6.4 Methane from Industrial Wastewater and Sludge Streams

Use WORKSHEET 6-3 METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE HANDLING to enter data for this submodule.

USING THE WORKSHEET

- Copy the Worksheet at the end of this section to complete the inventory.
- Keep the original of the worksheet blank so you can make further copies if necessary.

STEP 1 ESTIMATING TOTAL ORGANIC WASTEWATER AND SLUDGE

1 Enter Total Industrial Output for each industry in column A, in tonnes per year.

2 Enter the Degradable Organic Component in kg COD/m^3 wastewater in column B. Default values are provided in Table 6-6.

3 Enter the Wastewater Produced per unit product by industry in m^3/tonnes of product in column C.

4 Enter the Fraction of Degradable Organic Component Removed as Sludge in column D. The default fraction is zero.

5 Multiply the values in columns A, B, C, and one minus the value in column D. Enter the product in column E. This is the Total Organic Wastewater from Industrial Source.

6 Multiply the values in columns A, B, C, and D. Enter the product in column F. This is the Total Organic Sludge from Industrial Source.

STEP 2 ESTIMATE EMISSION FACTORS FOR INDUSTRIAL WASTEWATER HANDLING SYSTEMS

Determine the Aggregate MCF for the industrial wastewater stream.

1 Enter the name of the industrial wastewater source on the 'Source' line.

2 In column A, enter the types of Wastewater Handling Systems used for the selected wastewater source.

3 In column B, enter the Fraction of Wastewater Treated by the Handling System in column A.

4 In column C, enter the Methane Conversion Factor for the Handling System in column A.

5 Multiply the values in columns B and C. Enter the Product in column D.

6 Enter the sum of the products in the bottom of column D.

7 Enter the Maximum Methane Producing Capacity for the wastewater in the bottom of column E. The default (theoretical) value for B_o is 0.25 kg CH_4/kg BOD.

8 Calculate the average Emission Factor for the Industrial Wastewater Source by multiplying the value in the bottom of column D by the value in the bottom of column E. Enter the product in the bottom of column F.

STEP 3 ESTIMATE EMISSION FACTORS FOR INDUSTRIAL SLUDGE HANDLING SYSTEMS

Determine the Aggregate MCF for the industrial sludge stream.

1 Enter the name of the industrial sludge source on the 'Source' line.

2 In column A, enter the types of Sludge Handling System used for the selected sludge source.

3 In column B, enter the Fraction of Sludge Treated by the handling system in column A.

4 In column C, enter the Methane Conversion Factor for the handling system in column A.

5 Multiply the values in columns B and C. Enter the Product in column D.

6 Enter the sum of the products in the bottom of column D.

7 Enter the Maximum Methane Producing Capacity for the sludge in the bottom of column E. The default (theoretical) value for B_o is 0.25 kg CH_4/kg BOD.

8 Calculate the average Emission Factor for the Industrial Sludge Source by multiplying the value in the bottom of column D by the value in the bottom of column E. Enter the product in the bottom of column F.

STEP 4 ESTIMATE METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE

1 In column A, rows 1 and 2, copy the Total Organic Wastewater from Industrial Source value from column E of Worksheet 6-3, Sheet 1, and the Total Organic Sludge from Industrial Source value from column F of Worksheet 6-3, Sheet 1.

2 In column B, copy the average Emission Factor for Industrial Wastewater value from column F of Worksheet 6-3, Sheet 2 and the average Emission Factor for Industrial Sludge Source from column F of Worksheet 6-3, Sheet 3.

3 Multiply the values of columns A and B. Enter the product in column C.

4 Enter the total amount of Methane Recovered and/or Flared from the industrial wastewater and sludge source in column D in kg CH_4. If no data are available, the default is zero.

5 Subtract the value in column D from the product in column C. Multiply by 10^{-6} to convert emissions to gigagrams. Enter the difference in column E. Sum the values in both rows of column E at the bottom of the column. This is the Net CH_4 Emissions from the selected industrial wastewater and sludge source.

6.5 Nitrous Oxide from Human Sewage

ESTIMATE INDIRECT NITROUS OXIDE EMISSIONS FROM HUMAN SEWAGE

Use WORKSHEET 6-4 INDIRECT NITROUS OXIDE EMISSIONS FROM HUMAN SEWAGE to enter date for this submodule.

1 In column A, enter, average annual Per Capita Protein Consumption in the country (Protein in kg/person/yr).

2 In column B, enter the Population in country (number)(where number equals NR_{PEOPLE}).

3 In column C, enter the Fraction of Nitrogen in Protein ($Frac_{NPR}$). The default value is 0.16 kg N/kg protein. (Table 4-19 in Agriculture Chapter.)

4 In column D, enter the Emission Factor, EF_6. The default factor is 0.01 kg N_2O-N/kg sewage-N produced. (Table 4-18 in Agriculture Chapter.)

5 Multiply the values in columns A, B, C and D, and then multiply by the conversion ratio 44/28 and by 10^{-6} to convert to gigagrams. Enter the product in column E. This value is the Total Annual N_2O Emissions from human sewage.

For a detailed description of this methodology see Section 4.5.4 of the *Reference Manual*.

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM SOLID WASTE DISPOSAL SITES**
WORKSHEET	**6-1**
SHEET	**1 OF 1**

STEP 1	**STEP 2**	**STEP 3**						**STEP 4**				
A	B	C	D	E	F	G	H	J	K	L	M	N
Total Annual MSW Disposed to SWDSs (Gg MSW)	Methane Correction Factor (MCF)	Fraction of DOC in MSW	Fraction of DOC which Actually Degrades	Fraction of Carbon Released as Methane	Conversion Ratio	Potential Methane Generation Rate per Unit of Waste (Gg CH_4/Gg MSW)	Realised (Country-specific) Methane Generation Rate per Unit of Waste (Gg CH_4/ Gg MSW)	Gross Annual Methane Generation (Gg CH_4)	Recovered Methane per Year (Gg CH_4)	Net Annual Methane Generation (Gg CH_4)	One Minus Methane Oxidation Correction Factor	Net Annual Methane Emissions (Gg CH_4)
						G= (C x D x E x F)	H= (B x G)	J= (H x A)		L= (J - K)		N= (L x M)
					16/12							

MODULE	WASTE			
SUBMODULE	QUANTITY OF MSW DISPOSED OF IN SOLID WASTE DISPOSAL SITES USING COUNTRY DATA			
WORKSHEET	6-1A (SUPPLEMENTAL)			
SHEET	1 OF 1			
A Population whose Waste goes to SWDSs (Urban or Total) (persons)	B MSW Generation Rate (kg/capita/day)	C Annual Amount of MSW Generated (Gg MSW)	D Fraction of MSW Disposed to SWDSs (Urban or Total)	E Total Annual MSW Disposed to SWDSs (Gg MSW)
		C = (A x B x 365)/10^6		E = (C x D)

MODULE	WASTE	
SUBMODULE	QUANTITY OF MSW DISPOSED OF IN SOLID WASTE DISPOSAL SITES USING DISPOSAL RATE DEFAULT DATA	
WORKSHEET	6-1B (SUPPLEMENTAL)	
SHEET	1 OF 1	
A Population whose Waste goes to SWDSs (Urban or Total) (persons)	B MSW Disposal Rate to SWDSs (kg/capita/day)	C Total Annual MSW Disposed to SWDSs (Gg MSW)
		$C = (A \times B \times 365)/10^6$

	MODULE	WASTE	
	SUBMODULE	METHANE CORRECTION FACTOR	
	WORKSHEET	6-1C (SUPPLEMENTAL)	
	SHEET	1 OF 1	
	W	X	Y
Type of Site	Proportion of Waste (by weight) for Each Type of SWDSs	Methane Correction Factor (MCF)	Weighted Average MCF for Each Type of SWDS
			Y = W x X
Managed		1.0	
Unmanaged - deep (≥ 5m waste)		0.8	
Unmanaged-shallow (< 5m waste)		0.4	
Total		0.6	

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER AND SLUDGE TREATMENT**
WORKSHEET	**6- 2**
SHEET	**1 OF 4 ESTIMATION OF ORGANIC WASTEWATER AND SLUDGE**

STEP 1					
A Region or City	B Population (1,000 persons)	C Degradable Organic Component (kg BOD/1000 persons/yr)	D Fraction of Degradable Organic Component Removed as Sludge	E Total Domestic/Commercial Organic Wastewater (kg BOD/yr)	F Total Domestic/Commercial Organic Sludge (kg BOD/yr)
				E = [B x C x (1-D)]	F = (B x C x D)
			Total:		

MODULE	WASTE
SUBMODULE	METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER TREATMENT
WORKSHEET	6- 2
SHEET	2 OF 4 ESTIMATION OF EMISSION FACTOR FOR WASTEWATER HANDLING SYSTEMS

STEP 2					
A Wastewater Handling System	B Fraction of Wastewater Treated by the Handling System	C Methane Conversion Factor for the Handling System	D Product	E Maximum Methane Producing Capacity (kg CH_4/kg BOD	F Emission Factor for Domestic/Commercial Wastewater (kg CH_4/kg BOD)
			D = (B x C)		F = (D x E)
		Aggregate MCF:			

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER TREATMENT**
WORKSHEET	**6- 2**
SHEET	**3 OF 4 ESTIMATION OF EMISSION FACTOR FOR SLUDGE HANDLING SYSTEMS**

STEP 3

A Sludge Handling System	B Fraction of Sludge Treated by the Handling System	C Methane Conversion Factor for the Handling System	D Product	E Maximum Methane Producing Capacity (kg CH_4/kg BOD)	F Emission Factor for Domestic/ Commercial Sludge (kg CH_4/kg BOD)
			D = (B x C)		F = (D x E)
		Aggregate MCF:			

MODULE	WASTE				
SUBMODULE	METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER AND SLUDGE TREATMENT				
WORKSHEET	6- 2				
SHEET	4 OF 4 ESTIMATION OF METHANE EMISSIONS FROM DOMESTIC/COMMERCIAL WASTEWATER AND SLUDGE				
STEP 4					
	A Total Organic Product (kg BOD/yr)	B Emission Factor (kg CH_4/kg BOD)	C Methane Emissions Without Recovery/Flaring	D Methane Recovered and/or Flared (kg CH_4)	E Net Methane Emissions (Gg CH_4)
	from Worksheet 6-2, Sheet 1	from Worksheet 6-2, Sheets 2 and 3	C = (A x B)		E = (C - D) x 10^{-6}
Wastewater					
Sludge					
				Total:	

MODULE	WASTE
SUBMODULE	METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE HANDLING
WORKSHEET	6-3
SHEET	1 OF 4 TOTAL ORGANIC WASTEWATER AND SLUDGE

		STEP 1					
		A Total Industrial Output (t/yr)	B Degradable Organic Component (kg COD/m^3 wastewater)	C Wastewater Produced (m^3/tonne product)	D Fraction of Degradable Organic Component Removed as Sludge	E Total Organic Wastewater from Industrial Source (kg COD/yr)	F Total Organic Sludge from Industrial Source (kg COD/yr)
						E = [A x B x C x(1-D)]	F = (A x B x C x D)
Iron and Steel							
Non-ferrous metals							
Fertiliser							
Food & Beverage	Canneries						
	Beer						
	Wine						
	Meatpacking						
	Dairy products						
	Sugar						
	Fish processing						
	Oil & grease						
	Coffee						
	Soft drinks						
	Other						
Paper & Pulp	Paper						
	Pulp						
	Other						
Petroleum refining/Petrochemicals							
	Bleaching						
	Dying						
	Other						
Rubber							
Other							
Total							

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER TREATMENT**
SOURCE	
WORKSHEET	**6- 3**
SHEET	**2 OF 4 ESTIMATION OF EMISSION FACTOR FOR WASTEWATER HANDLING SYSTEMS**

STEP 2					
A Wastewater Handling System	B Fraction of Wastewater Treated by the Handling System	C Methane Conversion Factor (MCF)	D Product	E Maximum Methane Producing Capacity (kg CH_4/kg BOD)	F Emission Factor for Industrial Wastewater Source (kg CH_4/kg BOD)
			D = (B x C)		F = (D x E)
		Aggregate MCF:			

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER TREATMENT**
SOURCE	
WORKSHEET	**6- 3**
SHEET	**3 OF 4 ESTIMATION OF EMISSION FACTOR FOR SLUDGE HANDLING SYSTEMS**

STEP 3					
A Sludge Handling System	B Fraction of Sludge Treated by the Handling System	C Methane Conversion Factor (MCF)	D Product	E Maximum Methane Producing Capacity (kg CH_4/kg COD)	F Emission Factor for Industrial Sludge Source (kg CH_4/kg COD)
			D = (B x C)		F = (D x E)
		Aggregate MCF:			

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE TREATMENT**
WORKSHEET	**6- 3**
SHEET	**4 OF 4 ESTIMATION OF METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE**

STEP 4					
	A Total Organic Product (kg BOD/yr)	B Emission Factor (kg CH_4/kg BOD)	C Methane Emissions without Recovery/Flaring	D Methane Recovered and/or Flared (kg CH_4)	E Net Methane Emissions (Gg CH_4)
	Worksheet 6-3, Sheet 1	Worksheets 6-3, Sheets 2 and 3	C = (A x B)		E = (C - D) x 10^{-6}
Wastewater					
Sludge					
				Total:	

MODULE	WASTE				
SUBMODULE	INDIRECT NITROUS OXIDE EMISSIONS FROM HUMAN SEWAGE				
WORKSHEET	6-4				
SHEET	1 OF 1				
	A Per Capita Protein Consumption (Protein in kg/person/yr)	B Population (number)	C Fraction of Nitrogen in Protein $Frac_{NPR}$ (kg N/kg protein)	D Emission factor EF_6 (kg N_2O-N/kg sewage-N produced)	E Total Annual N_2O Emissions (Gg N_2O/yr)
					$E = (A \times B \times C \times D) \times 44/28 \times 10^{-6}$
Total					