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Thermophilic Anaerobic
Digestion***

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Anaerobic Digestion

Biological degradation in the absence of free oxygen

- stabilizes biosolids
- reduces biosolids
- reduces pathogens
- generates usable biogas energy

Advanced Anaerobic Digestion

Technologies include:

- Thermophilic Digestion only
- Temperature Phased Anaerobic Digestion (TPAD) Thermophilic Mesophilic in series
- Two-Phase Acid Gas in series
- Pre-Hydrolysis
- High pressure and high temperature pre-treatments e.g. Cambi

Mesophilic Anaerobic Digestion

Typical characteristics:

- Fully mixed tank
- single-stage
- 33°C to 38°C – typically 35°C
- 20 to 30 days SRT

Thermophilic Anaerobic Digestion

- Similar in principle to mesophilic anaerobic digestion
- 50°C to 57°C – typical 55°C
- 10 to 15 days SRT
- Increased solids destruction and increased biogas production compared to mesophilic by 15% to 30%

Staged Thermophilic Anaerobic Digestion

- Pathogen destruction - plug-flow or batch mode preferred
- Use two or more reactors in series (to meet USEPA Class A biosolids time/temp requirements for pathogen reduction)
- Second and third reactors have short SRT < 2 days.

USA Thermophilic Experience

- TPAD in ten mid-west WWTPs
- Thermophilic only at Hyperion WWTP (adjacent to Los Angeles International Airport) – one of the largest digestion plants in the world
- Long history at Hyperion – tried thermophilic digestion of fat scum in 1970's
- TPAD trials in 2001 gave organic solids destruction of 66% - the highest for all systems trialled

USA Thermophilic Experience (continued)

- VA averaged 700 mg/l from thermophilic and were reduced to 100 mg/l after mesophilic
- Didn't have space for heat exchangers (for cooling) so selected thermophilic only – two stages in series for Class A Biosolids and biogas increase exceeded predictions
- Optimum temperature range 55⁰C to 57⁰C for increased digestion and pathogen reduction. Above 57⁰C, VA's increase

Canadian Thermophilic Experience

- Major thermophilic digesters at Vancouver WWTPs – Annacis Island and Lions Gate
- Use four tanks-in-series for pathogen reduction to meet Class A biosolids criteria
- Annacis Island suffered from clogging of spiral sludge to sludge heat exchangers – passage only 16 mm

Temperature Phased Anaerobic Digestion (TPAD)

Thermophilic



VA formation
3-5 days

Mesophilic



VA reduction
10-15 days

Temperature Phased Anaerobic Digestion

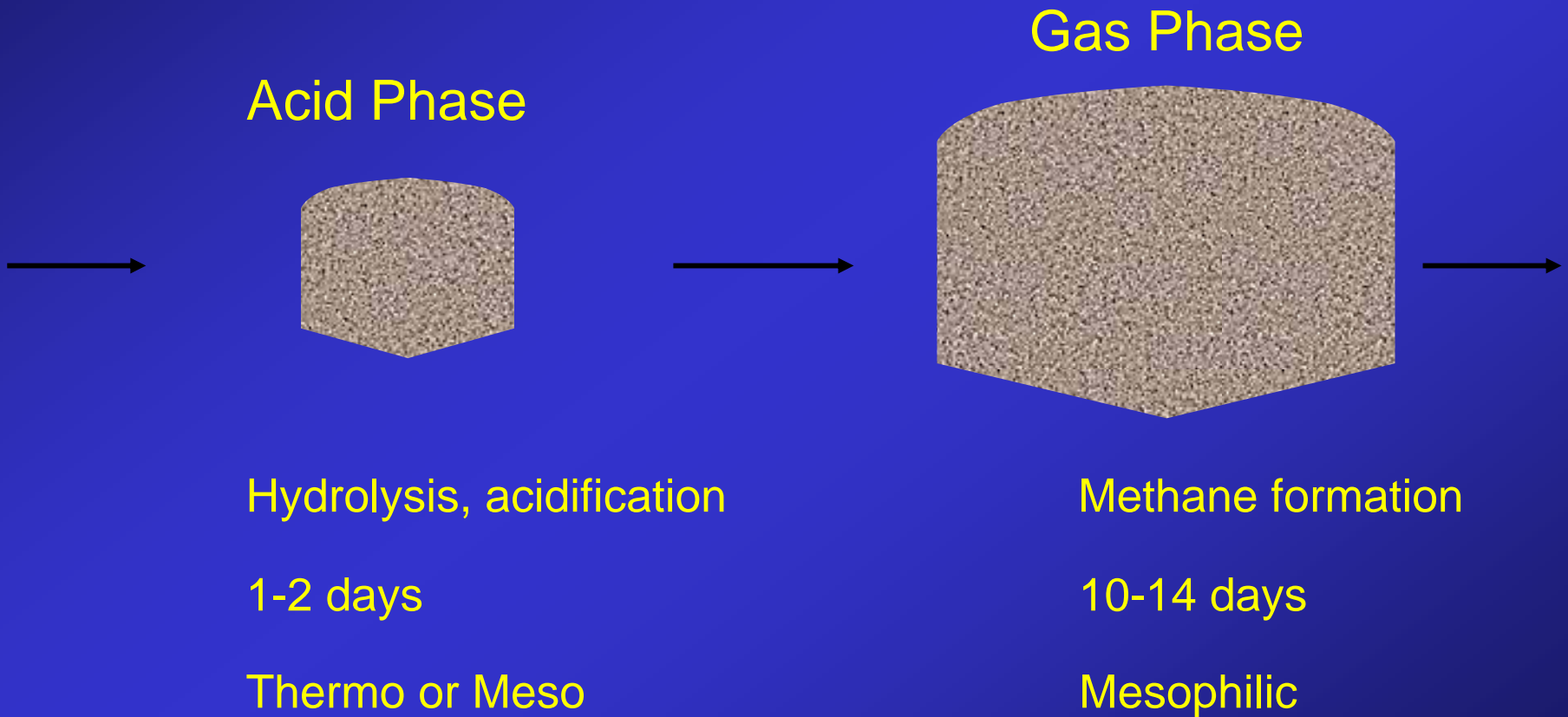
Advantages:

- thermophilic temperatures for increased solids destruction and increased biogas
- less odour than thermophilic alone
- less foam than mesophilic alone
- stable operation
- Improved dewaterability of digested solids

German TPAD Experience

- Full scale plants (> 20) from 1990
- Mainly installed by Oswald Schulze
- At Cologne organic solids destruction increased from 48% for mesophilic only, to 60% for TPAD
- Biogas increase of 16.5%

Two-Phase (Acid/Gas) Anaerobic Digestion



Digestion Process	SRT per Tank at Max Month (days)	Total SRT at Max Month (days)	Operating Temperature
Mesophilic	20	20	Meso
Staged Thermophilic	15/2/1	18	Thermo
Temperature phased (TPAD)	5/10	15	Thermo/Meso
Two-Phase Acid/Gas	2/12	14	Meso preferred

Hamilton WWTP

- Domestic 140,000 design pop
- Primary sedimentation
- Secondary – MLE BNR
- UV disinfection
- Acid/Gas sludge digestion
- Centrifuge dewatering
- Original plant commissioned 1975
- Upgraded plant commissioned 2001

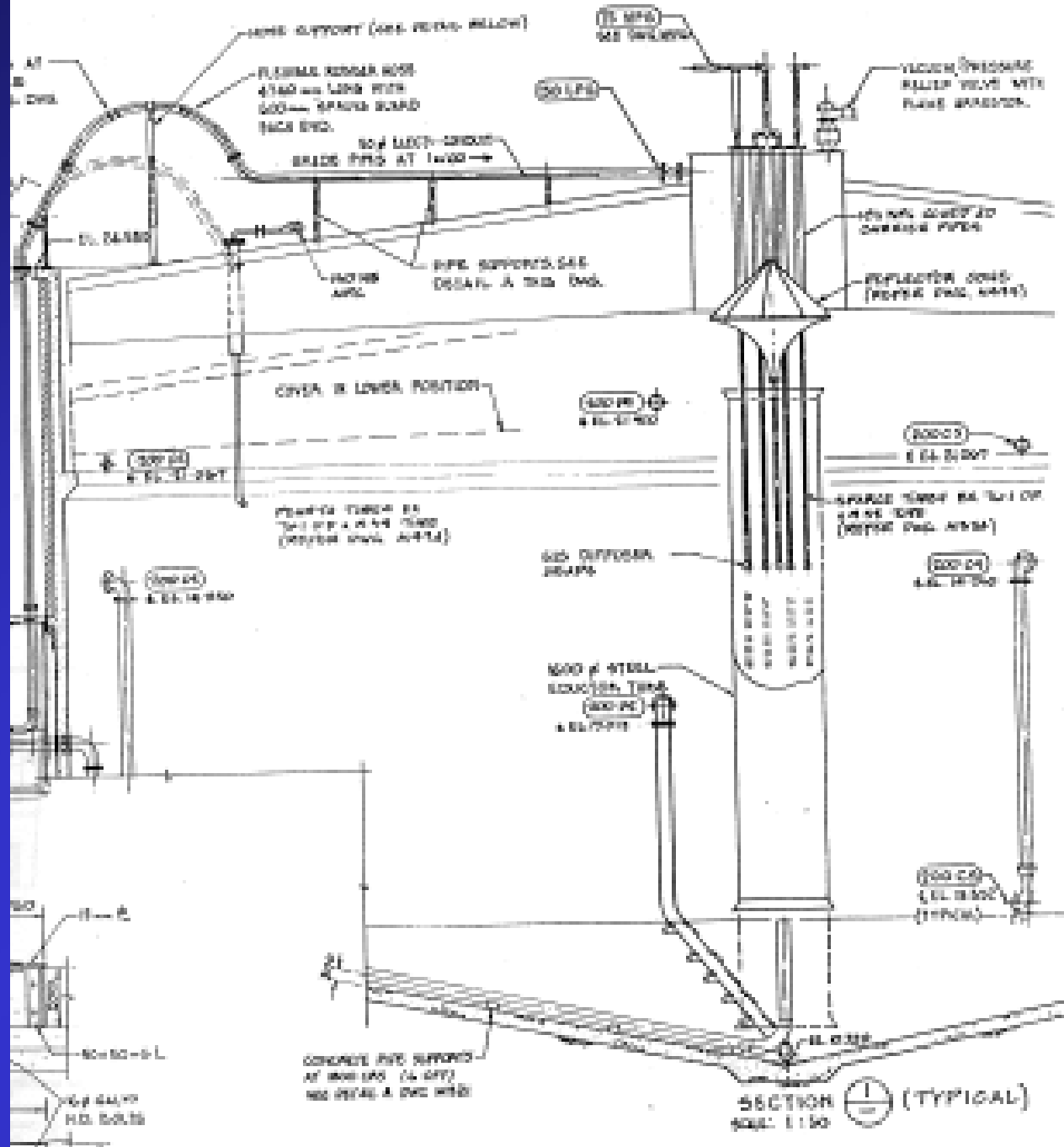
Hamilton WWTP Design Details

- Raw sludge 409m³/d (Prim plus TWAS)
- Sludge holding tank: 1 No. 170 m³
- Acid digesters: 2 No. 615 m³ each about 1 day retention
- Mesophilic digesters: 2 No. 2,400 m³ each about 15 day retention



Hamilton Features

- No problems with process start-up
- Modification to proprietary pump/nozzle mixer
- Blockage problem with sludge/sludge heat exchanger
- Deflector cone in mesophilic for enhanced gas lifter mixing



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Hamilton WWTP - Operations

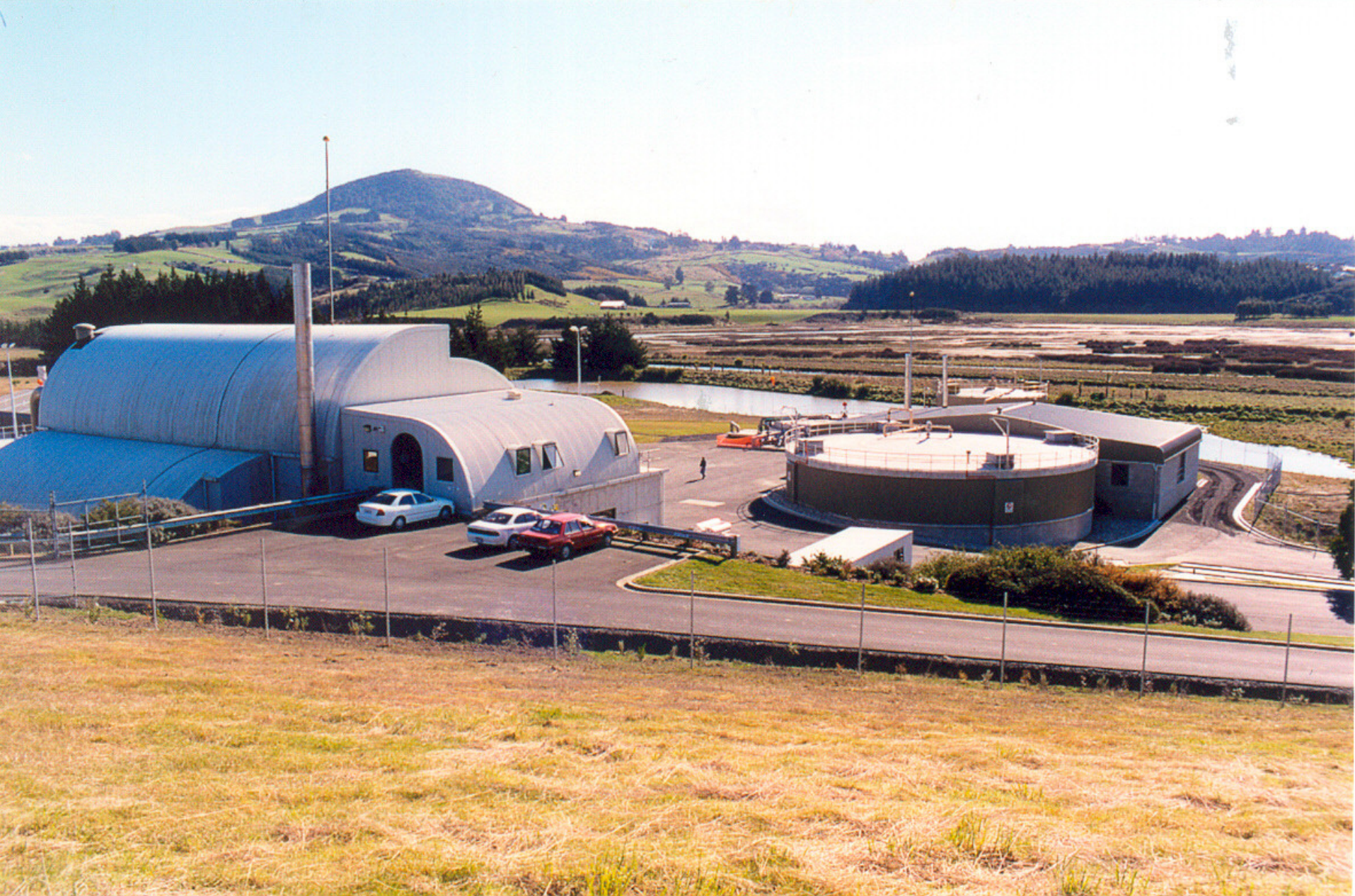
- Start-up February 2001
- Initially operated meso-meso (1yr)
- Then operated thermo-meso (1yr)
- Now operating meso-meso due to spiral heat exchanger blockage – also occurred in Vancouver

Green Island WWTP TPAD

- Domestic 12,000 pop, Industrial 50,000 PE, Max 100,000 PE
- Thermophilic 3 to 5 days
- Mesophilic 20 days retention.
- Based on German TPAD concept
- The only thermophilic system in NZ – maybe Australasia?
- Commissioned mid 2001, stable and reliable performance despite sudden industrial load swings.

Green Island WWTP (continued)

- Thermophilic digester, 500 m³, fixed cover, bolted steel, epoxy coated
- Mesophilic digester 2,700 m³ concrete fixed cover





Green Island WWTP

- Biogas fuelled hot water “boiler” to heat sludge, no other fuel source needed
- Excess gas is flared
- Alfa Laval double spiral heat exchangers
- Sludge to sludge heat exchanger hasn't clogged due to wider passage (25 mm) and 1 mm milliscreens at plant inlet

Green Island Hot Water to Sludge Heat Exchanger



Green Island Sludge to Sludge Heat Exchanger

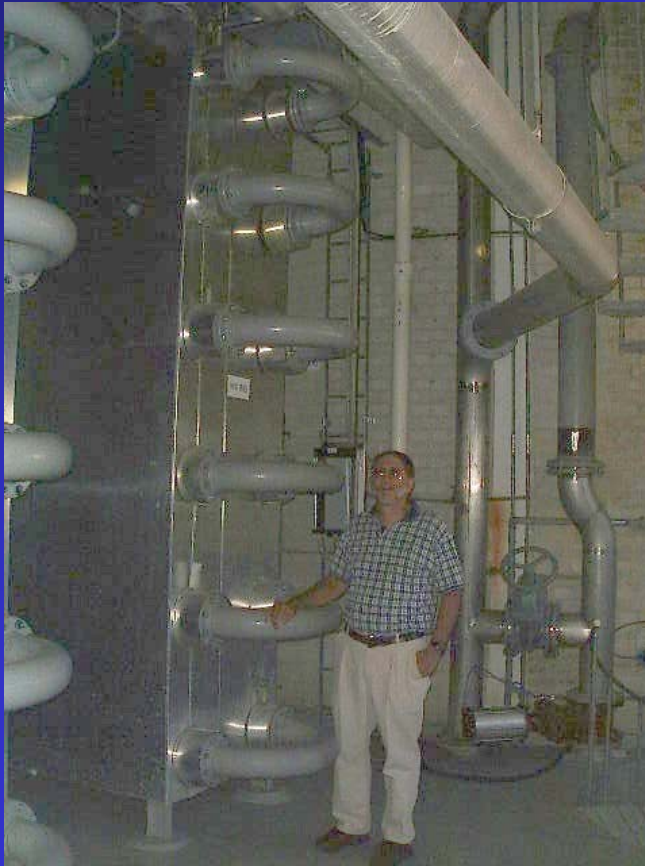


Christchurch WWTP TPAD

- Two new thermophilic digesters under commissioning, each 7000m³ volume
- Thermophilic will be followed by existing four mesophilic digesters in parallel
- Thermophilic chosen for sludge disinfection, increased solids destruction and increased biogas (which is used in cogen engines)
- Selected Lackeby heat exchangers for reduced clogging (also favourable cost and less space required)

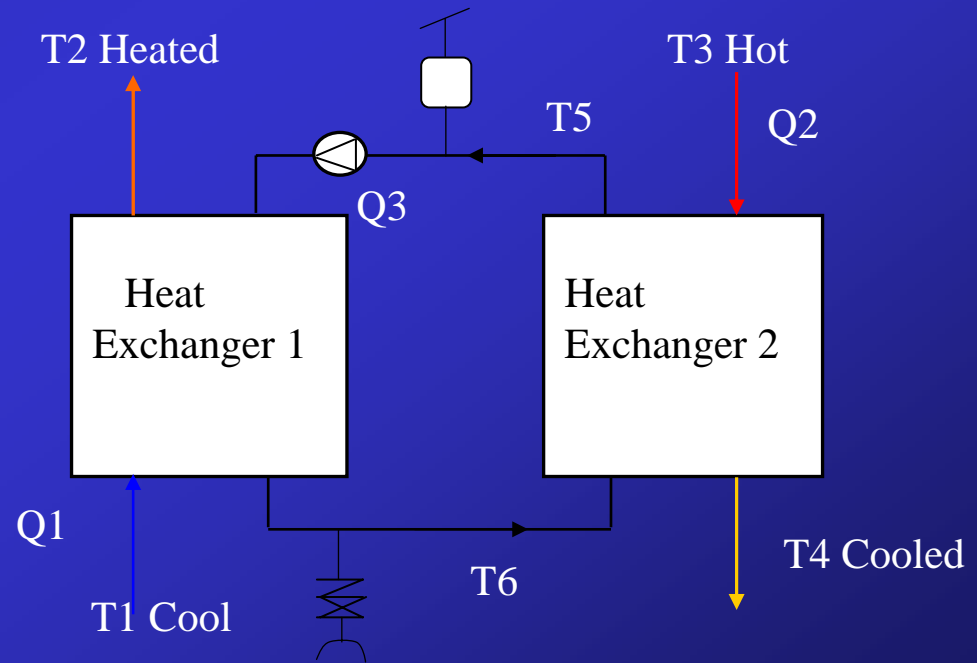
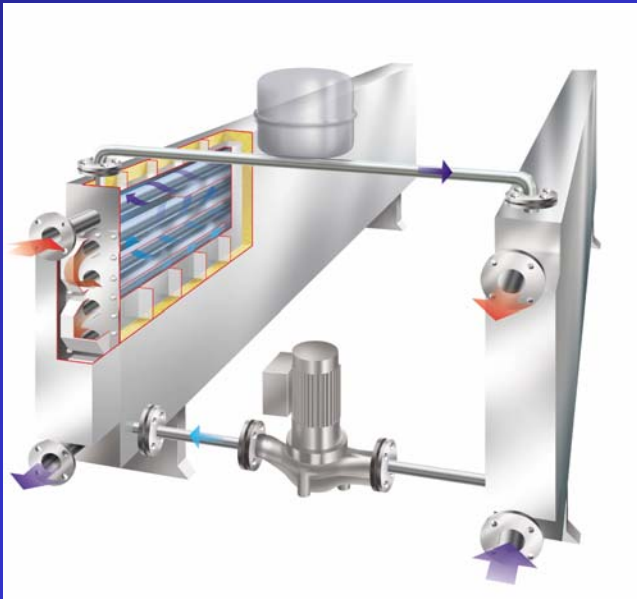


Gässlösa WWTP Borås



Features / Benefits

- Sludge/Sludge with water circulation
 - No risk for contamination of sludge through leakage



Conclusions and Recommendations

- Both acid/gas and TPAD proven in operation in NZ
- Appropriate for medium to large WWTP's with operations expertise
- Can achieve capital and operating cost savings due to increased solids destruction and more biogas, at same or reduced retention time.