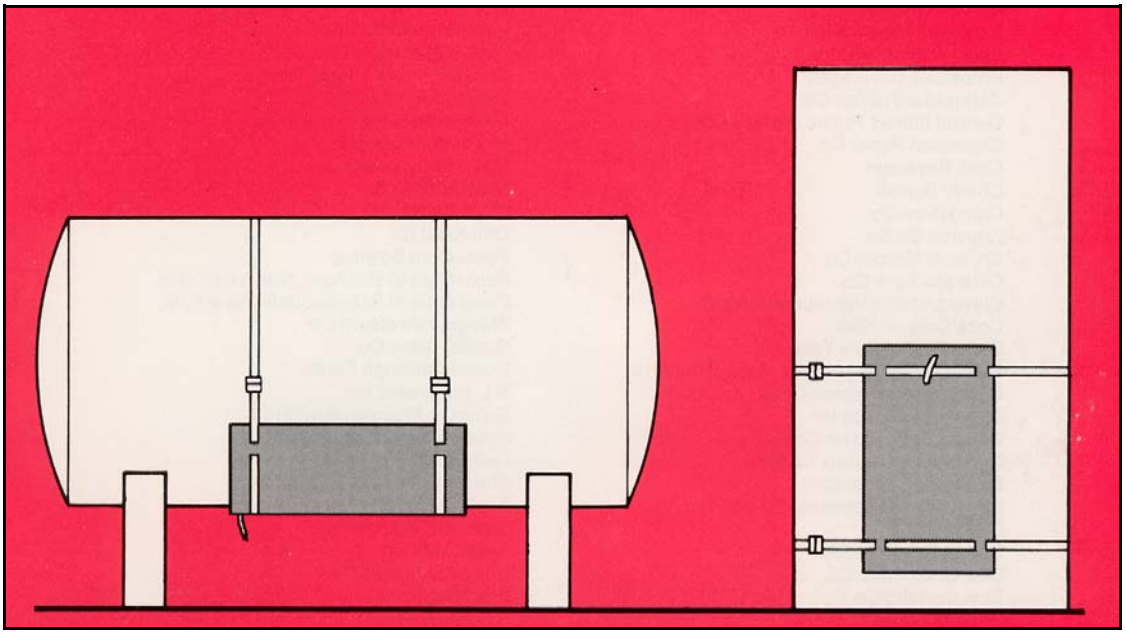
HTD HEAT TRACE

EAGLE

Thermal DesignGuide



HEATING PANELS FOR METAL AND FIBERGLASS TANKS

FM APPROVED

Class I, Div 2, Groups B, C & D
Class II, Div 2
Class III, Div 2
Retested and recertified to current IEEE and NEC Standards in 2003

EGLX-DG-F-6/03

Tank Heating

Thermal Design Guide

For freeze protection and process temperature maintenance applications up 200°F on Metal Tanks and 150°F on Fiberglass (FRP Tanks).

PURPOSE

Tank heating panels or pads, installed on the outside surfaces of tanks, are commonly used to ensure that fluid temperatures within the tanks are *maintained* above ambient temperatures during storage. These low watt density type heaters are safe, reliable alternatives to immersion heaters.

Under certain conditions, tank heating systems may be designed to increase (heat raise) the fluid temperature within a tank.

This Thermal Design Guide provides basic design information for conventional *temperature maintenance applications only* on Metal and Fiberglass (FRP) Tanks.

For design information relating to heat raise applications, or applications involving other types of Plastic Tanks(eg. polyethtylene, polypropylene etc), please consult HTD .

Additionally, HTD offers a free engineering design service for all Tank Heating applications. This service utilizes computerized versions of this Thermal Design Guide and allows the user to quickly review and evaluate many options.These options can only be evalauated after repeated calculations when manually using this guide. If the reader prefers to use our free engineering service please complete the Design Worksheet at the end of this document and fax or e-mail it to HTD at the addresses shown.

INDUSTRY STANDARDS AND PUBLICATIONS

Design considerations, heat loss calculations, installation and maintenances requirements for this type of product and system are extensively covered by IEEE Standard 515-1997. Additional information and requirements are also published in NFPA National Electrical Code under Article 427.

INDUSTRY STANDARDS AND PUBLICATIONS (con't)

The material used in this Thermal Design Guide is consistent with the information, requirements and recommendations of both of these industry standards and publications. This Thermal Design Guide is intended to provide supplementary information only and the reader should consult IEEE Std 515- 1997 and NEC NFPA 70-2002 for full and accurate details on all topics.

PRODUCTS

The material used in this Thermal Design Guide is intended for use with Eagle Tank Heating Panels, reference EGLX 400 and EGLX 500. These products are exclusively manufactured by HTD Heat Trace, Inc

HEAT LOSS FACTORS

The calculation to determine heat losses from a tank is shown in Annex B of the IEEE Std 515-1997. The factors listed in this calculation that can significantly affect the rate of heat loss for each application are shown following. This is the minimum information required to determine the Final Design Heat Loss (*Qtotal*) for all tank heating applications.

- Base heat losses from the insulated tank surface (*Qins*)
- Desired Fluid Maintain Temperature (*Tp*)
- Minimum Ambient Temperature (*Ta*)
- Insulated Tank Area (*A*)
- Thermal Insulation thickness (*x*)
- Thermal Insulation type (*k*)
- Location (Indoors or Outdoors)
- Desired safety factor
- Regional heat losses (slab, supports, manholes)

TANK HEAT LOSS CALCULATION STEPS 1 THROUGH 10

STEP 1
Determine the total insulated surface area of the tank (*A*) using Table 1. The total insulated surface area of a horizontal tank or a vertical tank that is standing above ground level is calculated by adding the areas of both tank ends to the area of the tank barrel. The total insulated area of a vertical tank that is standing on the ground or on a slab is calculated by using the area of one end of the tank plus the area of the tank barrel.

STEP 2
Determine the application ΔT. This is the difference between the desired Fluid Maintain Temperature (*Tp*) and the Minimum Ambient Temperature (*Ta*).

TANK HEAT LOSS CALCULATION STEPS 1 THROUGH 10 (con't)

STEP 3
Refer to Table 2 "Base Heat Losses - Insulated Tanks" and determine the base heat loss(*Qins*) in watts per sq.ft for the application ΔT determined in Step 1. Interpolate to determine the base heat loss values for all applications with ΔT parameters that fall between the values shown in Table 2.

STEP 4
The base heat losses shown in Table 2 have been calculated using the *K* factor for fiberglass insulation. Use Table 3 "Insulation Correction Factors" to determine the appropriate correction factor for the insulation being used.

STEP 5
Use a value 0.9 for all indoor applications. Ignore this Step for all outdoor applications

STEP 6

Use Table 4 to select the Windage Factor applicable to your outdoor application. If no specific Wind Speed Data is available, use the factor of 1.17 for 31 to 50 mph wind speeds.

STEP 7

Determine the Base Heat Loss (*Qins*) for the Insulated Tank by multiplying Steps 1, 3, 4, 5 and 6 together.

STEP 8

HTD recommends a 20% safety factor to satisfy the requirements of IEEE 515 and manufacturing tolerances. Multiply STEP 7 by 1.2 to determine the Base Heat Loss (*Qins*) for your tank.

Before the design can be completed and the number of EGLX Tank Heating Panels to be used can be determined, individual heat loss values must be included for all heat sinks that are integral to the tank body. Typical integral heat sinks are :

- (only when appropriate) the ground or slab that the tank is resting upon
- tank saddles, supports or skirts
- manways or manholes

STEP 9

Using Tables 5A, 5B, 5C, 5D and 5E, determine individual heat loss values (shown in watts) for all heat sinks that are integral to the tank body.

STEP 10

Calculate the Final Design Heat Loss (*Qtotal*) by adding each value determined in Step 9 to the final Base Heat Loss (*Qins*) determined in Step 8.

REFERENCE TABLES

TABLE 1. TANK SURFACE AREAS - USE IN STEP 1

TWO END AREAS FT²		6.3	9.8	14.1	19.2	25.1	31.8	39.3	47.5	56.5	66.3	77.0	88	101	113	127	142	157	226	308	402	503
TANK DIAMETER		2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	12	14	16	18
HEIGHT OR LENGTH	.5	3.1	3.9	4.7	5.5	6.3	7.1	7.8	8.5	9.4	10	10.9	12	12.6	13	14	15	15.7	18.8	21.9	25.1	28.3
	1	6.3	7.8	9.4	11	12.6	14.1	15.7	17	18.8	20	22	24	25.1	27	28	30	31.4	37.7	43.9	50.2	56.5
	2	12.6	15.7	18.8	25.1	27	28	32	35	37.7	41	44	47	50.2	53	57	60	62.8	75.5	87.9	101	113
	3	18.9	23.5	28.3	33	37.7	42	47	52	56.5	61	66	71	75.4	80	85	90	94.2	113	132	151	170
	4	25.1	31.4	37.7	44	50.2	57	63	69	75.4	82	88	94	101	107	114	119	126	151	176	201	220
	5	31.4	39.3	47.1	55	62.8	71	79	86	94.2	102	110	118	126	133	141	149	157	188	220	251	283
	6	37.7	47.1	56.5	66	75.7	85	95	104	113	123	132	141	151	160	170	179	188	226	264	301	339
	7	44.0	54.9	65.9	77	87.9	99	110	121	132	143	154	165	176	187	198	209	220	264	308	352	396
	8	50.2	62.8	75.4	88	101	113	126	138	151	163	176	188	201	213	226	239	251	301	352	402	452
	9	56.5	70.6	84.8	99	113	127	142	155	170	184	198	212	226	240	254	268	283	339	396	452	509
	10	62.8	78.5	94.2	110	126	141	158	173	188	204	220	236	251	267	283	298	314	377	440	502	565
	12	75.4	94.2	113	132	151	170	189	207	226	245	264	283	301	320	339	358	377	452	515	603	618
	14	87.9	110	132	154	176	198	221	242	264	286	305	330	352	374	396	418	440	528	615	703	791
	16	101	126	151	176	201	226	252	276	301	327	352	377	402	427	452	477	502	618	703	804	904
	18	113	141	170	198	226	254	284	311	339	367	396	424	452	486	509	537	545	663	719	904	1017
	20	126	157	188	220	251	283	315	354	377	408	440	471	502	534	565	597	628	754	879	1005	1130
	30	188	236	287	330	377	424	473	518	565	612	659	707	754	800	848	895	942	1130	1319	1507	1702
	40	251	314	377	440	502	565	630	691	754	816	879	942	1005	1108	1130	1193	1256	1507	1758	2010	2260
	50	314	393	471	550	628	707	788	864	942	1021	1099	1178	1256	1335	1413	1492	1570	1884	2198	2512	2825

TABLE 2. BASE HEAT LOSSES (W/SQ.FT) - USE IN STEP 3

Δ T	THERMAL INSULATION THICKNESS				
(° F)	1 "	1½"	2"	3"	4"
50	3.4	2.3	1.7	1.2	0.9
75	5.3	3.6	2.7	1.8	1.4
100	7.1	4.8	3.6	2.4	1.8
125	9.1	6.2	4.6	3.1	2.3
150	11.0	7.5	5.6	3.7	2.8
175	13.2	8.9	6.7	4.5	3.4
200	15.3	10.3	7.7	5.2	3.9
225	17.7	11.9	9.0	6.0	4.5
250	20.0	13.5	10.2	6.8	5.1

TABLE 3. INSULATION CORRECTION FACTORS - USE IN STEP 4

INSULATION TYPE	CORRECTION FACTOR
FIBERGLASS	1.0
POLYURETHANE	0.66
POLYISOCYANURATE	0.67
POLYSTYRENE	0.88
CELLULAR GLASS	1.6
CALCIUM SILICATE	1.5

REFERENCE TABLES (cont)

TABLE 4. WINDAGE FACTORS - USE IN STEP 6

WIND SPEED (MPH)	WINDAGE FACTOR
0 - 10	1.03
11 - 20	1.07
21 - 30	1.12
31 - 50	1.17

TABLE 5A . CONCRETE SLAB OR EARTH FOUNDATION - USE IN STEP 9

	APPLICATION Δ T (° F)				
TANK DIA (FT)	50	100	150	200	250
5	137	278	451	566	711
10	283	573	864	1154	1452
20	566	1163	1760	2325	2922
30	848	1767	2616	3535	4383
40	1131	2388	3518	4649	5906
50	1374	2945	4320	5891	7265

TABLE 5B . CONCRETE SADDLES - USE IN STEP 9

	APPLICATION Δ T (° F)				
TANK DIA (FT)	50	100	150	200	250
5	93	186	275	368	461
10	145	290	430	576	721
15	198	395	586	783	981
20	250	500	741	991	1241

TABLE 5C . UNINSULATED SKIRT - USE IN STEP 9

	APPLICATION Δ T (° F)				
TANK DIA (FT)	50	100	150	200	250
5	402	805	1193	1595	1998
10	806	1612	2389	3195	4000
15	1209	2419	3585	4794	6003
20	1613	3225	4780	6393	8006

TABLE 5D . SUPPORT LEGS (PER LEG) - USE IN STEP 9

	APPLICATION Δ T (° F)				
TANK DIA (FT)	50	100	150	200	250
5	26	52	77	103	129
10 & ABOVE	85	169	351	336	420

TABLE 5E . MANHOLE - USE IN STEP 9 (based upon an uninsulated 24" dia cover and 12" tall base)

APPLICATION Δ T (° F)				
50	100	150	200	250
564	1120	1680	2237	2807

HEAT LOSS EXAMPLE

APPLICATION PARAMETERS

Desired Fluid Maintain Temperature (*Tp*)	80°F
Minimum Ambient Temperature (*Ta*)	-20°F
Tank Size	8ft dia by 12ft high
Tank Material	Fiberglass (FRP)
Thermal Insulation type	Polyurethane
Thermal Insulation Thickness	2"
Tank Location	Outdoors
Maximum Wind Speed	40 mph
Safety Factor	20%
Tank Support	Concrete Pad
Tank Accessories	Two Manholes

CALCULATION

Step 1 Total Surface Area of the Tank (*A)* from Table 1
Barrel Area + One End
301 + 50.5 = 351.5 sq.ft

Step 2 Application Δ T
80 - -20 = 100° F

Step 3 Base Heat Loss from Table 2
3.6 watts/sq.ft

Step 4 Thermal Insulation Correction Factor from Table 3
0.66

Step 5 Tank Location - Outdoors
No adjustment required

Step 6 Windage Factor from Table 4
1.17

Step 7 Base Heat Losses for Tank (*Qins*)
Multiply Steps 1,3,4,5 and 6
351.5 x 3.6 x 0.66 x 1.17
Qins = 977.1 watts

Step 8 Apply Safety Factor to *Qins*
977.1 x 1.2 = 1,172.5 watts

Step 9 Determine losses for heat sinks from Tables 5A and 5E
Concrete Pad (interpolated value) = 248.4 w
Manholes = 2 x 1,120 = 2,240 w

Step 10 Final Design Heat Loss *(Qtotal)*
Step 8 + Step 9
1,172.5 + 248.4 + 2,240

Qtotal = 3,660.9 watts

EGLX HEATING PANEL SELECTION PROCEDURE

Selecting the correct type of EGLX Tank Heating Panel and the correct number of heating panels to use to meet the requirements of the above example is simple.

First, consult the Heating Panel Selection Chart shown in the Eagle Tank Heating Panel sales literature or the EGLX Data Sheet. This shows that the EGLX 500 heating panel is recommeded for use on Fiberglass Tanks with application temperatures up to 120° F.

The EGLX 500 is a 500 watt heating panel. To meet the requirements shown in the above example, divide the Final Design Heat Loss (*Qtotal*) by 500 to determine the number of EGLX heating panels required

3,660.9 / 500 = 7.32

In all instances when the above calculation yeilds a fractionalized number greater than 0.25, always add one more heating panel. In this example, the requirement (0.32) is greater than than 0.25, the correct quantity of heating panels, therefore, will increase to 8.

The final design is completed by specifying the supply voltage for the heating panels and the type of cold lead cable termination that is most suited for your installation. Consult the EGLX Data Sheet for details or contact HTD to discuss your choices.

DESIGN WORKSHEET

HTD Heat Trace, Inc. offers a free engineering design service for all tank heating applications. This service includes all of the calculations shown in this Thermal Design Guide plus :

- Investigation and recommendations for optimum type and thickness of thermal insulation
- Choosing the best style of heating panel to meet the installation requirements
- Heating panel layout and orientation considerations
- Control System choices for each application
- System Pricing and equipment availability

The use of this service is recommended for all hazardous area applications.

Please copy this page, complete the information sections shown and fax to **(908) 534 8023** or scan this page and e-mail to **sales@htdheattrace.com** Designs and proposals are normally completed and returned within 24 hours.

YOUR NAME : _____
TITLE : _____
COMPANY NAME : _____
ADDRESS : _____
_____
_____
TEL # and EXT: _____
FAX # : _____
E MAIL ADDRESS : _____

APPLICATION DETAILS :
Fluid being stored _____
Is the Fluid sensitive to heat _____ (identify max temp if applicable)
Desired Maintain Temperature _____
Minimum Ambient Temerature _____

TANK DETAILS :
Tank Material _____ (identify max temp if applicable)
Tank Thickness _____
Liner Material _____ (identify max temp if applicable)
Tank Style _____ (horizontal, vertical)
Tank Diameter _____
Tank Height (or Length) _____
Tank Support System _____ (concrete pad, legs, skirt, saddles etc)
Specify Tank Base _____ (flat, dished, conical etc)
Specify Tank Top (or Ends) _____ (flat, domed)
Tank Accessories _____ (manholes, ladders etc)
Thermal Insulation Type _____ (HTD can recommend if desired)
Thermal Insulation Thickness _____ (HTD can recommend if desired)
Is the tank fitted with Agitation _____

TANK LOCATION :
Indoors or Outdoors _____
Hazardous area _____ (if YES, specify area Class, Div, Group and T Rating)
Corrosive Environment _____ (specify type of chemicals present)

ELECTRICAL DETAILS :
Supply Voltage _____

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