Update on Biogas Cleanup Survey & Cost Estimator Toolkit

Alfonso Baez
Program Supervisor
Best Available Control Technology
Technology Advancement Office

Biogas Cleanup Survey

- 16 manufacturers/vendors and developers of biogas cleanup systems (fuel cells, engines, turbines, etc.) with a main focus on siloxane removal technologies for engine applications were identified
- Vendor survey questionnaire was developed and sent for obtaining both cost and supporting data for their cleanup systems

Biogas Cleanup Survey (cont'd)

- Nine vendors provided cost data.
  - Six could remove all contaminants and siloxanes to the required levels for SCR post-combustion catalyst
  - Three were suited for removing siloxanes to the required levels for SCR post-combustion catalyst.
  - Contaminants considered for the cleanup system are siloxanes, H_2S, other sulfur compounds, volatile organics and halogenated organics

Cost Estimator Tookit

- Toolkit is an Excel-based calculation spreadsheet that determines the capital (equipment), installation and annualized operating and maintenance (O&M) costs of a siloxane removal system
- Targeted for SCR-equipped lean-burn spark ignition (SI) engines 200-4300 BHP (150-3200 kW).
- Toolkit was based only on vendor survey cost data since this would be a more effective source of procuring data as opposed to using outdated and/or unverifiable literature data

Cost Estimator Tookit (cont'd)

- System equipment and O&M costs as a function of biogas flow rate (200, 500 and 1000 SCFM) were received
- Regression analysis of the vendor cost data was performed to obtain correlations for use in the toolkit
- Correlations applied to the user input data for estimation of the capital, installation and final annualized costs for the cleanup system
- Development of an algorithm to offset annual operating costs via installation of the biogas cleanup system is being developed for incorporation in the toolkit

Input Data

Cost Item	User Input	Default Value
Engine	kW or BHP	NA
Biogas		
Flow	SCFM	NA
Siloxanes	mg/M^3 (as Si)	NA
H_2S	ppmv	NA
Other sulfur compounds	ppmv	NA
VOCs	ppmv	NA
Halogenated hydrocarbons	ppmv	NA
DIRECT CAPITAL COSTS (DCC) ESTIMATION FACTORS		
(1) System Auxiliary Equipment (control panel, etc.)	%	5.0%
(2) Freight	%	5.0%
(3) Sales Tax	%	8.0%
Subtotal: Total Equipment Cost (TEC) Estimation Factors		
(a) Foundation and Structural Support	%	8.0%
(b) Handling & Erection	%	5.0%
(c) Electrical	%	16.0%
(d) Piping	%	16.0%
(e) Insulation	%	1.0%
INDIRECT CAPITAL COSTS (ICC) ESTIMATION FACTORS		
(1) Indirect Installation Costs		
(a) General Facilities	%	5.0%
(b) Engineering and Home Office Fees	%	5.0%
(c) Process Contingency	%	10.0%
(2) Other Indirect Costs		
(a) Emissions Monitoring	%	
(b) Performance Testing	%	1.0%
(c) Spare Parts	%	1.0%
(d) Contractor Fees	%	10.0%
PROJECT CONTINGENCY ESTIMATION FACTOR	%	15.0%
DIRECT OPERATING COSTS (DOC) ESTIMATION FACTORS		
(1) Operating Labor		
Operator		
hr per shift	# hrs	0.50
Labor cost per hour	$	$30
hrs per year	# hrs	8760
Supervisor	%	15.0%
(2) Maintenance (labor and material)	%	1.5%
(3) System Energy Requirement	%	TBD
(3) Removal Media Replacement	%	35.0%
(4) System Calibration	%	TBD
Total DOC:		
INDIRECT OPERATING COSTS (IOC) ESTIMATION FACTORS		
(1) Overhead	%	60.0%
(2) Property Taxes	%	1.0%
(3) Insurance	%	1.0%
(4) Administration	%	2.0%
CAPITAL RECOVERY COSTS (CRC) ESTIMATION FACTOR	%	9.4%

Output Data

SILOXANE REMOVAL SYSTEM CAPITAL AND ANNUAL COSTS CALCULATION

Cost Items	Cost Factors	Factor	Siloxane Removal System Cost ($)
DIRECT CAPITAL COSTS (DCC):			
(1) Siloxane Removal System	Vendor Quote (equipment cost)		175,000
Auxiliary Equipment (control panel, etc.)	5% of equipment cost	5.0%	8,750
(2) Freight	5% of equipment cost, CCM Chapter 2	5.0%	8,750
(3) Sales Tax	NA - Pollution Control Equipment	8.0%	15,400
Subtotal: Total Equipment Cost (TEC)			**207,900**
(4) Direct Installation Costs			
(a) Foundation and Structural Support	8% of TEC, Cost Control Manual (CCM), Section 3, Table	8.0%	16,632
(b) Handling & Erection	14% of TEC, CCM, Section 3, Table 2.8	5.0%	10,395
(c) Electrical	16% of TEC, Engineering Estimate	16.0%	33,264
(d) Piping	16% of TEC, Engineering Estimate	16.0%	33,264
(e) Insulation	1% of TEC, CCM, Section 3, Table 2.8	1.0%	2,079
Subtotal: Total Direct Installation Costs (DIC)			**95,634**
Total DCC:			**303,534**
INDIRECT CAPITAL COSTS (ICC): (b)			
(1) Indirect Installation Costs			
(a) General Facilities	5% of TEC, CCM Section 4, Table 2.5	5.0%	10,395
(b) Engineering and Home Office Fees	10% of TEC, CCM Section 4, Table 2.5	5.0%	19,250
(c) Process Contingency	5% of TEC, CCM Section 4, Table 2.5	10.0%	9,625
(2) Other Indirect Costs			
(a) Emissions Monitoring	Engineering Estimate		5,000
(b) Performance Testing	1% of TEC, CCM Section 3, Table 2.8	1.0%	1,925
(c) Spare Parts	Engineering Estimate	1.0%	5,000
(d) Contractor Fees	10% of TEC, CCM Section 3, Table 2.8	10.0%	19,250
Total ICC:			**70,445**
PROJECT CONTINGENCY	15% of (DCC+ICC)	15.0%	**56,097**
TOTAL CAPITAL INVESTMENT (Total Plant Cost) (TCI):	DCC + ICC + Project Contingency		**430,076**
DIRECT OPERATING COSTS (DOC): (b)			
(1) Operating Labor			
Operator	1/2 hr/shift, $30/hr, 8760 hrs/yr		16,425
Supervisor	15% of operator cost	15.0%	2,464
(2) Maintenance (labor and material)	1.5% of TCI, CCM Section 4, Equation 2.46	1.5%	6,451
(3) Siloxane System Energy Requirement	6-in ΔP, 48 MW/year, $60/MW		2,880
(3) Siloxane Removal Media Replacement	Vendor estimate, 35% of Equipment, Media Life 1/2 year	35.0%	61,250
(4) Siloxane System Calibration	Vendor or Engineering Estimate- about $500K for 5 years		100,000
Total DOC:			**189,470**
INDIRECT OPERATING COSTS (IOC): (b)			
(1) Overhead	60% of oper. labor & maintenance, CCM Chapter 2	60.0%	15,204
(2) Property Taxes	1% of total capital investment, CCM Chapter 2	1.0%	4,301
(3) Insurance	1% of total capital investment, CCM Chapter 2	1.0%	4,301
(4) Administration	2% of total capital investment, CCM Chapter 2	2.0%	8,602
Total IOC:	(1) + (2) + (3) + (4)		**32,407**
CAPITAL RECOVERY COSTS (CRC):	CRF of 0.0944 times TCI (20 yrs @ 7%)	9.4%	**40,599**
ANNUALIZED COSTS (AC):	DOC + IOC + CRC		**262,476**

Questions/Contact

- Rule Development

  Kevin Orellana

  (909) 396-3492

  korellana@aqmd.gov

- BACT/GTI Project

  Al Baez

  (909) 396-2516

  abaez@aqmd.gov