

THERMOPHILIC ANAEROBIC DIGESTION WITH ULTRAFILTER PILOT STUDY

Presented to: Biogas Development Group

By

THOMAS C. BACHMAN
TRIAD ENGINEERING INC

In Association With
Marquette University
Frost Farms

Grant Administered by DATCP

Goals

- Maximize biogas production per unit volume of manure
- Provide a stabilized, pathogen free digested material for reuse as bedding
- Create a low solids effluent that will be easier to handle for crop irrigation or byproduct reuse

Proposed Technology

- Thermophilic anaerobic digestion with Ultrafilter
 - Higher temperature than mesophilic
 - 130°F (55°C) vs. 95°F (35°C)
 - Results in Class A Sludge
 - Ultrafilter to increase solids retention and maintain higher biomass concentration in reactor
 - More stabilized sludge
 - More gas production

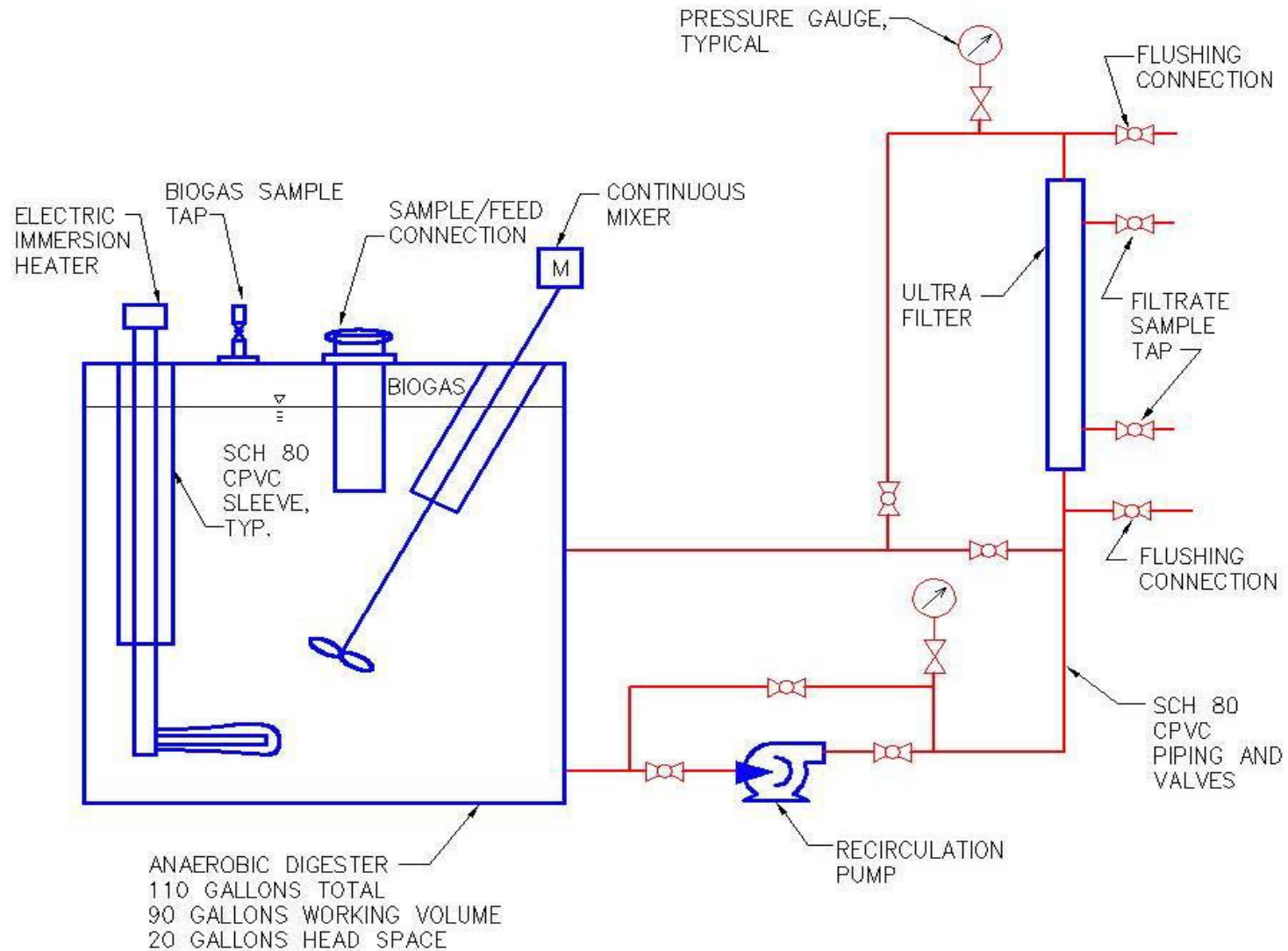
Deficiencies of Current Technologies

- Unmixed plug flow reactor
 - Contact with bacteria and organic matter as well as temperature are not optimal leading to less biogas
- Complete mix heated mesophilic reactor
 - Higher solids in effluent
 - Larger volume needed to improve volatile solids destruction and increase biogas production
 - Sludge is not Class A with respect to pathogens

Deficiencies of Current Technologies

- Two stage temperature phased reactor
 - Performance issues have been documented
 - Limited by solids concentration that can be maintained in the reactor

Pilot Scale System



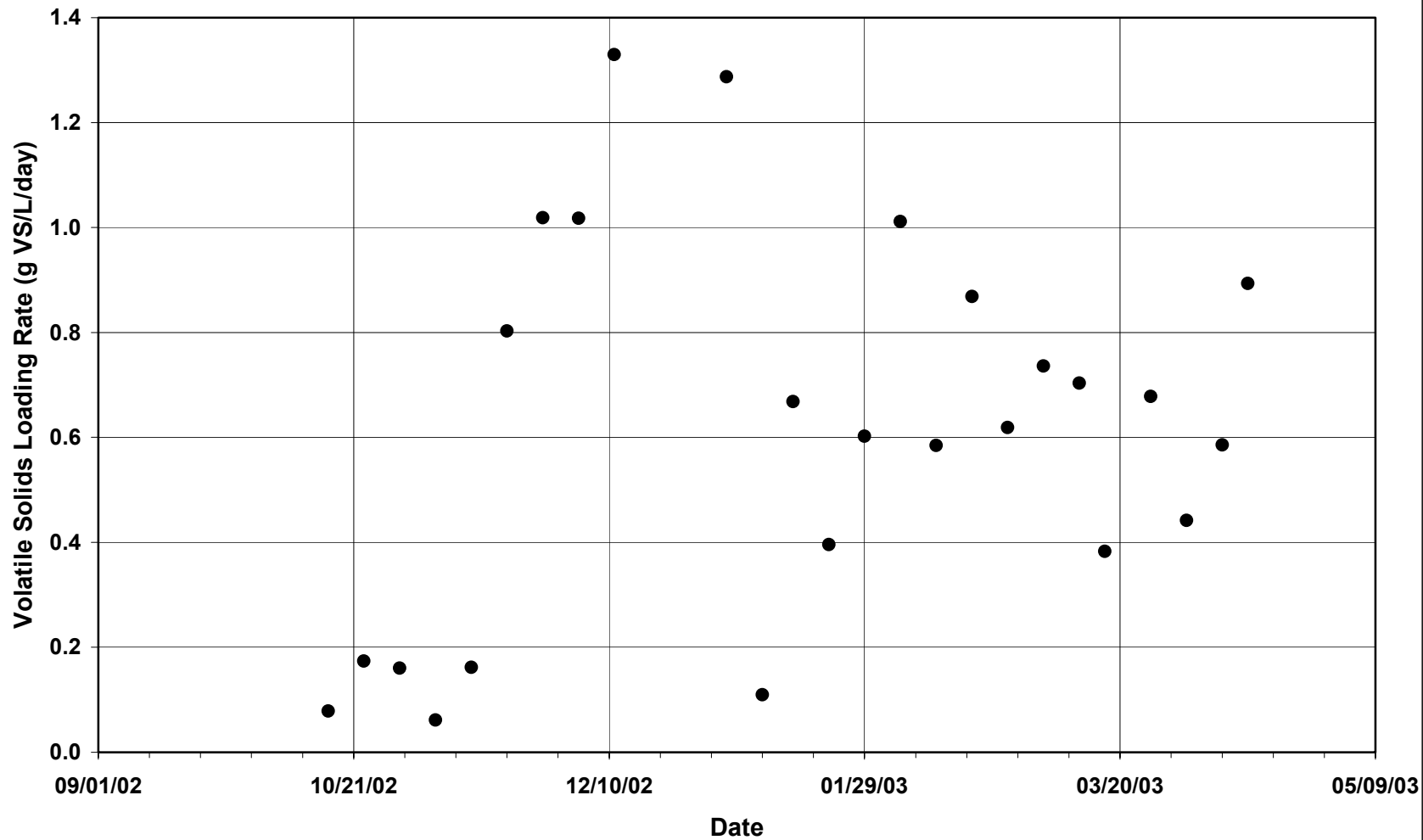
Operational Parameters

- Influent
 - Loading Rate 0.6 to 1.3 g VS/L/d
~2.8 g COD/L/d
 - Coliforms 10 million – 80 million
- Reactor
 - HRT 20 days
 - Temperature $52^{\circ}\text{C} \pm$ (125°F)
 - pH 8.0 S.U.

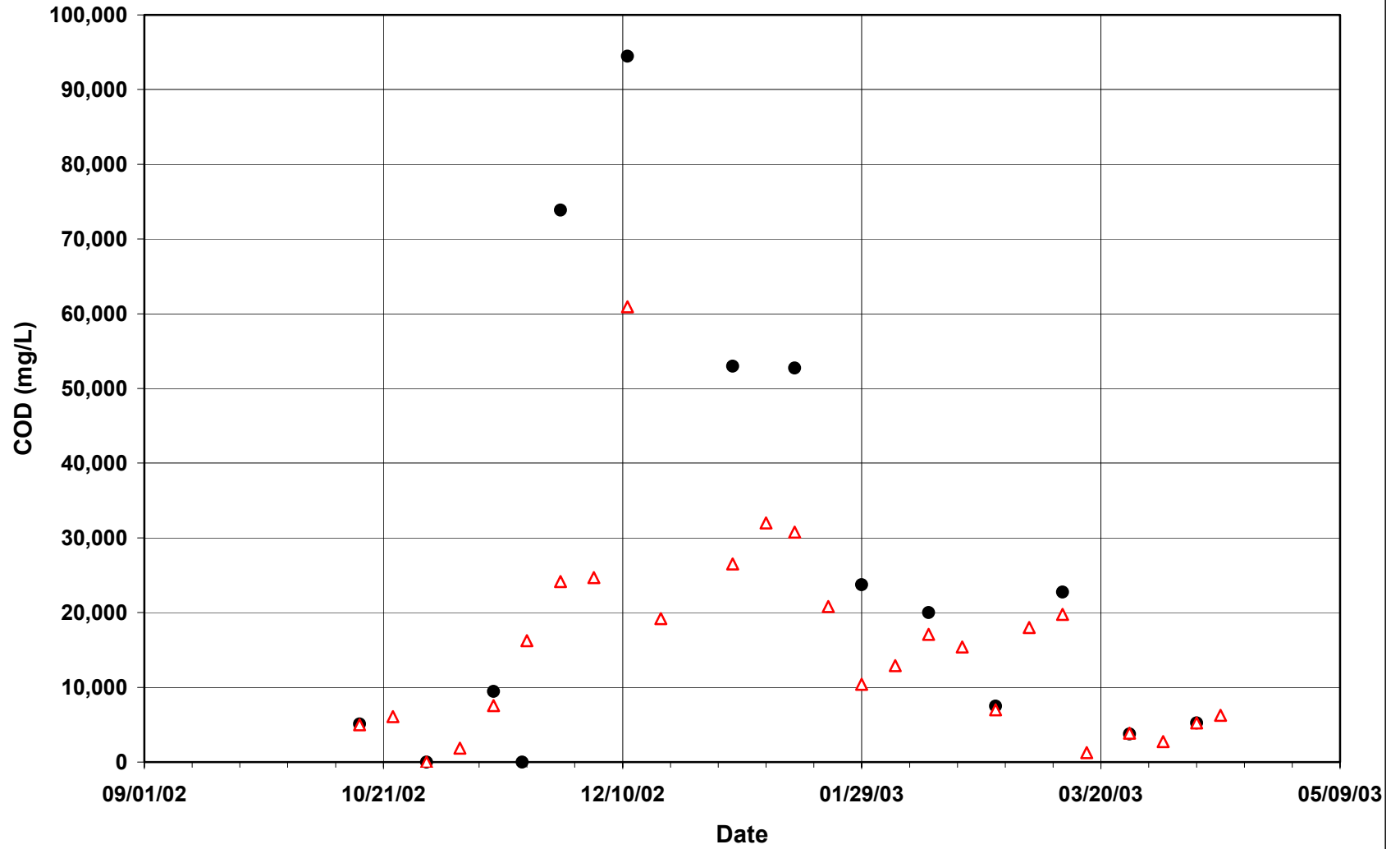
Influent Dairy Manure Wastewater Parameters

	Range	Average
Total COD, mg/L	23,745 - 297,554	79,262
Soluble COD, mg/L	8,772 - 68,093	25,814
Total Solids, mg/L	23,262 - 173,884	68,880
Volatile Solids, mg/L	18,326 - 74,056	42,578
Organic Nitrogen, mg/L	795 - 3,880	1,808
Ammonia Nitrogen, mg/L	428 - 3,530	1,445

Variation in Volatile Solids Loading Rate



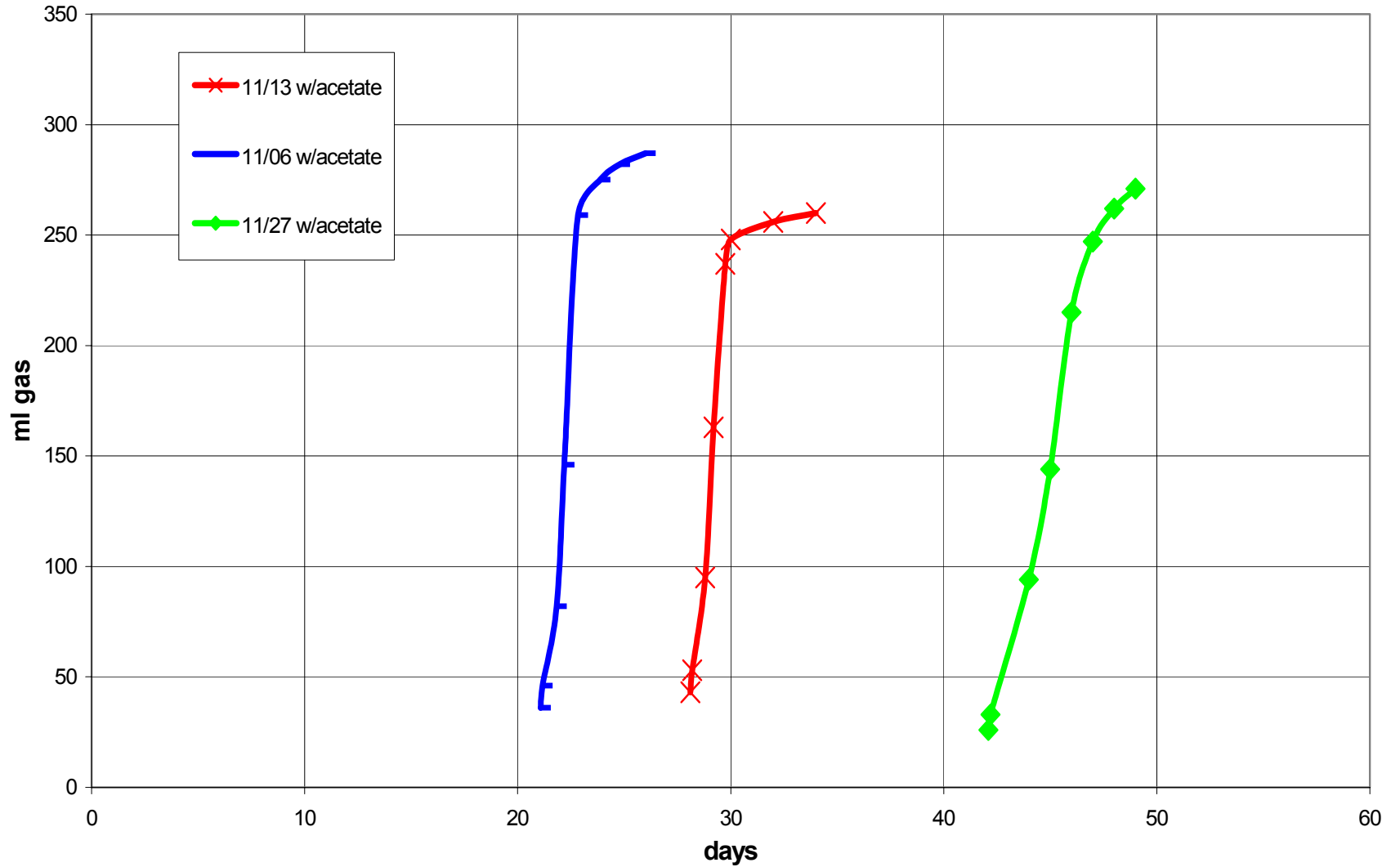
Variation in Effluent COD



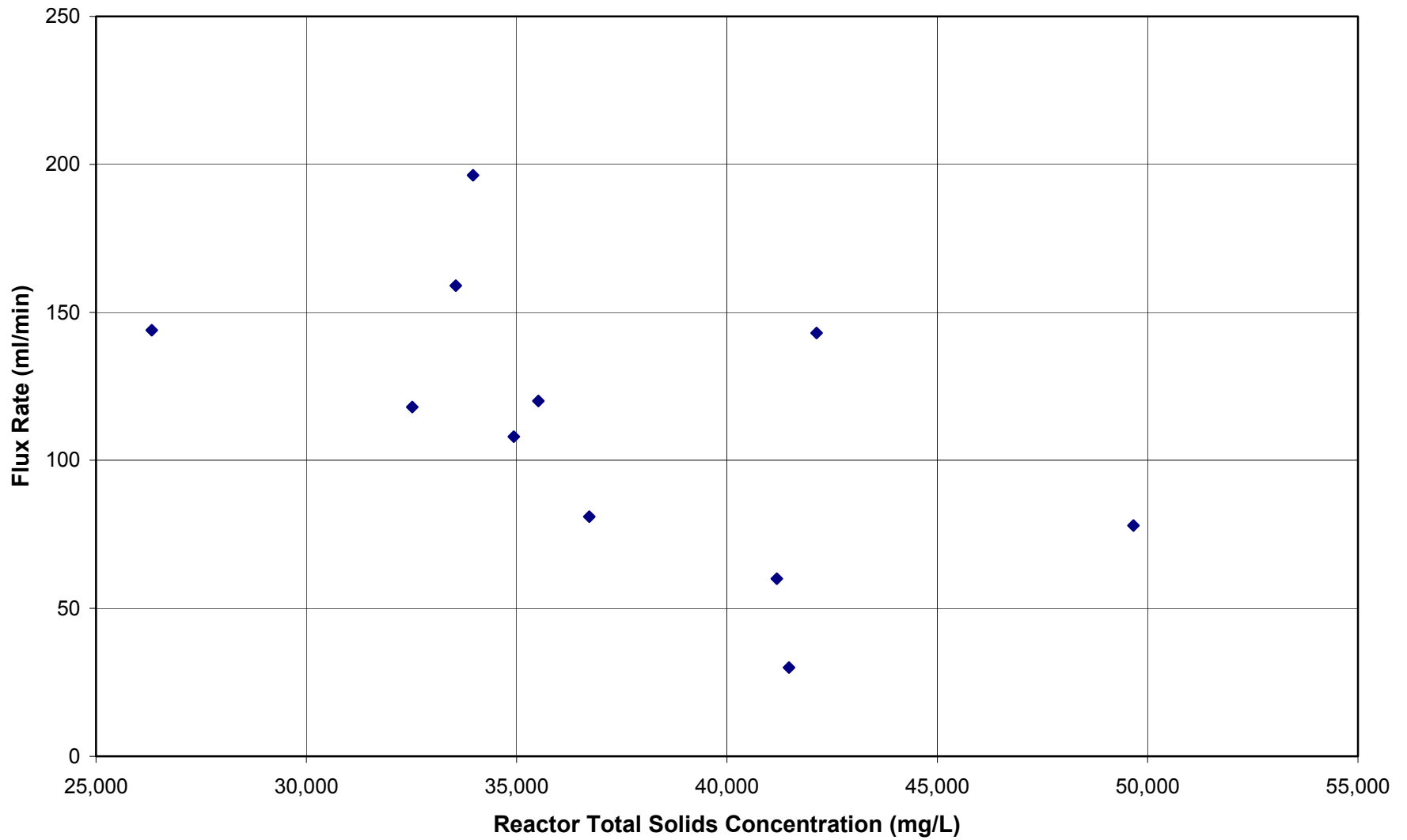
● Total COD

△ Soluble COD

Benchscale Methane Production (BMP)



Ultrafilter Flux Rate Versus Reactor Solids Concentration



Pilot Testing Findings

- Short startup with mesophilic anaerobic sludge to thermophilic
- Greater than 45% destruction of volatile solids on average
- Ultrafilter flux rates – 40 gpd/ft² @ 4% TS
- Gas production 1.0 m³/Kg VSS destroyed (16 ft³/lb VSS)
- Not easily upset with respect to temperature fluctuation

Pilot Testing Findings

- Virtually 100% removal of fecal coliform through ultrafilter
- Virtually no suspended solids or biomass in ultrafilter effluent
- Digested sludge was not odorous
- Effluent VFA less than 300 mg/L

Conclusions

- Mesophilic anaerobic sludge and aerobic activated sludge were used to develop a viable thermophilic system in about 4 weeks
- Thermophilic effluent after stable operation was not noticeably odorous
- High biogas production relative to other systems

Recommendations

- More research is needed to determine economics and expected steady state performance of a full scale system
- Need to optimize ultrafilter performance and cleaning procedure
- Not recommended for high solids manure in excess of 10 percent