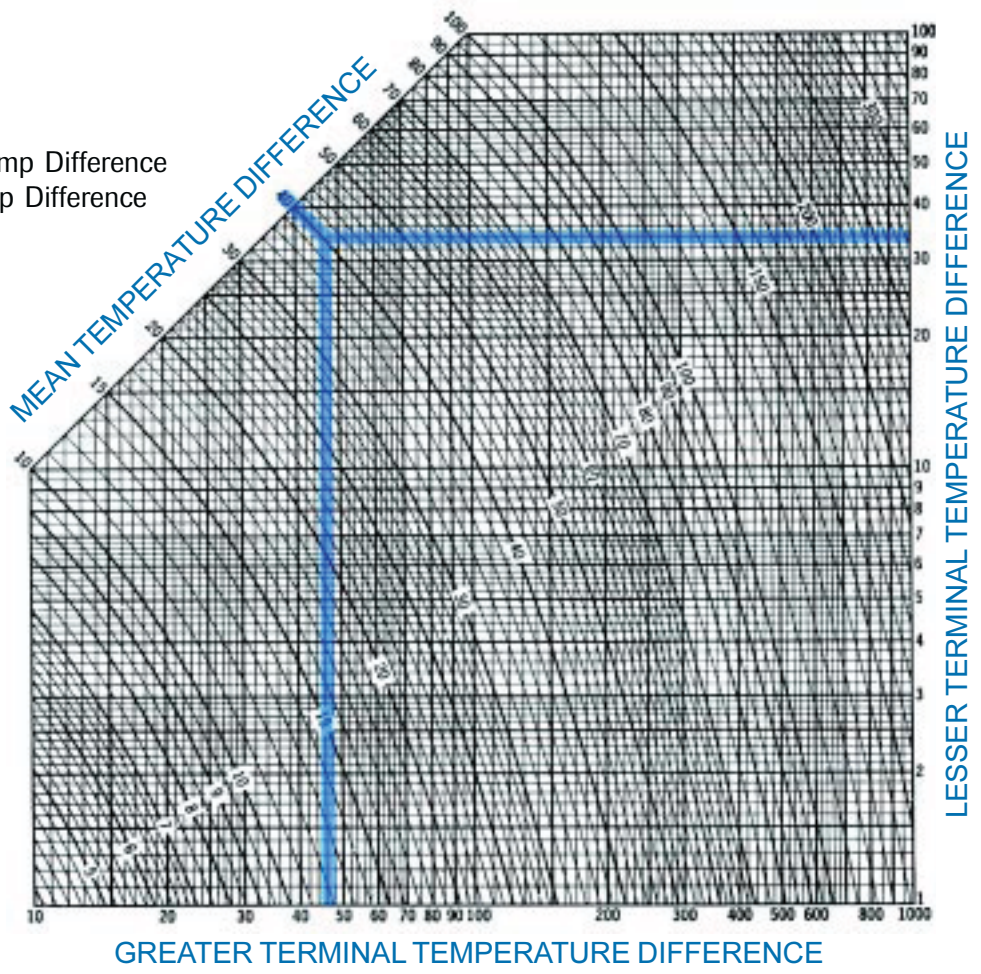
$$LMTD = \frac{(GTTD - LTTD)}{LogN\left(\frac{GTTD}{LTTD}\right)}$$

GTTD = Greater Terminal Temp Difference
LTTD = Lesser Terminal Temp Difference



P

R \ P	0.5	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.6	0.7	0.8	0.9	1.0
0.2								.99	.99	.98	.97	.94	.90	.84	.71
0.4							.99	.98	.97	.95	.92	.85	.70		
0.6						.99	.98	.96	.94	.92	.84				
0.8					.99	.98	.96	.94	.91	.87					
1.0					.98	.97	.94	.91	.86	.77					
2.0			.99	.97	.94	.84	.74								
3.0			.97	.93	.83										
4.0		.99	.95	.85											
5.0		.98	.91												
6.0		.96	.85												
8.0		.93													
10.0	.99	.88													
12.0	.98	.72													
14.0	.97														
16.0	.95														
18.0	.94														
20.0	.91														

$$P = \frac{T_1 - T_2}{t_2 - t_1}$$

$$R = \frac{t_2 - t_1}{T_1 - t_1}$$

Locate Correction Factor at Intersection of "R" and "P"

Correction for LMTD when Using Multi-Pass Heat Exchangers.

Multi-pass heat exchangers cannot take full advantage of counter-current flow, which changes the LMTD for the application.

To correct the LMTD, multiply the value obtained from the above graph by the correction factor obtained from this correction graph. If the P and R values intersect outside the graph, consult the factory to discuss your specific application.

T_1 ..... Hot Fluid Inlet Temp, °F
T_2 ..... Hot Fluid Outlet Temp, °F

t_1 ..... Cold Fluid Inlet Temp, °F
t_2 ..... Cold Fluid Outlet Temp, °F

Sample Calculation To Select the Right Type 500 Heat Exchanger.

Conditions

Process Fluid ..... 20 GPM of SAE 10 Oil to be cooled from 140° to 120°F.

Cooling Medium ... Water at 85°F. Assume a 10° maximum temperature rise.

Cooler Design ..... 4-Pass design is selected to conserve water and energy usage.

Thermal Duty Determination

Q = ΔT • Thermal Duty Value (Chart) • GPM (or air SCFM)

Q = (140-120) • 204 • 20

Q = 81,600 Btuh (Btu's per hour)

Determine Cooling Water Flow Required

Q = Δt(allowable temp rise) • Flow Constant • GPM

$$\frac{Q}{\Delta T \bullet \text{Flow Constant}} = \text{GPM} = \frac{81{,}000}{10 \bullet 500}$$

= 16.3 GPM

Determine Exchanger Surface Required

$$\text{Area} = \frac{Q}{U \bullet \text{Log Mean Temp Difference}}$$

Q = 81,600 Btuh

"U-Value" is obtained from the chart. For light oil the range is from 70-100. Assuming the oil to be typical machine lubricant with moderate fouling characteristics we will use *80* as a conservative U-Value.

Calculate LMTD from graph on facing page

140°	—	120°	(Oil ΔT)
- 95°	—	- 85°	(Water ΔT)
45°	—	35°	

Thus... greater temperature difference = 45°
lesser temperature difference = 35°

Reading from the graph, LMTD = 40°F

$$\text{Area} = \frac{Q}{U \bullet \text{LMTD}} = \frac{81{,}600 \text{ Btuh}}{80 \bullet 40}$$

= 25.5 sq. ft.

Select a Type 500 Heat Exchanger

Refer to the Common Specification chart on page five. Notice that Model 05036 has 24 square feet of surface and is too small for the application.

Model 06036 has 116 tubes and contains 34 sq. ft. of tube surface. Now assure the max flow rate is not exceeded. The previous calculated flow rate is 16.3 GPM. The 06036 has a maximum flow rate of 57 GPM. This is acceptable.

In the event that the required flow rate exceeds the maximum flow rate for the heat exchanger, a larger model is required.

Calculating Actual Heat Exchanger Length

You can calculate the actual length of the heat exchanger required to satisfy a given set of conditions. The typical tube surface contained per linear foot of tubing is:

1/4" Tubing ..... 0.0655 sq. ft per ft. of tubing
3/8" Tubing ..... 0.0982 sq. ft per ft. of tubing
5/8" Tubing ..... 0.1636 sq. ft per ft. of tubing

$$\text{Linear feet of tubing required} = \frac{\text{Area Required}}{\text{No. of Tubes} \bullet \text{Area Per Foot}}$$

Using the previous example...

$$\text{Linear Feet} = \frac{26 \text{ sq. ft.}}{116 \text{ tubes} \bullet 0.0982} = \textbf{2.28 feet}$$

Calculating Tube Side Velocity

You can calculate the velocity of the fluid flowing through the tubes. Velocity should fall between 2 and 6 feet per second and not exceed 8 feet per second. Velocity factors for standard tubing are:

1/4" Tubing ..... 9.66 velocity factor, (Vf)
3/8" Tubing ..... 4.02 velocity factor, (Vf)
5/8" Tubing ..... 1.47 velocity factor, (Vf)

Using the previous example...

$$\text{Velocity (ft./sec.)} = \frac{16.3 \text{ (GPM)} \bullet 4.02 \text{ (Vf)} \bullet 4 \text{ (Passes)}}{116 \text{ (No. of Tubes)}}$$

= 2.26 feet per second in the tubes

Common Heat Transfer Formulas

Btuh	=	Btu/min. • 60
Btuh	=	Horsepower • 2,545
Btuh	=	Kw • 3,413
Btuh Oil	=	GPM (Oil) • 204 • ΔT
Btuh Water	=	GPM (Water) • 500 • ΔT
LMTD °F	=	LMTD °C • 1.8

TYPICAL THERMAL DUTY VALUES

Liquid Type	Constant Value		Spec. Gravity		Spec. Heat		°C Liters/min		°F Gallons/min
Water	500	x	1.0	x	1.0	=	238	or	500
50% Ethlene Glycol	500	x	1.04	x	.83	=	203	or	428
Oil (150 SSU)	500	x	.85	x	.48	=	97	or	204
Air	4.58	x	-	x	.241	=	110 SCFM		

TYPICAL OVERALL U-VALUES

Hot Fluid	Cooling Fluid	U-Value (typical)
Steam	Water	300-500
Steam	Light Oil (SAE 10)	70-100
Steam	Heavy Oil	40-50
Steam	Air	30-40
Water	Water (85°F)	275-325
Oil (SAE 10)	Water (85°F)	70-100
Oil (SAE 30)	Water (85°F)	60-80
50% Glycol	Water	150-180

Note: Higher U-Values apply to clean, low viscosity flows. Use lower U-Values for higher pressure, dirty or viscous fluids as they tend to foul a heat exchanger.

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Hubbed Shell and Tube Heat Exchangers

Straight or U-tube, fixed or removable tubesheet general purpose exchangers designed to cool oil, water, compressed air and other industrial fluids. A variety of port configurations and materials are available. Diameters from 3" (7.62 cm) to 12" (30.48 cm).

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A wide variety of TEMA types are available using pre-engineered or custom designs in various sizes and materials. Shell diameters from 6" (15.24 cm) to 60" (152.4 cm), ASME, TEMA, API, ABS, TUV, ISPESL and other code constructions available.

Brazed Plate Heat Exchangers

Off-the-shelf, standard units reflect the latest in plate heat exchanger technology for maximum performance and low cost. Ideal for OEM or aftermarket applications. Many models stocked and ready to ship. Models for process or refrigeration applications.

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Form 500-322 7/00

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