

Appendix D

BOSCH MODEL TW 122 SPECIFICATIONS

*Montana Artesian Water Company MPDES Permit
Kalispell, Montana*



Geothermal System Report

System 1 - Geo System

Weather Data Location: Kalispell Glacier Pk IntL Ar MT

Design Loads

Design Heating Load:	211000 Btu/hr
Indoor Design Temperature:	70 °F
Outdoor Design Temperature:	-3 °F

Utilities

Heating Electric Rate:	0.09 \$/kwh
Cooling Electric Rate:	0.09 \$/kwh
Winter Peak Electrical Demand:	12.70 kW
Summer Peak Electric Demand:	5.34 kW

Loop Information

Loop Type:	Well Water
Yearly Water Flow:	4,002,956 gal

Bosch Model

20 Tons of TW	
Water Heater:	Electric
Load Temp (Entering) Htg/Clg	100/45 °F
	Propane 90%
Balance Point	-8 °F

Operating Cost

Heating	
Annual Heating Load:	370.5 MMBtu
Electricity (Bosch):	25452 kWh
Electricity (Auxiliary):	0 kWh
% by Bosch:	100.0 %
Annual Cost:	\$2,545

Total Annual Operating Costs

Heating:	\$2,545
Total^{1,2,3}	\$2,545

1 Total estimated annual operating costs includes heating. Base electric use (electric use other than heating) is not included, and will vary depending upon lifestyle. Total annual utilities equals heating costs plus base electric use.

2 The operating costs shown above are considered to be an estimate due to the variability of living habits, weather, and system installation.

3 This software uses the latest algorithms from IGSHPA (International Ground Source Heat Pump Association) for ground loop sizing. Operating costs are based upon IGSHPA and ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) algorithms. All calculations are based upon Bosch equipment, and may not be comparable for other manufacturer's equipment.



WATER COOLED CHILLERS AND LOW TEMP BOILERS

UNIT PERFORMANCE DATA

FHP BOSCH HIGH-EFFICIENCY WATER SOURCE HEAT PUMPS

TW122

Refrigerant R-410A

Unit Tag	Qty	Configuration	Remarks
TW-122	2	Unit Mounted Controller	Bottling Plant

Electrical Specifications

Voltage	Stages	Compressor		Unit	
		RLA	LRA	MCA	MFS
1 - 208-230/60/1	2	28.3	178.0	63.7	90

Cooling Performance

Heating Performance

Condenser	Condenser Entering Fluid Temp (F)	86.0	Source	Source Entering Fluid Temp (F)	53.0
	Leaving Fluid Temp (F)	95.6		Leaving Fluid Temp (F)	45.1
	Flow Rate (GPM)	30.0		Flow Rate (GPM)	30.0
	Pressure Drop (FOH)	11.8		Pressure Drop (FOH)	13.6
	% Propylene Glycol	0.0		% Propylene Glycol	0.0
	Freeze Point	32.0		Freeze Point	32.0

Evaporator	Evaporator Entering Fluid Temp (F)	53.6	Load	Load Entering Fluid Temp (F)	80.0
	Leaving Fluid Temp (F)	43.6		Leaving Fluid Temp (F)	92.7
	Flow Rate (GPM)	23.0		Flow Rate (GPM)	23.0
	Pressure Drop (FOH)	8.4		Pressure Drop (FOH)	7.4
	% Propylene Glycol	0.0		% Propylene Glycol	0.0
	Freeze Point	32.0		Freeze Point	32.0

Chiller Capacity (BtuH)	115,040	Heating Capacity (BtuH)	145,627
Input Watts (W)	8,389	Input Watts (W)	7,922
EER (BtuH/W)	13.7	COP (W/W)	5.4
Heat Rejection (BtuH)	143,665	Heat Absorption (BtuH)	118,596

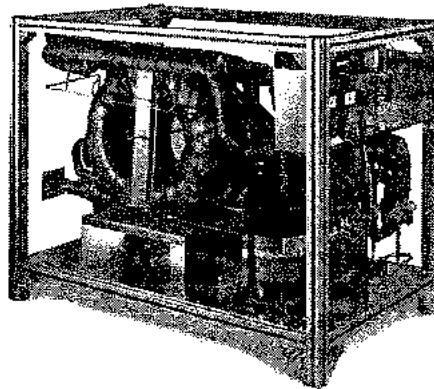
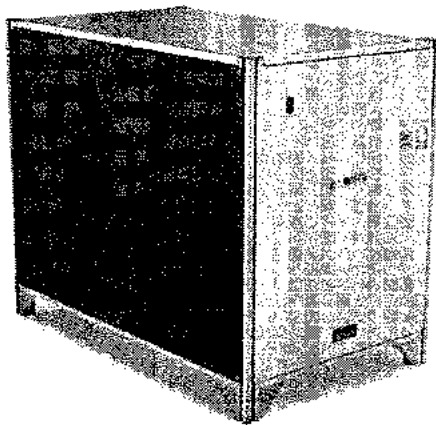
Warnings:

Units are complete packages featuring 2 stage operation and containing refrigeration compressors, reversing valves, expansion valve metering devices and coaxial style water to refrigerant heat exchangers. Also included are safety controls: overload protection for compressors, high and low refrigerant pressure switches and lock-out control circuit (CAP 4.05).

The results reported herein are based on testing by FHP. Variations in the installation and operational environment may alter performance. FHP disclaims all warranties, express and implied, that the performance will be as reported, including the warranty of merchantability and fitness for purpose. Continuous research and development may result in a change to an appliances design and specifications, which FHP may change without notice

Introducing The NEW Bosch TW122 10 Ton, High Efficiency Water to Water unit

The new high efficiency water to water product meets current Energy Star tier 3 efficiency standards. It offers all of the features and comfort of a high end residential appliance, coupled with the ruggedness and durability of a premier industrial unit.



TW
SERIES

Model	Dimensions		
	A(width)	B(depth)	C(height)
TW122	29.00	46.00	37.50

The NEW TW122 meets current Energy Star tier 3 efficiency standards.

TW122 Features

- ▶ Copeland scroll compressors offer great efficiency
- ▶ Dual density compressor blankets for quiet operation
- ▶ Black vinyl cabinet with silver brushed aluminum front panels
- ▶ Comfort alert diagnostic module
- ▶ Schrader access ports, high & low pressure switch, and lockout circuit
- ▶ UPM unit protection module standard in -CSC, -CSN models
- ▶ Unit mounted controller standard on -USC, -USN models
- ▶ Single point electrical connections
- ▶ 75VA transformer



For more information go to
www.Bosch-Climate.us
www.BoschWaytoGrow.com

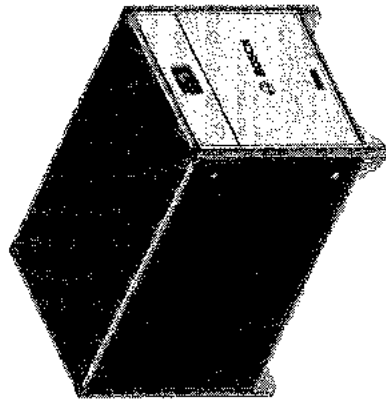


BOSCH



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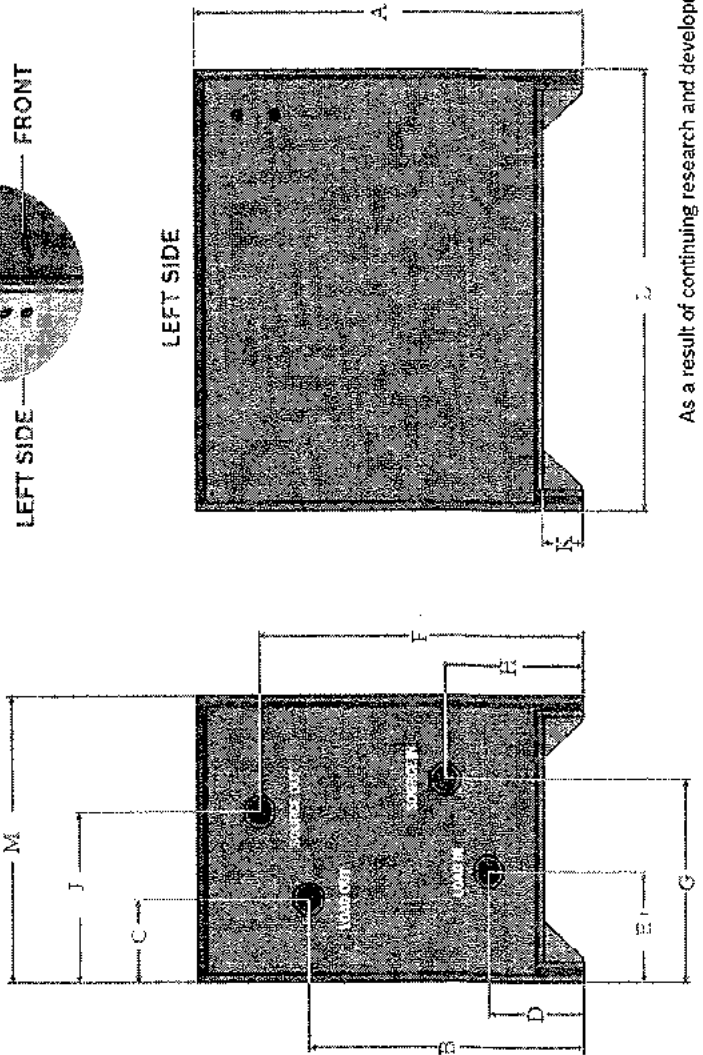
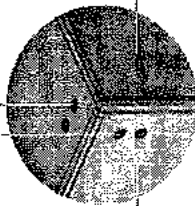
TW122 Series Two Stage Reverse Cycle Chillers



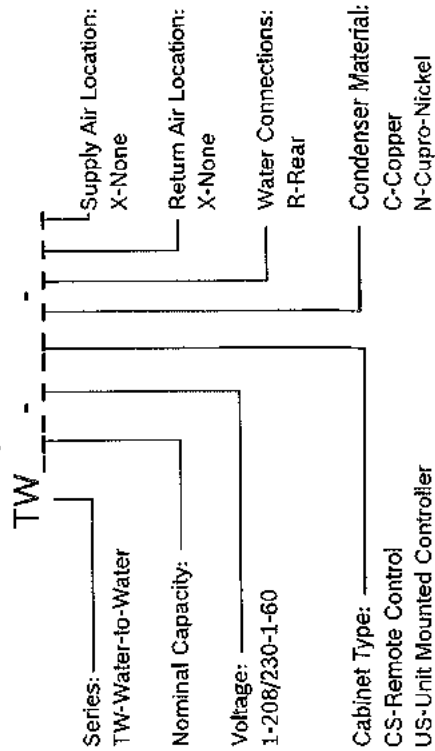
MODEL	Dimensions										Water Conn.		
	A	B	C	D	E	F	G	H	J	K		L	M
TW122	37.50	27.62	7.00	8.38	9.25	33.50	20.75	13.50	17.50	3.50	46.00	28.00	1 1/4" FPT

NOTES: All dimensions within +/- 0.125".
Specifications subject to change without notice.

ELECTRICAL CONNECTIONS



TW Series Reverse Cycle Chiller Nomenclature



BOSCH WATER COOLED CHILLERS AND LOW TEMP BOILERS
SPECIFICATION DATA SHEET

TW122
TW SERIES

ELECTRICAL SPECIFICATIONS

Electrical Characteristics	Elect. Symbol	Compressor X2		Min. Circuit Ampacity	Max. Fuse Size
		RLA	LRA		
208-230/1/60	-1	28.3	178	63.7	90

FLUID FLOW & PRESSURE DROP

Chilled Fluid Side (@ 44°F)		Cond. Fluid Side (@ 104°F)	
Flow (GPM)	ΔP (FOH)	Flow (GPM)	ΔP (FOH)
18	5.4	18	4.7
22	7.7	22	6.7
26	10.5	26	9.1
30	13.6	30	11.9
34	17.0	34	14.9



CHILLER PERFORMANCE - FULL LOAD

Based on 25 GPM load and 30 GPM source fluid flow.

Leaving Load Fluid (°F)	Entering Source Fluid (°F)	Total Capacity (Tons)	Total Capacity (MBtuH)	Power Input (kW)	EER	Heat Rejection (MBtuH)
40°	75°	9.33	111.93	6.73	16.64	134.88
	80°	9.09	109.10	7.15	15.26	133.49
	85°	8.85	106.20	7.60	13.98	132.12
	90°	8.60	103.21	8.08	12.78	130.76
	95°	8.34	100.11	8.59	11.65	129.42
42°	75°	9.67	116.06	6.74	17.23	139.05
	80°	9.43	113.12	7.16	15.80	137.55
	85°	9.18	110.12	7.61	14.47	136.07
	90°	8.92	107.03	8.09	13.23	134.62
	95°	8.65	103.83	8.60	12.07	133.18
44°	75°	10.03	120.31	6.75	17.82	143.34
	80°	9.77	117.28	7.17	16.35	141.75
	85°	9.51	114.16	7.62	14.98	140.16
	90°	9.25	110.95	8.10	13.70	138.59
	95°	8.97	107.65	8.61	12.50	137.04
45°	75°	10.21	122.47	6.76	18.13	145.53
	80°	9.95	119.37	7.18	16.63	143.87
	85°	9.68	116.21	7.63	15.23	142.24
	90°	9.41	112.95	8.11	13.93	140.61
	95°	9.13	109.59	8.62	12.71	139.00
46°	75°	10.39	124.68	6.76	18.43	147.76
	80°	10.13	121.53	7.19	16.91	146.06
	85°	9.86	118.30	7.64	15.49	144.36
	90°	9.58	114.98	8.11	14.17	142.67
	95°	9.30	111.57	8.63	12.93	141.01
48°	75°	10.76	129.18	6.78	19.06	152.31
	80°	10.49	125.91	7.20	17.48	150.49
	85°	10.21	122.56	7.65	16.02	148.67
	90°	9.93	119.12	8.13	14.65	146.86
	95°	9.63	115.60	8.64	13.37	145.08
50°	75°	11.15	133.81	6.79	19.69	156.99
	80°	10.87	130.42	7.22	18.06	155.05
	85°	10.58	126.94	7.67	16.55	153.11
	90°	10.28	123.40	8.15	15.15	151.20
	95°	9.98	119.73	8.66	13.83	149.28

HEATING PERFORMANCE

Based on 25 GPM load and 30 GPM source fluid flow.

Leaving Load Fluid (°F)	Entering Source Fluid (°F)	Total Capacity (MBtuH)	Power Input (kW)	COP	Heat of Abs. (MBtuH)
100°	35°	110.92	8.21	3.96	82.90
	40°	118.43	8.17	4.25	90.54
	50°	134.86	8.10	4.88	107.23
	60°	153.37	8.03	5.60	125.96
	70°	174.16	7.98	6.40	146.94
110°	35°	109.84	9.33	3.45	77.99
	40°	117.03	9.28	3.69	85.36
	50°	132.74	9.19	4.23	101.39
	60°	150.41	9.10	4.84	119.35
	70°	170.28	9.03	5.52	139.45
120°	35°	108.91	10.65	3.00	72.58
	40°	115.77	10.58	3.21	79.66
	50°	130.72	10.46	3.66	95.04
	60°	147.53	10.34	4.18	112.23
	70°	166.42	10.25	4.76	131.45
125°	35°	108.52	11.39	2.79	69.66
	40°	115.20	11.31	2.98	76.59
	50°	129.76	11.17	3.40	91.65
	60°	146.12	11.04	3.88	108.45
	70°	164.52	10.93	4.41	127.24

Units are complete packages featuring 2 stage operation and containing refrigeration compressor, reversing valve, expansion valve metering device and water to refrigerant heat exchangers. Also included are safety controls. Overload protection for compressor, high and low refrigerant pressure switches and a lock-out control circuit.

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Appendix E

VISUAL PLUMES – MODEL INPUTS & OUTPUTS

*Montana Artesian Water Company MPDES Permit
Kalispell, Montana*

Outfall 001 - Effluent Model Inputs

Diffuser: VP plume 23.ypp.db | Ambient: c:\plumes\VP plume 23.001.db | Special Settings | Text Output | Graphical Output

Project: C:\Plumes\VP plume 23

Notes:

Save as File for File name: Case

c:\plumes\VP plume 23.001.db 1 1

After run go to tab

- Diffuser
- Ambient
- Special
- Text
- Graphics

Units Conversion

- Convert data
- Label only

Model Configuration

- Brooks far-field solution
- Graph effective dilution
- Average plume boundary
- Amb. current vector averaging
- Tidal pollution buildup
- Same-levels time-series input

Case selection

- Base or selected case
- Sequential, all ambient list
- Sequential, parse ambient
- All combinations

Diffuser, Flow, Mixing Zone Inputs

Port diameter	n/t	Port elevation	ft	Vertical angle	deg	Hor angle	deg	Num of ports	n/t	Acute mix zone	ft	Chronic max zone	ft	Port depth	ft	Effluent flow	kg/s	Effluent temp	°C	Effluent conc	ppm
0.5		5		0	90	1				6	33	0.8	0.134	0.318	44.1	1					

Parameters for selected row

Froude number	
Eff density (kg/m ³)	
Port vel (m/s)	0.1524
P-dia (m)	0.5
P-dia (ft)	1.0
Case No.	

Time Series Files (optional)

Borrow time-series from project: c:\plumes\VP plume 23

Port depth	Effluent flow	Effluent temp	Effluent conc
	click for file	click for file	click for file

Time-series filename
Time increment (hrs)
Time cycling period
Measurement unit

Outfall 001 – Receiving Water Model Inputs

Diffuser_VP plume 23.vpo.db Ambient c:\plumes\VP plume 23.001.db | Special Settings | Text Output | Graphical Output |

Ambient Inputs

Measurement	Current direction	Ambient velocity	Ambient temperature	Background concentration	Background direction	Far field diffusion coeff
depth	depth	depth	depth	depth	depth	depth
0	0.05	0	47.3	0.01	0	0.0003
1	0.01	0	47.5	0.01	0	0.0003

Measurement	Current direction	Ambient velocity	Ambient temperature	Background concentration	Background direction	Far field diffusion coeff
depth	depth	depth	depth	depth	depth	depth
constant	constant	constant	constant	constant	constant	constant
constant	constant	constant	constant	constant	constant	constant
m/s	deg	mmho/cm	F	ppm	m/s	deg



UM3
 Ambient File Job
 Filename
 VP plume 23.001.db 1 1

Time-Series Files (optional)

Borrow time-series files from project: c:\plumes\VP plume 23

Time-series filename	click for file
Time measurement (hrs)	click for file
Exporting period	click for file
File measurement unit	click for file

Outfall 001 - Model Output

Diffuser: VP plume 23.vpp.db | Ambient: c:\plumes\VP plume 23.001.db | Special Settings: Text Output | Graphical Output

Clear text display | Clear + | Output options | Numerical only

UN3: 10/7/2015 8:53:09 AM

Case 1: ambient file c:\plumes\VP plume 23.001.db; Diffuser table record 1:

Ambient Table:

Depth	Amb-cur	Amb-dir	Amb-con	Amb-tem	Amb-pol	Decay	Far-sp	Far-dir	Disprsn	Density
m	m/s	deg	psu	C	kg/kg	s-1	m/s	deg	m ^{0.67} /s ²	sigma-T
0.0	0.0152	0.0	0.343	8.5	1.0000E-8	0.0	-	-	0.0003	0.151
0.305	0.00305	0.0	0.343	8.5	1.0000E-8	0.0	-	-	0.0003	0.151

Diffuser table:

P-dia	P-elev	V-angle	H-angle	Ports	AcuteMZ	ChrcMZ	P-depth	Ttl-flo	Eff-con	Temp
(ft)	(ft)	(deg)	(deg)	(ft)	(ft)	(ft)	(ft)	(ft ³ /s)	(mmho/cm)	(F)
0.5	5.0	0.0	90.0	1.0	6.0	32.0	0.8	0.134	0.318	44.1
										1.0

Simulation:

Froude number: -16.36; effluent density (sigma-T) 0.202; effluent velocity 0.208(m/s):

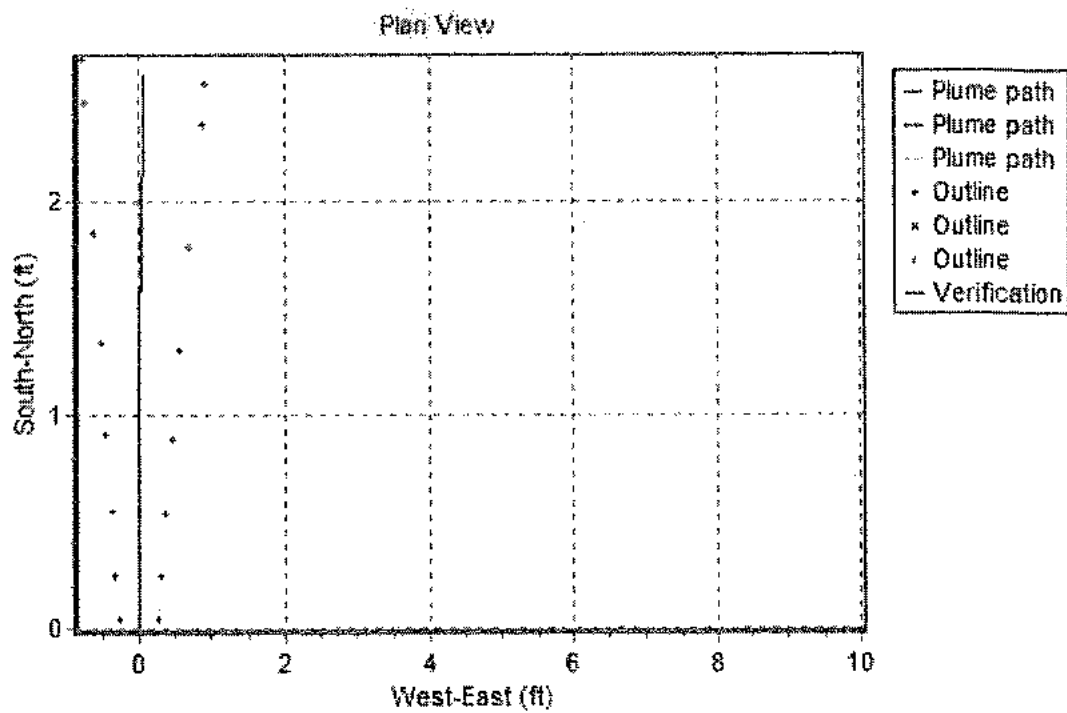
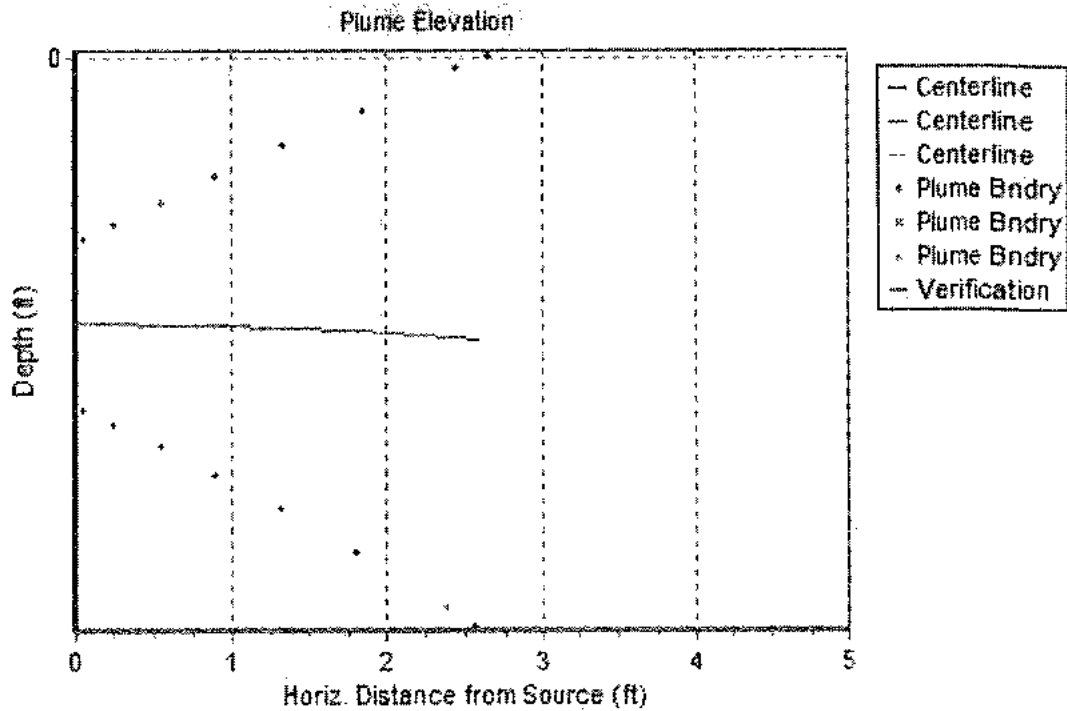
Step	Depth	Amb-cur	P-dia	Temp	Polutnt	Dilutn	x-posn	y-posn
	(ft)	(ft/s)	(ft)	(F)	(ppm)	(ft)	(ft)	(ft)
0	0.8	0.018	0.5	44.1	1.0	1.0	0.0	0.0
40	0.81	0.0176	1.093	45.85	0.458	2.208	0.0212	1.321
63	0.852	0.0161	1.721	46.38	0.294	3.482	0.0834	2.607

stream limit reached;

surface:

8:53:09 AM. amb fills: 2

Outfall 001 – Model Output



Outfall 002 - Effluent Model Inputs

Diffuser: VP plume 19.vpp.db | Ambient: c:\plumes\VP plume 19.001.db | Special Settings | Text Output | Graphical Output

Project C:\Plumes\VP plume 19

Notes:

After run go to tab

- Diffuser
- Ambient
- Special
- Text
- Graphics

Units Conversion:

- Convert data
- Label only

Model Configuration:

- Brooks far-field solution
- Graph effective dilution
- Average plume boundary
- Amb. current vector averaging
- Tidal pollution buildup
- Same-levels time-series input

Case selection:

- Base or selected case
- Sequential, all ambient list
- Sequential, parse ambient
- All combinations

File name: c:\plumes\VP plume 19.001.db 1 1

Diffuser, Flow, Mixing Zone Inputs

Port diameter	Port elevation	Vertical angle	Hor angle	Num of ports	Flow	Acute mix zone	Chronic mix zone	Port depth	Effluent flow	Effluent concn	Effluent temp	Effluent concn
ft	ft	deg	deg		m ³ /s	ft	ft	ft	ft ³ /s	mg/l	°C	mg/l
0.25	5	90	90	1	0.011	6	32	0.8	0.011	0.318	55	1

Parameters for selected row

Flow number	
Eff density (kg/m ³)	
Port vel (m/s)	
P-dia (m)	0.0762
P-dia (ft)	0.25
Case No.	1.0

Time Series-Files (optional)

Borrow time-series from project: c:\plumes\VP plume 19

Port depth	Effluent flow	Effluent concn	Effluent temp	Effluent concn
	click for file	click for file	click for file	click for file

Time-series filename: _____

Time increment (hrs): _____

Time cycling period: _____

Measurement unit: _____

Outfall 002 - Receiving Water Model Inputs

Diffuser: VP plume 19.vpp.db Ambient: c:\plumes\VP plume 19.001.db | Special Settings | Text Output | Graphical Output

Ambient Inputs

Measurement	Current	Current direction	Ambient Conductivity	Ambient Temperature	Background Concentration	Pollutant (axial level)	W	W	W	W	W
depth of Height	depth	depth	depth	depth	depth	depth	depth	depth	depth	depth	depth
Extrapolation (ft)	constant	constant	constant	constant	constant	constant	constant	constant	constant	constant	constant
Extrapolation (ft)	constant	constant	constant	constant	constant	constant	constant	constant	constant	constant	constant
Measurement unit	ft/s	deg	mmho/cm	F	ppm	s-1	m/s	deg	deg	deg	deg
0.0	0.03	0	0.52	45.04	0.01	0	0	0	0	0	0
1	0.01	0	0.52	45.04	0.01	0	0	0	0	0	0



Ambient (Level)
File name
VP plume 19.001.db 11

Time-Series Files (optional)

Borrow time-series files from project: c:\plumes\VP plume 19

Time-series filename	click for file	click for file	click for file	click for file	click for file	click for file
Time measurement (hrs)						
Cycling period						
File measurement unit						

Outfall 002 - Model Output

Diffuser: VP plume 19.vpp.db | Ambient: c:\plumes\VP plume 19.001.db | Special Settings | Text Output | Graphical Output

Clear text display | Clear + | Output options | Numerical only

Case 1: ambient file c:\plumes\VP plume 19.001.db; Diffuser table record 1: -----

Ambient Table:

Depth	Amb-cur	Amb-dir	Amb-con	Amb-tem	Amb-pol	Decay	Far-spd	Far-dir	Disprsn	Density
m	m/s	deg	psu	C	kg/kg	s-1	m/s	deg	m0.67/s2	sigma-t
0.0	0.0152	0.0	0.274	7.8	1.0000E-8	0.0	-	-	0.0003	0.142
0.183	0.0152	0.0	0.274	7.8	1.0000E-8	0.0	-	-	0.0003	0.142

Diffuser table:

P-dia	P-elev	V-angle	H-angle	Ports	AcuteMZ	ChrcMZ	P-depth	Ttl-flt	Eff-con	Temp	Polutnt
(ft)	(ft)	(deg)	(deg)	()	(ft)	(ft)	(ft)	(ft3/s)	(mmho/cm)	(F)	(ppm)
0.25	5.0	0.0	90.0	1.0	32.0	0.8	0.011	0.318	53.0	53.0	1.0

Simulation:

Step	Depth	Amb-cur	P-dia	effleunt density (sigma-T)	Dilutn	x-posn	y-posn	effleunt velocity
(ft)	(ft)	(ft/s)	(ft)	(ppm)	()	(ft)	(ft)	(m/s)
0	0.8	0.0485	0.25	1.0	1.0	0.0	0.0	0.0
87	0.693	0.0493	1.044	0.213	4.878	0.252	0.754	begin overlap;
88	0.69	0.0493	1.056	0.21	4.955	0.258	0.751	matched energy radial vel = 7.2E-3m/s;
100	0.653	0.0496	1.206	0.174	6.017	0.348	0.852	
107	0.628	0.0498	1.302	0.156	6.783	0.411	0.905	end overlap;
108	0.624	0.0498	1.316	0.153	6.904	0.421	0.913	surface;

3:50:56 PM. amb fills: 2

Outfall 002 – Model Outputs

