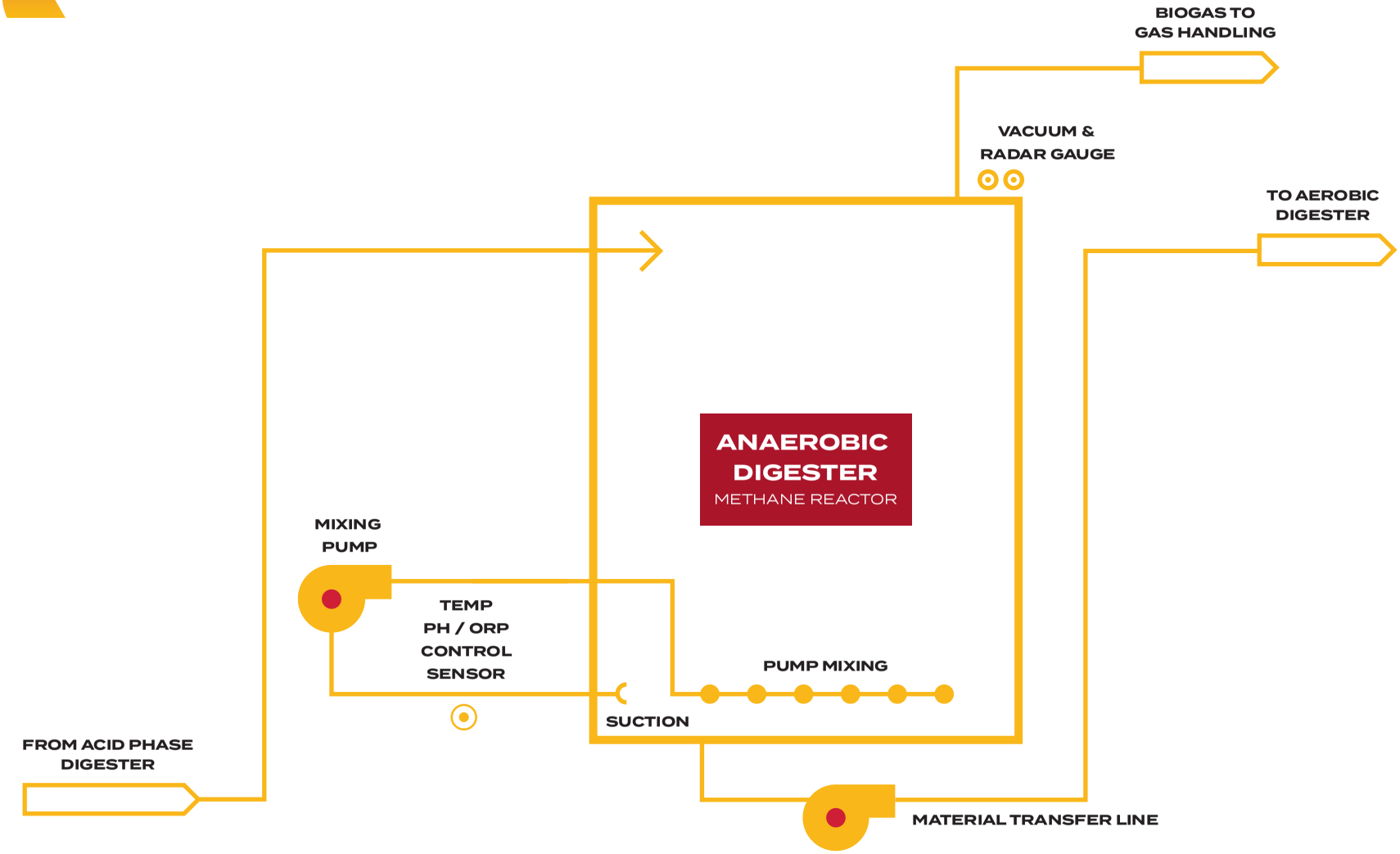

TYPICAL TANK - ANAEROBIC DIGESTER

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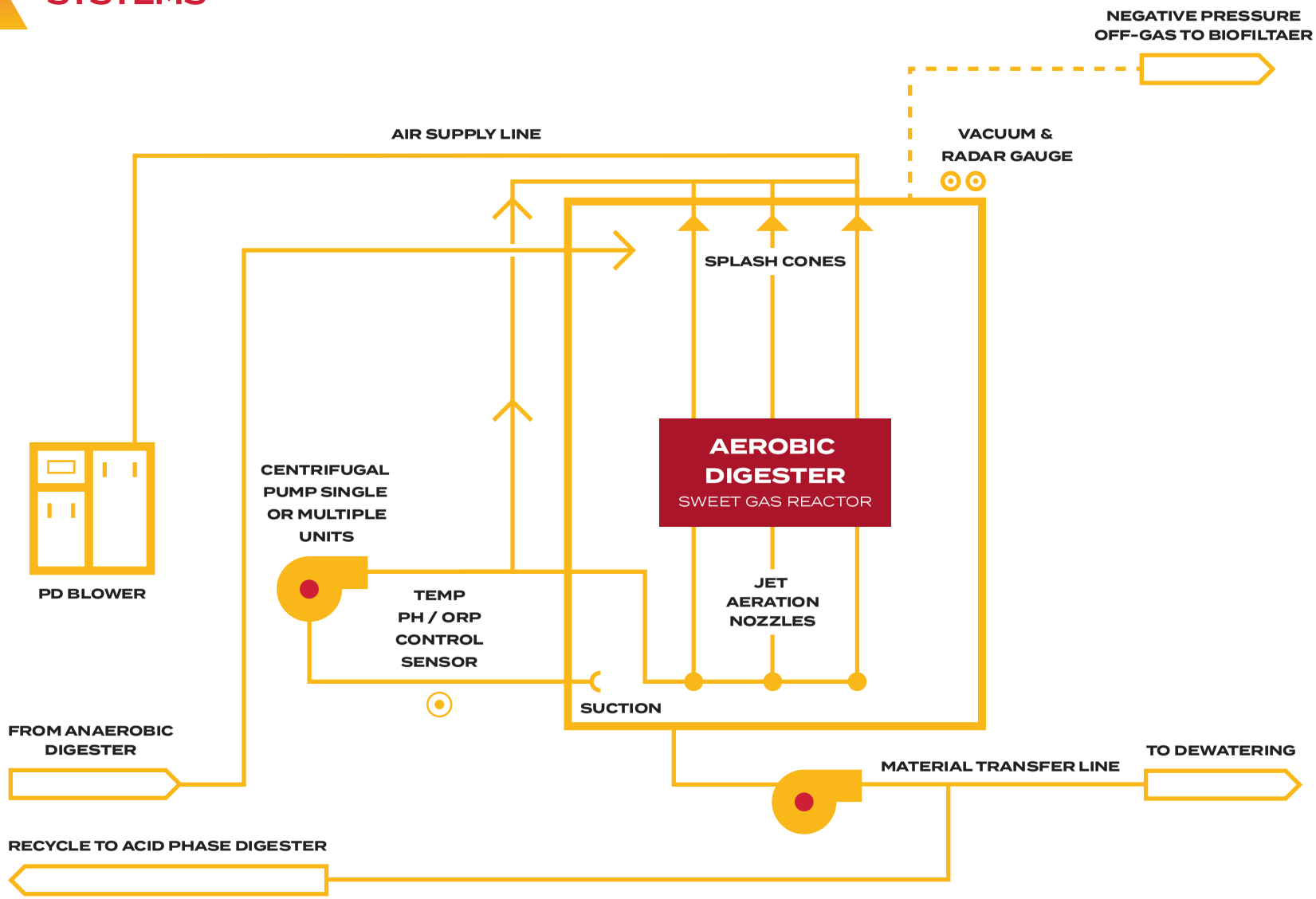

TYPICAL TANK - AEROBIC DIGESTER

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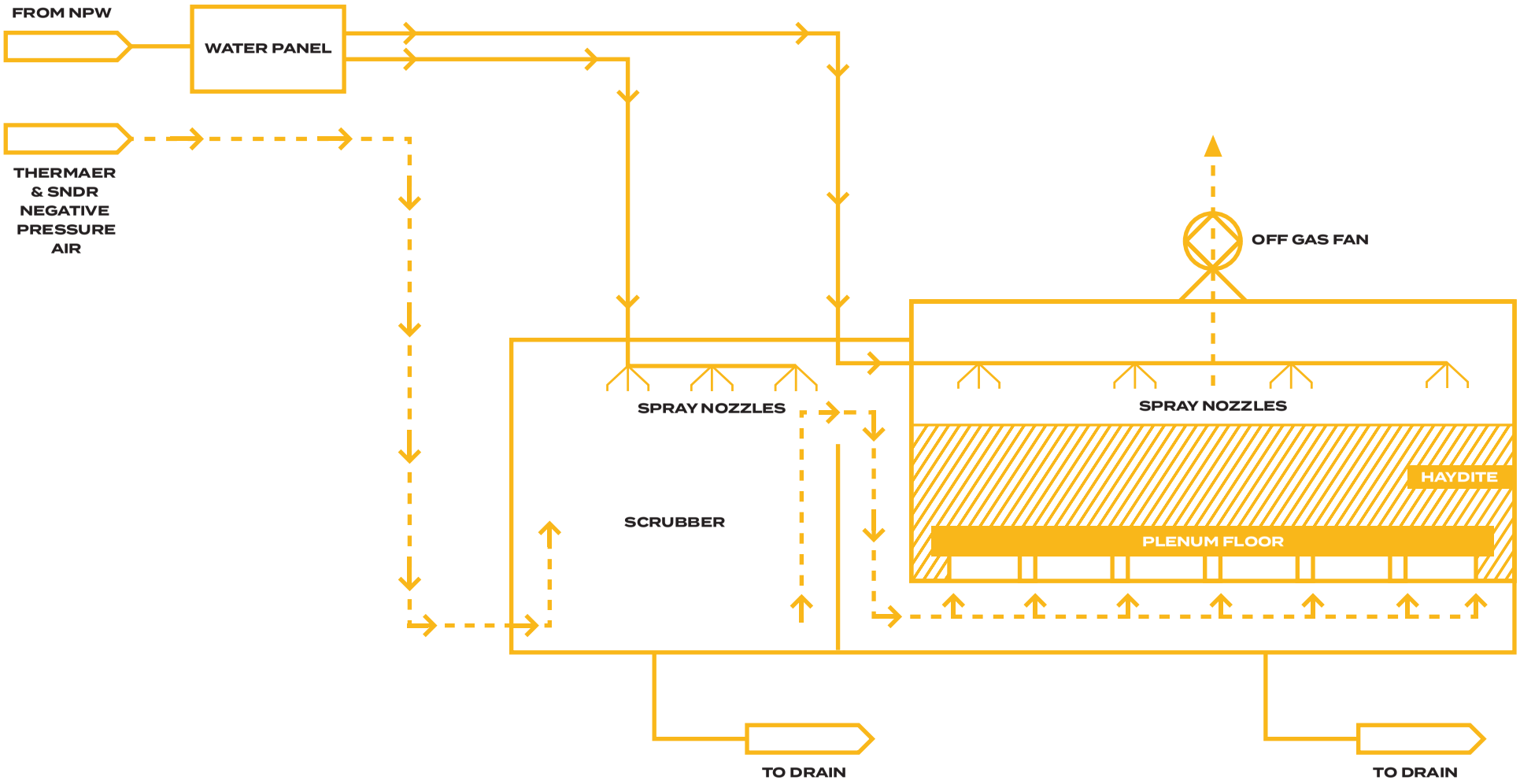

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Thermal Process Systems is renowned for forging enduring relationships with our clients, with many partnerships flourishing for decades. Our commitment extends beyond project completion, offering comprehensive support through spare parts sales, tailored labor agreements, and expert technical guidance. Choosing Thermal Process Systems means investing in more than a solution; it signifies a lasting partnership with a proven industry leader. Discover the difference of our innovative, cost-effective solutions, and unparalleled support.

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