

Environmental Operating Solutions

Evaluation of Methanol Feed, Storage and Handling Costs at Municipal Wastewater Treatment Facilities

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Final Report

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Section 1

Evaluation of Methanol Feed, Storage and Handling Costs at Municipal Wastewater Treatment Facilities

Executive Summary

Introduction and Background

Environmental Operating Solutions, Inc. (EOS) provides agriculturally derived products that are utilized in the wastewater treatment industry. EOS's products, Micro C™ and Micro C G™ are used as a supplemental carbon source in wastewater treatment biological denitrification processes.

The need to achieve very low levels of total nitrogen in wastewater treatment plant effluent is driven by water quality based improvement programs for large estuaries such as Chesapeake Bay and Long Island Sound. In other areas of the United States low level nitrogen limits are required for water reuse programs and aquifer protection programs.

Objective of the Study

The objective of the study is to evaluate the cost of construction and operation of a methanol feed carbon source system vs. the use of a Micro C G™, non-flammable, non-hazardous supplemental carbon feed system. Three municipal wastewater treatment facilities in Connecticut designed for methanol use were evaluated for the capital construction costs and operation and maintenance costs associated with the use of methanol on a continuous basis for meeting low level nitrogen discharges. The three facilities evaluated meet the applicable NFPA 30, 820 and OSHA code requirements for the storage and use of flammable liquids at a wastewater treatment facility. The study evaluated only the constructability and cost of these facilities to meet the applicable safety regulations and did not evaluate the suitability of Micro C G™ products as a carbon source at these facilities.

Wastewater treatment facilities that are required to denitrify or remove nitrogen generally employ a fixed film or suspended growth type of process for denitrification. In these processes, supplemental carbon is added when the natural carbon or BOD is not present in sufficient quantities for nitrate reduction and to increase the rate of denitrification in carbon limited facilities. The carbon source is diluted and mixed with the wastewater entering the anoxic zone, denitrification filter or reactor in a typical ratio of 3-5 mg (milligrams) of carbon product to 1 mg of nitrate nitrogen to be reduced.

Along with Micro C™ products, other carbon sources such as methanol and ethanol are utilized in wastewater treatment facilities. Methanol and ethanol are alcohols and are classified as flammable liquids under the Nation Fire Protection Association (NFPA) Flammable and Combustible Liquids Code, NFPA 30 and the United States Department of Transportation (US DOT). Methanol is also classified as a hazardous air pollutant under section 101(14) of the Comprehensive Environmental Responses Compensation and Liability Act (CERCLA). Use of methanol and ethanol at wastewater treatment facilities requires a number of fire protection, leakage prevention and detection systems to be designed and constructed in order to ensure compliance with local, state and federal regulations. In addition, specific training both (initial and ongoing) of plant operation staff and emergency response personnel is required under the Occupational Safety and Health Administration (OSHA), 29 CFR Part 1910, Occupational Safety and Health Standards.

Cost savings indicated in this report concerning capital and operation and maintenance costs would apply to the use of Micro C G™ that does not contain methanol and does not fall under the requirements of NFPA 30.

Capital Cost Evaluation

Three municipal wastewater treatment facilities in Connecticut were evaluated for the costs of construction of methanol delivery, storage and product pumping systems. Two of the facilities are constructed and in full operation using methanol on a year round basis. The other facility is presently under construction and will begin operations when construction is completed in approximately two years.

The three facilities represent a small to medium plant of 3.5 million gallons per day and medium to large facilities of 9 and 11 million gallons per day. In each of the three facilities evaluated a break down of capital construction costs for the methanol storage and feed system is provided. In addition, specific components of the methanol feed system that would be required for a system to meet the requirements of NFPA 30 are also estimated.

Operation and Maintenance Cost Evaluation

Two operating municipal wastewater treatment facilities in Connecticut and one under construction were evaluated for costs associated with the delivery and handling of methanol. Interviews with the treatment plant operations staff were conducted to determine the approximate number of hours that were required annually for safety training and handling of the product.

Summary of Capital and Operations Costs

Wastewater Treatment Facilities	Cheshire, CT	Fairfield, CT	Stratford, CT
Design Flow (MGD)	3.5	9.0	11.0
Estimated construction cost of methanol feed and storage facilities (2007 dollars)	\$550,000	\$260,000	\$315,000
Potential capital cost savings for using a non flammable carbon source (2007 dollars)	\$170,000	\$64,000	\$96,000
% of potential cost savings	31%	25%	30%
Annual operation costs for product handling and safety training (2007 dollars)	\$7,000	\$1,800	\$2,500 estimated for 2009
Current cost for methanol delivered 2007	\$1.71	\$2.19	N/A

Summary and Conclusions

This study reviewed three wastewater treatment facilities designed for the use of methanol meeting the NFPA code sections 30 and 820 for use of flammable and combustible liquids in wastewater treatment facilities. For these three facilities, the costs associated with meeting the required safety codes for the use of flammable and combustible liquids in wastewater treatment facilities added from 25 - 31% to the capital construction cost of the methanol storage, pumping and delivery systems over the use of a non flammable, non-hazardous product.

Other facilities evaluated in the literature have estimated capital costs for methanol feed and storage facilities that are much higher than the Connecticut facilities evaluated in the range of 1.5-4 million dollars. This is the case in particular in California where methanol vapor recovery systems would be required on storage tanks and product delivery stations at wastewater treatment facilities. The potential cost savings of using a non flammable, non hazardous carbon source would be greater in these facilities.

Annual operation costs for training and product delivery were in the range of \$2,000 - \$7,000 per facility. The facilities evaluated were relatively new and have not experienced significant costs related to replacement or repair of specific equipment for methanol use.

Section 4

Capital Cost of Methanol Storage and Handling

4.1 Cheshire Water Pollution Control Facility

The Cheshire Water Pollution Control Facility is 3.5 million gallon per day activated sludge nitrification treatment facility followed by a denitrification upflow filter. Nitrified effluent from the activated sludge process is pumped after secondary clarification to an upflow denitrification filter where methanol is added to the filter influent stream. Methanol provides the necessary carbon source for the denitrifying organisms growing on the filter media. Methanol is stored in two 6,000 gallon concrete encased double wall chemical storage tanks. The tanks are designed for a minimum four hour fire protection rating. The methanol storage facility is located remotely, approximately 170 feet from the denitrification filter building for safety. The NFPA guideline requires that the storage facility be located at least 25 feet from the site property line. All of the facilities evaluated in this report located the methanol storage and pumping facilities remote from other treatment plant process or administrative buildings. The filter building is shown on the left and the methanol storage facility on the right in the photo below.



Figure1 - Cheshire denitrification filter and methanol storage facility

The Cheshire Facility was constructed in 2005 and began operations in mid 2006. The denitrification improvement project cost \$7.4 million dollars for the filter building and methanol storage facility. Cheshire uses approximately 120,000 gallons per year of methanol. The approximate total cost of the methanol storage and pumping facility is \$550,000 (ENR 7939).



Figure 2 - Cheshire methanol storage and pumping facility

The methanol storage and pumping facility consists of the following: two 6,000 concrete encased double wall chemical storage tanks, vapor venting system with flame arrestor, three 18 gallon per hour explosion proof chemical meeting pumps and motors, explosion proof controls, stainless steel valves, piping and fittings, a concrete chemical off loading receiving facility, dilution water feed system, emergency eye wash station and methanol piping and storage leak detection system interconnected into the facility alarm system. All piping from the methanol storage facility to the denitrification filter building is 316L stainless steel double wall containment chemical piping with leak detection monitoring. Methanol is diluted with plant water at the storage and pumping facility before being pumped to the denitrification filter building.

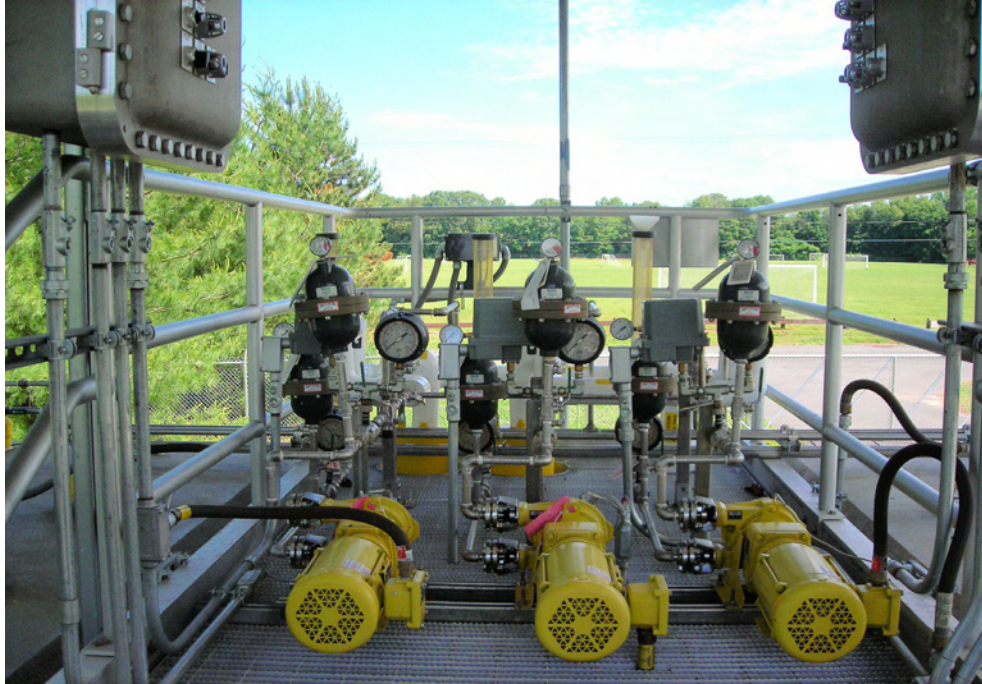


Figure 3 - Cheshire methanol pumping system

The area shown in the above photo and to 5 feet around the methanol storage tanks are classified as a Class I Division I Group D hazardous area under NFPA 70, National Electric Code 2005 and NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities 2003. All electrical equipment in hazardous areas must be explosion proof.

Specific capital items for use of a flammable or combustible carbon source at Cheshire in 2005 dollars:

1. Methanol storage tanks - \$76,700
2. Explosion proof chemical metering pumps - \$42,900
3. Explosion proof fill panel - \$2,000
4. Double wall chemical containment pipe and installation - \$89,400
5. Stainless steel piping, valves, eyewash station and installation - \$17,800

6. Lightning protection for storage facility - \$6,000
7. Fire and leakage alarms systems - \$11,000
8. Heat tracing of eye wash and dilution water systems - \$6,000
9. Contractor general conditions on the above work - \$23,400

Total costs for above items - \$275,200

The above costs represent the specific items that were needed as a requirement of NFPA 30 and 820 codes. Cost for the pre-engineered steel canopy were not shown as it was assumed that a canopy would still be needed regardless of carbon source used.

Potential cost savings areas if a non-flammable, non-hazardous carbon source is used:

1. Locate the chemical storage facility directly adjacent or inside the denitrification filter building. This will eliminate the need for chemical containment piping. The quantity of pipe is greatly reduced and an alternate material such as PVC can be used. Potential savings of \$80,000.
2. Use non-explosion proof rated pumps and motors. Potential savings \$6,000.
3. Use fiberglass reinforced plastic (FRP) tanks. Potential savings \$35,000.
4. Use PVC piping and valves. Potential savings \$8,000.
5. Eliminate the need for lightning protection. Potential savings \$6,000.
6. Eliminate explosion proof fill panel. Potential savings \$2,000.
7. Eliminate fire and leakage alarm system. Potential savings \$11,000.
8. Eliminate eye wash station. Potential savings \$6,000.
9. Contractor general conditions on the above work – Potential savings \$16,000.

Total potential cost savings - \$170,000

The above cost savings assume that a similar structure (and costs) would still be needed to house the storage tanks and pumps. The cost savings analysis was based on review of the completed project cost estimate and schedule of values for the project.

December 2004 ENR construction cost index 7308 (project bid date)

June 2007 ENR construction cost index 7939

Total potential cost savings updated to June 2007 dollars - \$184,000



Single wall reinforced fiber glass tanks can be used as a lower cost alternate to double wall fire rated concrete tanks for Micro C G™ storage.

4.2 Stratford Water Pollution Control Facility

The Stratford Water Pollution Control Facility is an 11 million gallon per day four stage activated sludge nitrogen removal facility. The process employs two anoxic zones. The first zone uses primary effluent as a carbon source. The second anoxic zone will use methanol as the carbon source. The facility is presently under construction and is scheduled to be completed in 2009. The Stratford facility project began construction in late 2006. The total project construction cost is \$49.5 million dollars. The approximate cost of the methanol pumping and storage facilities is \$315,000. Methanol use for this facility has not been established as the facility is presently under construction. Expected use for this size facility using methanol only in the 2nd anoxic zone would be in the range 100 gallons per day or approximately 36,000 gallons per year.

Methanol is proposed to provide the necessary carbon source for the denitrifying organisms in the second anoxic zone in order to denitrify the available nitrate nitrogen in this zone to very low levels. Naturally available carbon is very limited in the second anoxic zone and longer hydraulic detention times are needed without the use of a supplemental carbon source. Methanol is to be stored in a single 5,200 gallon concrete encased double walled fire rated chemical storage tank with a vapor venting system and flame arrestor. These facilities will be located at the southern end of the site next to the anoxic tanks. The tank is to be located on a concrete pad next to the methanol feed pumps and electrical equipment that are located small building (200 square feet) next to the methanol tank. This building is divided in half with one half containing the pumping equipment consisting of 3 explosion proof chemical feed pumps that are NFPA 70 classified as Division 1 Group D hazardous. The other side of the building contains the electrical, methanol leak and gas detection equipment and is not classified as hazardous.

Specific capital items for use of a flammable or combustible chemical in Stratford in 2006 dollars:

1. Methanol storage tank with leak detection \$45,000
2. Double wall chemical pipe \$60,000
3. Methanol feed pumping system with stainless steel valves \$39,000
4. Emergency eye wash station \$8,000
5. Contractor general conditions \$12,100

Total cost for the above items \$164,100

Potential cost savings if a non-flammable, non-hazardous carbon source is used.

1. Use an alternate fiberglass-reinforced plastic (RFP) tank. Potential savings \$18,000.
2. Use single wall PVC pipe in place of double wall chemical pipe. Potential savings \$40,000.
3. Use non-explosion proof pumps and motors for chemical feed pumps and PVC valves. Potential savings \$10,500.
4. Eliminate the need for emergency eye wash station. Potential savings \$8,000.
5. Eliminated leak detection and gas alarm system. Potential savings \$12,000
6. Contractor general conditions on the above work \$7,100

Total potential cost savings \$95,600

The cost-savings analysis was based on review of the project cost estimate and schedule of values for the project.

October 2006 ENR construction cost index 7883 (project bid date)

June 2007 ENR construction cost index 7939

Total potential cost savings updated to June 2007 dollars - \$96,280

4.3 Fairfield Water Pollution Control facility

The Fairfield Water Pollution Control Facility is a 9 million gallon per day four stage activated sludge nitrogen removal facility. The process employs two anoxic zones. The first zone uses primary effluent as a carbon source. The second anoxic zone uses methanol as the carbon source. The facility has been in operation since 2003. The total wastewater treatment plant project construction cost was 40.5 million dollars. The approximate cost of the methanol pumping and storage facilities was \$260,000 in 2007 dollars. Methanol use for this facility has been in the range of 25,000-30,000 gallons per year. The original three methanol pumps at the facility were recently replaced with higher capacity pumps at a cost of \$16,000.

Methanol is used to provide the necessary carbon source for the denitrifying organisms in the second anoxic zone in order to denitrify the available nitrate nitrogen in this zone to very low levels. Naturally available carbon is very limited in the second anoxic zone and longer hydraulic detention times are needed without the use of a supplemental carbon source. Methanol is to be stored in two 4,000 gallon concrete encased double walled fire rated chemical storage tanks with a vapor venting system. The methanol facility is located adjacent to the secondary anoxic tanks where methanol is pumped to each of the three secondary anoxic tanks. The methanol feed system in Fairfield does not dilute the methanol before pumping to the secondary anoxic tanks as with the other facilities evaluated. The methanol tanks are located on a concrete pad next with the methanol feed pumps on a steel platform above the methanol tanks. Electrical equipment is located in the septage pumping building near the methanol storage tanks. The pumping equipment consisting of 3 explosion proof chemical feed pumps that are NFPA 70 classified as Division 1 Group D hazardous.



Fairfield Water Pollution Control Facility methanol storage facility

Specific capital items for use of a flammable or combustible chemical in Fairfield in updated to June 2007 (ENR 7939) dollars:

1. Two 4,000 gallon double walled insulated methanol storage tanks \$70,000
2. Stainless steel chemical pipe \$20,000
3. Methanol feed pumping system with stainless steel valves \$35,000
4. Emergency eye wash station \$10,000
5. Contractor general conditions \$13,500

Total cost for the above items \$165,000



Fairfield Water Pollution Control facility explosion proof methanol pumps



Fairfield methanol feed piping to secondary anoxic tanks

Potential cost savings if a non-flammable, non-hazardous carbon source is used.

1. Use an alternate fiberglass-reinforced plastic (RFP) tanks. These tanks could be located inside the existing septage building, potential savings \$35,000.
2. Use single wall PVC pipe in place of stainless steel chemical pipe, potential savings \$5,000.
3. Use non-explosion proof pumps and motors for chemical feed pumps and PVC valves, potential savings \$8,000.
4. Eliminate the need for emergency eye wash station, potential savings \$10,000.
5. Contractor general conditions on the above work \$6,000

Total potential cost savings updated to June 2007 (ENR 7939) dollars = \$64,000

The cost-savings analysis was based on review of the schedule of values for the project.

Section 5

Operation and Maintenance Cost Evaluation

Three facilities were evaluated for annual operations costs specific to plant staff labor costs relating to the use of methanol. Cheshire and Fairfield are existing facilities that are presently using methanol and Stratford is presently under construction and scheduled start up in early 2009. The costs provided for Fairfield and Cheshire are based on information provided by plant operations staff at each facility. Stratford costs are estimates based on the projected use of methanol in 2009. Staff labor at each facility was based on an estimated cost of \$40/hour including benefits.

5.1 Cheshire Water Pollution Control Facility

The Cheshire Wastewater Treatment facility is a 3.5 million gallon per day activated sludge nitrification plant followed by an up flow denitrification filter. The denitrification filter process began operations in 2006 and uses approximately 120,000 gallons of methanol per year. The current cost (2007) for methanol for Cheshire delivered is \$1.71/gallon or approximately \$205,000 for the year. The facility spends 18 man hours per year on chemical safety training and additional 10 hours per year on related administrative record keeping. Approximately 140 hours per year are spent for safe product delivery and inspection of equipment. The facility receives 20 tank truck deliveries per year of 6,000 per truck load. Two treatment plant staff personnel are assigned to each product delivery as safety personnel during this process. This equates to approximately \$7,000 per year for treatment plant staff labor for this facility.

5.2 Fairfield Water Pollution Control Facility

The Fairfield Wastewater Treatment facility is a 9.0 million gallon per day four stage activated sludge nitrogen removal facility. The process employs two anoxic zones. The first zone uses primary effluent as a carbon source. The second anoxic zone uses methanol as the carbon source. The facility has been in operation since 2003. Fairfield began using methanol in 2003 and uses approximately 26,000 gallons of methanol per year. The current cost (2007) for methanol for Fairfield delivered is \$2.19/gallon or approximately \$57,000 for the year. The facility spends 26 man hours per year on chemical safety training. Approximately 20 hours per year are spent for safe product delivery and inspection of equipment. The facility typically receives 4 tank truck deliveries per year of 6,000 per truck load. Three treatment plant staff personnel are assigned to each product delivery. Two staff personnel are in full protective equipment and the third is a supervising safety person who remotely observes the

delivery process. This equates to approximately \$1,800 per year for treatment plant staff labor for this facility.



The Fairfield methanol storage and pumping facility, Fairfield uses three treatment plant staff to safely supervise product delivery.

5.3 Stratford Water Pollution Control Facility

The Stratford Wastewater Treatment facility is presently under construction and will have a capacity of 11 million gallons per day when completed in 2009. The treatment process is a four stage activated sludge nitrogen removal system. The process will employ two anoxic zones. The first zone uses primary effluent as a carbon source. The second anoxic zone will use methanol as the carbon source. It is estimated the facility will use approximately 100 gallons per day or 36,500 gallons per year of methanol. It is estimated the initial safety training will be approximately 60 man hours. Thereafter, annual training will be approximately 30 hours per year on chemical safety training. It is estimated the facility will receive six deliveries of 6,000 gallons per year. This will require Approximately 25 hours per year for safe product delivery and inspection of equipment. This results in approximately \$2,500 per year for training and product delivery.

Section 6

Conclusions

This study reviewed three wastewater treatment facilities designed for the use of methanol meeting the NFPA code sections 30 and 820 for use of flammable and combustible liquids in wastewater treatment facilities. For these three facilities, the costs associated with meeting the required safety codes for the use of flammable and combustible liquids in wastewater treatment facilities added from 25 – 31% to the capital construction cost of the methanol storage, pumping and delivery systems over the use of a non flammable non-hazardous product.

Annual operation costs for training and product delivery were in the range of \$1,800 - \$7,000 per facility. The facilities evaluated that currently use methanol were relatively new and have not experienced significant costs related to replacement or repair of specific equipment for methanol use.

Section 7

References

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