Appendix C

BAT Cost Calculations

BP Toledo - SCR Cost Analysis (Crude 1 furnace 450 mmbtu/hr total) Total Capital Investment		
SCR System for NOx removal from 40 ppm to 4 ppm		
Item	**Basis**	**Cost**
Direct Costs		
(1) Purchased Equipment		
SCR System	Vendor Quote (adjusted)	$2,750,722
Ammonia Storage and Pumping	*SCR quote for larger furnace has*	Incl. in above
Initial Catalyst Charge	*been scaled to TFO furnace using*	Incl. in above
	ratio of sizes raised to 0.6 power.	
(a) Total Equipment		$2,750,722
(b) Freight (0.05 x [1a])	OAQPS, Sect. 1, Table 2.4	$137,536
(c) Sales Tax (0.06 x [1a])	OAQPS, Sect. 1, Table 2.4	$165,043
(d) Instrumentation (0.10 x [1a])	OAQPS, Sect. 1, Table 2.4	$275,072
Total Purchased Equipment Cost, PEC [1a thru 1d]		$3,328,374
(2) Direct Installation (0.083 x PEC)	Peters & Timmerhaus, 1991	$276,255
(3) Instrumentation Controls (installed) (0.02 x PEC)	P & T, 1991	$66,567
(4) Piping (installed) (0.073 x PEC)	P & T, 1991	$242,971
(5) Electrical (installed) (0.046 x PEC)	P & T, 1991	$153,105
TOTAL DIRECT COST (TDC) (1thru 5)		$4,067,273
Indirect Costs		
(6) Indirect Installation		
(a) General Facilities (0.05 * TDC)	OAQPS, Sect. 4, Table 2.5	$203,364
(b) Engineering and Home Office Fees (0.10 * TDC)	OAQPS, Sect. 4, Table 2.5	$406,727
(c) Process Contingency (0.05 * TDC)	OAQPS, Sect. 4, Table 2.5	$203,364
(7) Other Indirect Costs		
(a) Startup & Performance Tests (0.08 x TDC)	P & T, 1991	$325,382
TOTAL INDIRECT COST (TIC) (6+7)		$1,138,836
Project Contingency		
(8) Project Contingency ((TDC + TIC) * 0.15)	OAQPS, Sect. 4, Table 2.5	$780,916
Total Plant Cost (TIC + TDC + Cont.)		**$5,987,026**
(9) Preproduction Cost (0.02 * TPC)	OAQPS, Sect. 4, Table 2.5	$119,741
(10) Initial Chemical Inventory (NH3)	OAQPS, Sect. 4, Table 2.5	
SUMMARY		
TOTAL CAPITAL INVESTMENT (TCI)		**$6,106,767**

Appendix C

BAT Cost Calculations

BP Toledo BAT Cost Effectiveness Analysis for SCR (Crude 1)

Unit Characteristics

Crude 1 Heater Firing Rate	MMBtu/hr	=	450
H	= annual operating hours	=	8,760
Catalyst Cost for one charge	URS Estimate		82,212
NO_x removal by SCR control	= tpy NO_x	=	70.96
N (Ammonia requirement, ton/yr)	= (tpy NO_x removed) (MW NH_3, 17/ MW NO_x, 46)	=	26.22

Costs

A. Total capital investment, $	See Separate TCI Spreadsheet	=	$6,106,767
B. Direct Annual Costs, $/yr			
1. Operating labor	= (1.0/8 hr shift) x ($25/hr) x (H)	=	$27,375
2. Supervisory labor	= (0.15) x (operating labor)	=	$4,106
3. Maintenance labor and materials	= (0.015 * TCI)	=	$91,601
4. Catalyst replacement	= Cost x 0.2439 (CRF for 5 yrs, 7%)	=	$20,051
5. Catalyst disposal		=	$0
6. Ammonia (anhydrous)	= (N) x ($425/ ton)	=	$11,145
7. Natural Gas	= 1% * firing rate * Operating Hrs / 1000 Btu/scf * $6/Mscf *	=	$236,520
TOTAL DIRECT COSTS			**$390,799**
C. Indirect Annual Costs, $/yr			
1. Overhead	= (0.6) x (all labor and maintenance material costs)	=	$73,850
2. Property Taxes, insurance, admin.	= (0.04) x (total capital investment)	=	$244,271
3. Capital recovery	= (0.1098) x [total capital investment - catalyst replacement cost)]	=	$661,496
TOTAL INDIRECT COSTS			**$979,616**
Total Annual cost	**= (Direct Annual Costs) + (Indirect Annual Costs)**	**=**	**$1,370,415**

Cost Effectiveness

NOx Emissions from Unit without SCR	= tpy NOx	=	78.8
NOx Removal from SCR	= tpy NOx, 90% of uncontrolled	=	71.0
Cost Effectiveness	***$/tons NOx***	=	***$19,313.59***

- The capital recovery factors assumes a 15 year equipment life, catalyst replaced every 5 yrs, and 7% interest.

Appendix C

BAT Cost Calculations

BP Toledo - SCR Cost Analysis (Vacuum 1 Furnace - 150 MMBtu/hr) Total Capital Investment		
SCR System for NOx removal from 40 ppm to 4 ppm		
Item	**Basis**	**Cost**
Direct Costs		
(1) Purchased Equipment		
SCR System	Vendor Quote (adjusted)	$1,422,899
Ammonia Storage and Pumping	*SCR quote for larger furnace has been scaled to TFO furnace using ratio of sizes raised to 0.6 power.*	Incl. in above
Initial Catalyst Charge		Incl. in above
(a) Total Equipment		$1,422,899
(b) Freight (0.05 x [1a])	OAQPS, Sect. 1, Table 2.4	$71,145
(c) Sales Tax (0.06 x [1a])	OAQPS, Sect. 1, Table 2.4	$85,374
(d) Instrumentation (0.10 x [1a])	OAQPS, Sect. 1, Table 2.4	$142,290
Total Purchased Equipment Cost, PEC [1a thru 1d]		$1,721,708
(2) Direct Installation (0.083 x PEC)	Peters & Timmerhaus, 1991	$142,902
(3) Instrumentation Controls (installed) (0.02 x PEC)	P & T, 1991	$34,434
(4) Piping (installed) (0.073 x PEC)	P & T, 1991	$125,685
(5) Electrical (installed) (0.046 x PEC)	P & T, 1991	$79,199
TOTAL DIRECT COST (TDC) (1thru 5)		$2,103,927
Indirect Costs		
(6) Indirect Installation		
(a) General Facilities (0.05 * TDC)	OAQPS, Sect. 4, Table 2.5	$105,196
(b) Engineering and Home Office Fees (0.10 * TDC)	OAQPS, Sect. 4, Table 2.5	$210,393
(c) Process Contingency (0.05 * TDC)	OAQPS, Sect. 4, Table 2.5	$105,196
(7) Other Indirect Costs		
(a) Startup & Performance Tests (0.08 x TDC)	P & T, 1991	$168,314
TOTAL INDIRECT COST (TIC) (6+7)		$589,099
Project Contingency		
(8) Project Contingency ((TDC + TIC) * 0.15)	OAQPS, Sect. 4, Table 2.5	$403,954
Total Plant Cost (TIC + TDC + Cont.)		**$3,096,980**
(9) Preproduction Cost (0.02 * TPC)	OAQPS, Sect. 4, Table 2.5	$61,940
(10) Initial Chemical Inventory (NH3)	OAQPS, Sect. 4, Table 2.5	
SUMMARY		
TOTAL CAPITAL INVESTMENT (TCI)		**$3,158,920**

Appendix C

BAT Cost Calculations

BP Toledo BAT Cost Effectiveness Analysis for SCR (Vacuum 1)

Unit Characteristics

Vac 1 Heater Firing Rate	MMBtu/hr	=	150
H	= annual operating hours	=	8,760
Catalyst Cost for one charge	URS Estimate		21,635
NO_x removal by SCR control	= tpy NO_x	=	23.65
N (Ammonia requirement, ton/yr)	= (tpy NO_x removed) (MW NH_3, 17/ MW NO_x, 46)	=	8.74

Costs

A. Total capital investment, $	See Separate TCI Spreadsheet	=	$3,158,920
B. Direct Annual Costs, $/yr			
1. Operating labor	= (1.0/8 hr shift) x ($25/hr) x (H)	=	$27,375
2. Supervisory labor	= (0.15) x (operating labor)	=	$4,106
3. Maintenance labor and materials	= (0.015 * TCI)	=	$47,384
4. Catalyst replacement	= Cost x 0.2439 (CRF for 5 yrs, 7%)	=	$5,277
5. Catalyst disposal		=	$0
6. Ammonia (anhydrous)	= (N) x ($425/ ton)	=	$3,715
7. Natural Gas	= 1% * firing rate * Operating Hrs / 1000 Btu/scf * $6/Mscf *	=	$78,840
TOTAL DIRECT COSTS			**$166,697**
C. Indirect Annual Costs, $/yr			
1. Overhead	= (0.6) x (all labor and maintenance material costs)	=	$47,319
2. Property Taxes, insurance, admin.	= (0.04) x (total capital investment)	=	$126,357
3. Capital recovery	= (0.1098) x [total capital investment - catalyst replacement cost)]	=	$344,474
TOTAL INDIRECT COSTS			**$518,150**
Total Annual cost	**= (Direct Annual Costs) + (Indirect Annual Costs)**	**=**	**$684,846**

Cost Effectiveness

NOx Emissions from Unit without SCR	= tpy NOx	=	26.3
NOx Removal from SCR	= tpy NOx, 90% of uncontrolled	=	23.7
Cost Effectiveness	***$/tons NOx***	=	***$28,955.11***

- The capital recovery factors assumes a 15 year equipment life, catalyst replaced every 5 yrs, and 7% interest.