Texas Commission on Environmental Quality
Calculations Guidance Package
Hot Dip Galvanizing

I. Instructions

This manual was developed for the purpose of providing a guide for calculating emissions at hot-dip galvanizing facilities. Tables are provided for identifying the input data required and the emission calculation results. In most cases, the upper portions of the tables are used to record input data/calculation parameters. Use the equations which follow the table to perform the emission calculations and record the results in the lower portion of the table.

Note: Some of the calculations are made using data from TCEQ Tables 6, 11, and 13. You should complete these forms for maximum operating conditions and actual equipment specifications for your facility.

The information provided below will be used throughout the calculations and establishes limitations for the permit.

II. Galvanizing Facility Capacity Data

AP = Maximum annual production (tons/year) ________________________

DP = Maximum daily production (tons/year) ________________________

HD = Hours of operation per day ________________________

DW = Number of days operated per week ________________________

WY = Number of weeks operated per year ________________________

HY = Maximum number of hours operated per year ________________________

ZN = Tons of zinc used per year ________________________

III. Degreasing/Cleaning Operations

1. Number of degreasing tanks? ________________________
2. Degreasing Tank Parameters

Tank No. 1 ____________ feet (ft) wide x __________ feet (ft) long

Tank No. 2 ____________ feet (ft) wide x __________ feet (ft) long

Type of degreasing compound used: ________________________

Concentration of degreasing compound: ________________________

Temperature of degreasing tank solution: ________________________

Type of heat source: ________________________

Note: The permit engineer will review the above data and determine if degreasing tank emissions will be considered.

IV. Acid/Pickle Tank Emissions

Instructions: Acid/Pickle tank emissions are calculated using the procedure below.

A. Acid Tank Data

Number of pickle tanks at facility: ______________________________

Tank No. 1 __________ feet wide x _________ feet long

Tank No. 2 __________ feet wide x _________ feet long

Type acid used: ____

Maximum acid concentration: __________ % weight/weight (w/w)

Minimum acid concentration: __________ % w/w (concentration at recharge)

Temperature of acid tanks: __________ degrees F

Fume suppressant used? ❑ Yes ❑ No

Submit a copy of the Safety Data Sheet (SDS) for the acid, the fume suppressant, and any other chemicals or additives used.

Are capture hoods used over the acid tanks? ❑ Yes ❑ No

Are any exhaust fans located near the tanks? ❑ Yes ❑ No

If yes, show their location on the plot plan and indicate the fan size (diameter), flow rate cubic feet per minute (CFM), and the height of the fan discharge point above the ground where it exhausts to the atmosphere.

B. Acid Pickle Tank Emission Calculation Procedure

Hydrochloric (HCl) Acid Tank Table

Table 2

HCl Pickle Tanks	1	2	3	4	5
A = Surface Area of tank (ft^2)					
T = Operating temperature (C°)					
Conc. = Percent concentration of HCl by weight (%w/w)					
V = Air velocity across surface of tank (fps)					
P_v = Vapor pressure of HCl (mmHg from the table in the Appendix)					
E = Evaporation rate from tank (lb/hr-ft^2)					
ER_1 = Emission rate uncontrolled (lb/hr)					
FE = Suppressant efficiency 1 - (%)/100					
CE = Hood capture efficiency (%)					
AE = Abatement device efficiency 1 - (%)/100					
ER_4 = Emission rate controlled (lb/hr)					
FUG = Fugitive emissions (lb/hr)					
OY = Annual operating hours					
AFUG = Annual HCl fugitive emission rate (tons/year)					
AER = Annual HCl emission rate (tons/year)					

Supplementary Information

Table 2a

HCl Pickle Tanks	1	2	3	4	5
ER_1 (enter into Table 2 (lbs/hr)					
ER_2 (lbs/hr)					
ER_3 (lbs/hr)					
(ER_2 - ER_3) (lbs/hr)					
ER_4 (enter into Table 2) (lbs/hr)					

C. Hydrochloric (HCl) Acid Tank Emissions Calculations

The following calculations are made with data provided by the applicant. To assist in these calculations, Table 2, Table 2a, and the table of Partial Pressures of HCl over Aqueous Solutions of HCl in the Appendix are provided for your use. A completed Table 2 and Table 2a, in addition to the applicant's calculations, will serve to expedite the permit review process.

Calculation Steps

1. Calculate the surface area (A) each tank in square feet and enter the value of A into Table 2.
2. Enter the operating temperature (T) in degrees centigrade (C°), acid concentration (conc.) by weight percent, Table 2.

3. Determine the vapor pressure (P_v) of the HCl solution from the table in the Appendix. Using the temperature (T, C°) and the percent acid concentration (Conc.) determine the partial pressure of the solution in mmHg and enter the value of P_v into Table 2.

4. Calculate the evaporation rate of HCl from the tank using the following equation [1,2,3]and enter the value of E (lb/hr-ft^2) into Table 2 (Requires a calculator with logarithmic functions):

   $E = 25[0.46 + 0.117(V)]\log[(760 - P_a)/(760 - P_v)]$ (lb/hr-ft^2)
   $P_a = 0$ for this calculation.

5. Calculate and enter into Tables 2 and 2a the uncontrolled emission rate:

   $ER_1 = E \times A$ (lb/hr).

6. Do you use a suppressant (foam, fume, or mechanical) in your HCl tank? If yes, complete the following then go to 7.

   FE = [1 - (%)/100], where % is the efficiency of the suppressant.

   The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant.

   Enter the value of FE into Table 2, then calculate the following (enter the value of):

   ER_2 into Table 2a

   $ER_2 = ER_1 \times FE$ (lbs/hr)

   If you do not use a fume suppressant, complete the following (enter the value of ER_2 into Table 2a) then go to 7.

   $ER_2 = ER_1$

7. Do you use a capture hood on your HCl tank? If yes, complete the following appropriate calculation, then go to 10. If no, skip to 8.

   If you use a hood, and do not use a fume suppressant, calculate the following (enter the value of ER_3 into TABLE 2a), then go to 10:

   $ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood, no fume suppressant)

   Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with the Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

   If you use a hood, and also use a fume suppressant, calculate the following (enter the value of ER_3 into Table 2a), then go to 10.

   $ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood and a fume suppressant)

8. If you do not use a capture hood but use a fume suppressant use the following (enter the value of ER_3 into Table 2a), then go to 12.

   $ER_3 = ER_2$ (lbs/hr) (No hood, use a fume suppressant)

   If you do not use a capture hood, and also do not use a fume suppressant, then go to 9.

9. You will not be authorized to operate a HCl pickle tank without the use of, as a minimum, a fume suppressant or a capture hood.

10. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE and ER_4 into Table 2, then go to 13. If not, then go to 11.

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

AE = [1-(%)/100], where % is the abatement device efficiency.

$ER_4 = ER_3$ x AE (lbs/hr)

11. Without an abatement device your hourly emission rate is the same as calculated in 7.

    Complete the following, enter the value of ER_4 into Tables 2 and 2a, then go to 13:

    $ER_4 = ER_3$ (lbs/hr)

12. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into Table 2, then go to 14:

    Fugitive emissions are those emissions that escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

    FUG = (ER_3) (0.5) (lbs/hr) (Fume suppressant only)

13. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into

    Table 2, then go to 15:

    Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

    FUG = $(ER_2 - ER_3)(0.5)$ (lbs/hr)

14. Calculate your annual fugitive emission rate (AFUG) and enter the value of AFUG into Table 2:

    AFUG = (FUG x OY)/2000 (tons/year)

15. Calculate your annual emission rate (AER) and the annual fugitive rate (AFUG) and enter the values of AER and AFUG into Table 2.

    AER = (ER_4 x OY)/2000 (tons/year)

    AFUG = (FUG x OY)/2000 (tons/year)

D. Sulfuric Acid Emission Calculations

If sulfuric acid is used as a pickling agent, use the above Steps 5 through 15 and Tables 2 and 2a. Begin with Step 5 and use 0.00015 $lbs/hr\text{-}ft^2$ for “E,” the emission factor for sulfuric acid.

V. Galvanizing/Zinc Kettle Uncontrolled Emissions

Galvanizing Facility Parameters	Zinc Kettle 1	Zinc Kettle 2	Zinc Kettle 3
HP = Maximum Hourly Production in Pounds/Hour of Galvanized Product (lbs/hr)			
AP = Maximum Annual Production in Tons/Year of Galvanized Product (tpy)			
AH = Maximum Annual Operating Hours Per Year (hrs/yr)			
EF = Zinc Kettle Emission Factor (lbs/ton)[4]	0.52	0.52	0.52
EH = Hourly Uncontrolled PM_{10} Emissions (lbs/hr)*			
EA = Annual Uncontrolled PM_{10} Emissions (tpy)**			

* EH= HP/2000 x EF

** EA= AP/2000 x EF

Note: The above calculations must be completed for each galvanizing kettle that exhausts to its own control device. For all kettles exhausting to a common control device, then this calculation may be made only once using an AP and HP for all kettles exhausting to the same control device.

VI. Galvanizing/Zinc Kettle Controlled Emissions

Galvanizing Facility Parameters	Zinc Kettle 1	Zinc Kettle 2	Zinc Kettle 3
EH = (See Previous Table) (lbs/hr)			
EA = (See Previous Table) (tpy)			
CE = Kettle Hood Capture Efficiency (%)			
AE = Control Device Efficiency (%)			
EHC = Hourly Controlled PM_{10} Emissions (lbs/hr)*			
EAC = Annual Controlled PM_{10} Emissions (tpy)**			
FH = Hourly Fugitive PM_{10} Emissions (lbs/hr)***			
FA = Annual Fugitive PM_{10} Emissions (tpy)****			

* EHC= EH x CE/100 x [1- (AE/100)] =

** EAC= EA x CE/100 x [1-(AE/100)] =

*** FH= EH x [1-(CE/100)] =

**** FA= EA x [1-(CE/100)] =

Note**:** This quantity must be completed for each galvanizing kettle that exhausts to its own control device. For all kettles exhausting to a common control device, then this calculation may be made only once using an AP and HP for all kettles exhausting to the same control device.

VII. Speciated Zinc Kettle Emissions[4]

(a) Hourly Controlled Emission (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	x	EHC	=	________
NH_4Cl	=	0.68	x	EHC	=	________
ZnO	=	0.16	x	EHC	=	________
$ZnCl_2$	=	0.04	x	EHC	=	________
Zn	=	0.05	x	EHC	=	________
NH_3	=	0.01	x	EHC	=	________

(b) Hourly Fugitive Emissions (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	x	FH	=	________
NH_4Cl	=	0.68	x	FH	=	________
ZnO	=	0.16	x	FH	=	________
$ZnCl_2$	=	0.04	x	FH	=	________
Zn	=	0.05	x	FH	=	________
NH_3	=	0.01	x	FH	=	________

(c) Annual Controlled Emissions (tpy)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	x	EAC	=	________
NH_4Cl	=	0.68	x	EAC	=	________
ZnO	=	0.16	x	EAC	=	________
$ZnCl_2$	=	0.04	x	EAC	=	________
Zn	=	0.05	x	EAC	=	________
NH_3	=	0.0	x	EAC	=	________

(d) Annual Fugitive Emissions (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	x	FA	=	________
NH_4Cl	=	0.68	x	FA	=	________
ZnO	=	0.16	x	FA	=	________
$ZnCl_2$	=	0.04	x	FA	=	________
Zn	=	0.05	x	FA	=	________
NH_3	=	0.01	x	FA	=	________

VIII. Heat Source Emissions

The following caluculations must be completed for each heat source, i.e. zinc kettle burner, boiler, tank heater, etc.

1. Heat source parameters (From the completed TCEQ Table 6 to be filled out by the applicant)

Parameter	Design Max	Annual Average
Total Flow Rate (SFM)		
FRH = Total Flow Rate (SCF/hr)		
Avg. Heat Content (BTU/SCF)		
Total Heat Rate (BTU/hr)		

2. Emission Factors (Refer to AP-42 natural gas Chapter 1.4)

Contaminant		Emission Factor ($lb/10^6$ SCF)
PM	________	(EPM)
SO_2	________	(ESO_2)
CO	________	(ECO)
NO_x	________	(ENO_x)
VOC	________	(EVOC)

3. Emission Calculatin (lbs/hr)

Use FRH (from above at design maximum (FRH_{max}) in the following calculations:

PM = EPM x FRH_{max}
SO_2 = ESO_2 x FRH_{max}
CO = ECO x FRH_{max}
NO_x = ENO_x x FRH_{max}
VOC = EVOC x FRH_{max}

4. Emission Calculation (tons/yr)

Use FRH_{avg} in the following calculations:

HY (Hours of operation per year) =

PM = EPM x FRH_{avg} x HY / 2000
SO_2 = ESO_2 x FRH_{avg} x HY / 2000
CO = ECO x FRH_{avg} x HY / 2000
NO_x = ENO_x x FRH_{avg} x HY / 2000
VOC = EVOC x FRH_{avg} x HY / 2000

Hot Dip Galvanizing Facility Example Calculations

I. Instructions

This manual was developed for the purpose of providing a guide for calculating emissions at hot-dip galvanizing facilities. Tables are provided for identifying the input data required and the emission calculation results. In most cases, the upper portions of the tables are used to record input data/calculation parameters. Use the equations which follow the table to perform the emission calculations and record the results in the lower portion of the table.

Note: Some of the calculations are made using data from TCEQ Tables 6, 11, and 13. You should complete these forms for maximum operating conditions and actual equipment specifications for your facility.

The information provided below will be used throughout the calculations and establishes limitations for the permit.

II. Galvanizing Facility Capacity Data

AP = Maximum annual production (tons/year) 20,000.
DP = Maximum daily production (tons/year) 100.
HD = Hours of operation per day 24.
DW = Number of days operated per week 5.
WY = Number of weeks operated per year 52.
HY = Maximum number of hours operated per year 6,240.
ZN = Tons of zinc used per year 1,200.

III. Degreasing/Cleaning Operations

1. Number of degreasing tanks? 2
2. Degreasing tank parameters

Tank No. 1	5	feet (ft) wide	x	45	feet (ft) long
Tank No. 2	5	feet (ft) wide	x	45	feet (ft) long

Type of degreasing compound used:	Sodium Hydroxide
Concentration of degreasing compound:	10%
Temperature of degreasing tank solution:	200 degree F
Type of heat source:	NG fired tube heater

Note: The permit engineer will review the above data and determine if degreasing tank emissions will be considered.

IV. Acid/Pickle Tank Emissions

Instructions: Acid/pickle tank emissions are calculated using the procedure below.

A. Acid Tank Data

Number of pickle tanks at facility: 2

Tank No. 1	5	feet (ft) wide	x	45	feet (ft) long
Tank No. 2	5	feet (ft) wide	x	45	feet (ft) long

Type of acid used:	Hydrochloric acid (HCl)
Maximum acid concentration:	16% weight/weight (w/w)
Minimum acid concentration:	8 % w/w (concentration at recharge)
Temperature of acid tanks:	ambient degrees F
Fume suppressant used?	☒ Yes ☐ No

Submit a copy of the Safety Data Sheet (SDS) for the acid, the fume suppressant, and any other chemicals or additives used.

Are capture hoods used over the acid tanks? ☐ Yes ☒ No

Are any exhaust fans located near the tanks? ☒ Yes ☐ No

If yes, show their location on the plot plan and indicate the fan size (diameter), flow rate (CFM), and the height of the fan discharge point above the ground where it exhausts to the atmosphere.

B. Acid Pickle Tank Emission Calculation Procedure.

Hydrochloric (HCl) Acid Tank Table

Table 2

HCl Pickle Tanks	1	2	3	4	5
A = Surface area of tank (ft^2)	225	225			
T = Operating temperature (C°)	30	30			
Conc. = Percent concentration of HCl by weight (%w/w)	16	16			
V = Air velocity across surface of tank (fps)	1.0	1.0			
P_v = Vapor pressure of HCl (mmHg from the table in the Appendix)	0.106	0.106			
E = Evaporation rate from tank (lb/hr-ft^2)	0.009	0.009			
ER_1 = Emission rate uncontrolled (lb/hr)	0.196	0.196			
FE = Suppressant efficiency 1 - (%)/100	0.05	0.05			
CE = Hood capture efficiency (%)	N/A	N/A			
AE = Abatement device efficiency 1 - (%)/100	N/A	N/A			
ER_4 = Emission rate controlled (lb/hr)	0.0098	0.0098			
FUG = Fugitive emissions (lb/hr)	0.0049	0.0049			
OY = Annual operating hours	8760	8760	Tanks	Emit	All the time
AFUG = Annual HCl fugitive emission rate (tons/year)	0.021	0.021			
AER = Annual HCl emission rate (tons/year)	N/A	N/A			

Supplementary Information

Table 2a

HCl Pickle Tanks	1	2	3	4	5
ER_1 (enter into Table 2) (lbs/hr)	0.196	0.196			
ER_2 (lbs/hr)	0.0098	0.0098			
ER_3 (lbs/hr)	0.0098	0.0098			
(ER_2 - ER_3) (lbs/hr)	N/A	N/A			
ER_4 (enter into Table 2) (lbs/hr)	0.0098	0.0098			

C. Hydrochloric (HCl) Acid Tank Emissions Calculations

The following calculations are made with data provided by the applicant. To assist in these calculations, Table 2, Table 2a, and the table of Partial Pressures of HCl over Aqueous Solutions of HCl in the Appendix are provided for your use. A completed Table 2 and Table 2a, in addition to the applicant's calculations, will serve to expedite the permit review process.

Calculation Steps

1. Calculate the surface area (A) each tank in square feet and enter the value of A into Table 2.

2. Enter the operating temperature (T) in degrees centigrade (C°), acid concentration (conc.) by weight percent, and air velocity (V) in feet per second (fps) across the surface of each tank into Table 2.

3. Determine the vapor pressure (P_v) of the HCl solution from the table in the Appendix. Using the temperature (T, C°) and the percent acid concentration (Conc.) determine the partial pressure of the solution in mmHg and enter the value of P_v into Table 2.

4. Calculate the evaporation rate of HCl from the tank using the following equation and enter the value of E (lb/hr-ft^2) into Table 2 (Requires a calculator with logarithmic functions):

   $E = 25[0.46 + 0.117(V)]\log[(760 - P_a)/(760 - P_v)]$ (lb/hr-ft^2)
   $P_a = 0$ for this calculation.

5. Calculate and enter into Tables 2 and 2a the uncontrolled emission rate, $ER_1 = E \times A$ (lb/hr)

6. Do you use a suppressant (foam, fume, or mechanical) in your HCl tank? If yes, complete the following then go to 7.

   $FE = [1 - (\%)/100]$, where % is the efficiency of the suppressant.

   The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant.

   Enter the value of FE into Table 2, then calculate the following (enter the value of

   ER_2 into Table 2a):

   $ER_2 = ER_1 \times FE$ (lbs/hr)

   If you do not use a fume suppressant, complete the following (enter the value of ER_2 into Table 2a) then go to 7.

   $ER_2 = ER_1$

7. Do you use a capture hood on your HCl tank? If yes, complete the following appropriate calculation, then go to 10. If no, skip to 8.

   If you use a hood, and do not use a fume suppressant, calculate the following (enter the value of ER_3 into Table 2a), then go to 10:

   $ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood, no fume suppressant)

   Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with the Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

   If you use a hood, and also use a fume suppressant, calculate the following (enter the value of ER_3 into Table 2a), then go to 10:

   $ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood and a fume suppressant)

8. If you do not use a capture hood, but use a fume suppressant use the following (enter the value of ER_3 into Table 2a), then go to 12.

   $ER_3 = ER_2$ (lbs/hr) (No hood, use a fume suppressant)

   If you do not use a capture hood, and also do not use a fume suppressant, then go to 9.

9. You will not be authorized to operate a HCl pickle tank without the use of, as a minimum, a fume suppressant or a capture hood.

10. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE and ER_4 into Table 2, then go to 13. If not, then go to 11.

    The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

    AE = [1-(%)/100], where % is the abatement device efficiency.

    $ER_4 = ER_3 \times AE$ (lbs/hr)

11. Without an abatement device your hourly emission rate is the same as calculated in 7.

    Complete the following, enter the value of ER_4 into Tables 2 and 2a, then go to 13:

    $ER_4 = ER_3$ (lbs/hr)

12. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into Table 2, then go to 14:

    Fugitive emissions are those emissions that escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

    $FUG = (ER_3)(0.5)$ (lbs/hr) (Fume suppressant only)

13. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into Table 2, then go to 15:

    Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

    $FUG = (ER_2 - ER_3)(0.5)$ (lbs/hr)

14. Calculate your annual fugitive emission rate (AFUG) and enter the value of AFUG into Table 2:

    $AFUG = (FUG \times OY)/2000$ (tons/year)

15. Calculate your annual emission rate (AER) and the annual fugitive rate (AFUG) and enter the values of AER and AFUG into Table 2.

    $AER = (ER_4 \times OY)/2000$ (tons/year)

    $AFUG = (FUG \times OY)/2000$ (tons/year)

D. Sulfuric Acid Emission Calculations

If sulfuric acid is used as a pickling agent, use the above Steps 5 through 15 and Tables 2 and 2a. Begin with Step 5 and use 0.00015 $lbs/hr\text{-}ft^2$ for “E”, the emission factor for sulfuric acid.

V. Galvanizing/Kettle Uncontrolled Emissions

Galvanizing Facility Parameters	Zinc Kettle 1	Zinc Kettle 2	Zinc Kettle 3
HP = Maximum Hourly Production in Pounds/Hour of Galvanized Product (lbs/hr)	10,000		
AP = Maximum Annual Production in Tons/Year of Galvanized Product (tpy)	20,000		
AH = Maximum Annual Operating Hours Per Year (hrs/yr)	6,240		
EF = Zinc Kettle Emission Factor (lbs/ton)	0.52	0.52	0.52
EH = Hourly Uncontrolled PM_{10} Emissions (lbs/hr)*	2.6		
EA = Annual Uncontrolled PM_{10} Emissions (tpy)**	5.2		

* EH= 10,000/2000 x 0.52 = 2.6 lbs/hr

** EA= 20,000/2000 x 0.52 = 5.2 tons/yr

Note: The above calculations must be completed for each galvanizing kettle that exhausts to its own control device. For all kettles exhausting to a common control device, then this calculation may be made only once using an AP and HP for all kettles exhausting to the same control device.

VI. Galvanizing/Zinc Kettle Controlled Emissions

Galvanizing Facility Parameters	Zinc Kettle 1	Zinc Kettle 2	Zinc Kettle 3
EH = (See Previous Table) (lbs/hr)	2.6		
EA = (See Previous Table) (tpy)	5.2		
CE = Kettle Hood Capture Efficiency (%)	98%		
AE = Control Device Efficiency (%)	99%		
EHC = Hourly Controlled PM_{10} Emissions (lbs/hr)*	0.03		
EAC = Annual Controlled PM_{10} Emissions (tpy)**	0.05		
FH = Hourly Fugitive PM_{10} Emissions (lbs/hr)***	0.05		
FA = Annual Fugitive PM_{10} Emissions (tpy)****	0.104		

* EHC= 2.6 X 0.98 X 0.01 = 0.03 lbs/hr

** EAC= 5.2 X 0.98 x 0.01 = 0.05 tons/yr

*** FH= 2.6 X 0.02 = 0.05 lbs/hr

**** FA= 5.2 X 0.02 = 0.104 tons/yr

Note: This quantity must be completed for each galvanizing kettle that exhausts to its own control device. For all kettles exhausting to a common control device, then this calculation may be made only once using an AP and HP for all kettles exhausting to the same control device.

VII. Speciated Zinc Kettle Emissions

(a) Hourly Controlled Emission (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	X	0.03	=	0.03
NH_4Cl	=	0.68	X	0.03	=	0.02
ZnO	=	0.16	X	0.03	=	0.005
$ZnCl_2$	=	0.04	X	0.03	=	0.0012
Zn	=	0.05	X	0.03	=	0.0045
NH_3	=	0.01	X	0.03	=	0.0003

(b) Hourly Fugitive Emissions (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	X	0.05	=	0.05
NH_4Cl	=	0.68	X	0.05	=	0.034
ZnO	=	0.16	X	0.05	=	0.008
$ZnCl_2$	=	0.04	X	0.05	=	0.002
Zn	=	0.05	X	0.05	=	0.003
NH_3	=	0.01	X	0.05	=	0.0005

(c) Annual Controlled Emissions (tpy)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	X	0.05	=	0.05
NH_4Cl	=	0.68	X	0.05	=	0.034
ZnO	=	0.16	X	0.05	=	0.008
$ZnCl_2$	=	0.04	X	0.05	=	0.002
Zn	=	0.05	X	0.05	=	0.003
NH_3	=	0.01	X	0.05	=	0.0005

(d) Annual Fugitive Emissions (lbs/hr)

Contaminant		Percentage in Decimal				
PM_{10}	=	1.00	X	0.104	=	0.104
NH_4Cl	=	0.68	X	0.104	=	0.071
ZnO	=	0.16	X	0.104	=	0.017
$ZnCl_2$	=	0.04	X	0.104	=	0.0042
Zn	=	0.05	X	0.104	=	0.005
NH_3	=	0.01	X	0.104	=	0.001

VIII. Heat Source Emissions

The following calculations must be completed for each heat source, i.e. zinc kettle burner, boiler, tank heater, etc.

A. Tube Heater

1. Tuber heater parameters (From the completed TCEQ Table 6 to be filled out by the applicant)

Parameter	Design Max	Annual Average
Total Flow Rate (SFM)	10	5
FRH = Total Flow Rate (SCF/hr)	600	300
Average Heat Content (BTU/SCF)	1,050	
Total Heat Rate (BTU/hr)	630,000	

2. Emission Factors (Refer to AP-42 natural gas Chapter 1.4)

Contaminant	Emission Factor ($lb/10^6$ SCF)	
PM	12	(EPM)
SO_2	0.6	(ESO_2)
CO	21	(ECO)
NO_X	100	(ENO_X)
VOC	5.8	(EVOC)

3. Emission Calculation (lbs/hr)

Use FRH_{max} in the following calculations:

PM	=	12	x	0.0006	=	0.007
SO_2	=	0.6	x	0.0006	=	0.0004
CO	=	21	x	0.0006	=	0.013
NO_X	=	100	x	0.0006	=	0.06
VOC	=	5.8	x	0.0006	=	0.0035

4. Emission Calculation (tons/yr)

Use FRH_{avg} in the following calculations

HY (Hours of operation per year) = 6,240

PM	=	12	x	0.0003 x	6,240 /	2,000 =	0.011
SO_2	=	0.6	x	0.0003 x	6,240 /	2,000 =	0.00056
CO	=	21	x	0.0003 x	6,240 /	2,000 =	0.0197
NO_X	=	100	x	0.0003 x	6,240 /	2,000 =	0.094
VOC	=	5.8	x	0.0003 x	6,240 /	2,000 =	0.0054

B. Kettle Heater

1. Kettle heater parameters (From the completed TCEQ Table 6 to be filled out by the applicant.

Parameter	Design Max	Annual Average
Total Flow Rate (SFM)	120	60
FRH = Total Flow Rate (SCF/hr)	7,200	3,600
Avg. Heat Content (BTU/SCF)	1,050	
Total Heat Rate (BTU/hr)	7,560,000	

2. Emission Factors (Refer to AP-42 natural gas Chapter 1.4)

Contaminant		**Emission Factor** ($lb/10^6$ SCF)
PM	12	(EPM)
SO_2	0.6	(ESO_2)
CO	21	(ECO)
NO_x	100	(ENO_x)
VOC	5.8	(EVOC)

3. Emission Calculation (lbs/hr)

Use FRH_{max} in the following calculations:

PM = 12 x 0.0072 = 0.086
SO2 = 0.6 x 0.0072 = 0.004
CO = 21 x 0.0072 = 0.15
NOx = 100 x 0.0072 = 0.72
VOC = 5.8 x 0.0072 = 0.042

4. Emission Calculatin (tons/yr)

Use FRH_{avg} in the following calculations.

HY (Hours of operation per year) = 6,240

PM = 12 x 0.0036 x 6,240 / 2,000 = 0.135
SO_2 = 0.6 x 0.0036 x 6,240 /2,000 = 0.0067
CO = 21 x 0.0036 x 6,240 / 2,000 = 0.24
NO_x = 100 x 0.0036 x 6,240 / 2,000 = 1.12
VOC = 5.8 x 0.0036 x 6,240 / 2,000 = 0.07

Appendix: Partial Pressures (P_v) of HCl over Aqueous Solutions of HCl*

% HCl	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°	90°	100°	110°
2			0.0000117	0.000023	0.000044	0.000084	0.000151	0.000275	0.00047	0.00083	0.00104	0.0038	0.01	0.0245	0.058	0.132	0.28
4	0.000018	0.000036	0.000069	0.000131	0.00024	0.00044	0.00077	0.00134	0.0023	0.00385	0.0064	0.0165	0.0405	0.095	0.21	0.46	0.93
6	0.000066	0.000125	0.000234	0.000425	0.00076	0.00131	0.00225	0.0038	0.0062	0.0102	0.0163	0.04	0.094	0.206	0.44	0.92	1.78
8	0.000118	0.000323	0.000583	0.00104	0.00178	0.0031	0.00515	0.0085	0.0136	0.022	0.0344	0.081	0.183	0.39	0.82	1.64	3.1
10	0.00042	0.00075	0.00134	0.0232	0.00395	0.0067	0.0111	0.0178	0.0282	0.045	0.069	0.157	0.35	0.73	1.48	2.9	5.4
12	0.00099	0.00175	0.00305	0.0052	0.008	0.0145	0.0234	0.037	0.058	0.091	0.136	0.305	0.66	1.34	2.65	5.1	9.3
14	0.0024	0.00415	0.0071	0.0118	0.0196	0.0316	0.05	0.078	0.121	0.185	0.275	0.6	1.25	2.5	4.8	9	16
16	0.0056	0.0095	0.0016	0.0265	0.0428	0.0685	0.106	0.163	0.247	0.375	0.55	1.17	2.4	4.66	8.8	16.1	28
18	0.0135	0.0225	0.037	0.06	0.095	0.148	0.228	0.345	0.515	0.77	1.11	2.3	4.55	8.6	15.7	28	48
20	0.0316	0.052	0.084	0.132	0.205	0.32	0.48	0.72	1.06	1.55	2.21	4.4	8.5	15.6	28.1	49	83
22	0.0734	0.119	0.187	0.294	0.45	0.68	1.02	1.5	2.18	3.14	4.42	8.6	16.3	29.3	52	90	146
24	0.175	0.277	0.43	0.66	1	1.49	2.17	3.14	4.5	6.4	8.9	16.9	31	54.5	94	157	253
26	0.41	0.64	0.98	1.47	2.17	3.2	4.56	6.5	9.2	12.7	17.5	32.5	58.5	100	169	276	436
28	1	1.52	2.27	3.36	4.9	7.05	9.9	13.8	19.1	26.4	35.7	64	112	188	309	493	760
30	2.4	3.57	5.23	7.6	10.6	15.1	21	28.6	39.4	53	71	124	208	340	542	845	
32	5.7	8.3	11.8	16.8	23.5	32.5	44.5	60	81	107	141	238	390	623	970		
34	13.1	18.8	26.4	36.8	50.5	68.5	92	122	161	211	273	450	720				
36	29	41	56.4	78	105.5	142	188	246	322	416	535	860					
38	63	87	117	158	210	277	360	464	598	758	955						
40	130	176	233	307	399	515	627	830									
42	253	332	430	560	709	900											
44	510	655	840														
46	940																

*Note: %HCL, weight percent; Temperature, centigrade (C°); partial pressures, mmHg.

References

1. National Emission Standards for Hazardous Air Pollutants (NESHAP) for Steel Pickling HCl Process-Background Information for Proposed Standards
   Appendix E, 1997
2. "Emissions from Open Tanks" model for HCl pickling process developed by Mr. Neil Stone of Esco Engineering Company available on the Esco Engineering website
3. "Heat Losses from Tanks, Vats, and Kettles," Friedman, S.J., Heating and Ventilating, April 1948. p 94-107
4. Emissions from Hot-Dip Galvanizing Processes Final Report EPA – 905/4-76-002, 1976