WOLVERINE TUBE, INC.
Engineering Thermal Innovation

TURBO-A®

For Air Conditioning, Refrigeration and Freezer Applications

Maximum Your ACR Equipment Efficiency

Turbo-A is a seamless copper tube with plain O.D. surface and helical, integral ridges on the I.D. for enhanced heat transfer. The internal ridges significantly improve the efficiency of heat exchangers in which refrigerant condenses or evaporates within the tube. Typical applications include fin and tube evaporator and condenser coils for air conditioners, freezers, and refrigerators.

The tube is typically supplied in Level Wound Coils. However, it can also be provided in straight lengths.

Wolverine Tube also makes products intended for tube and shell heat exchangers. See the Turbo-DX bulletin. In addition, Turbo-ASG and Turbo-AXG, a welded tube with identical characteristic performance to Turbo-A characteristics, is also available.

Alloys Available
UNS C12200, DHP Copper only. CU 99.9% Minimum, P 0.015 to 40%

Application Standards
ASTM B743 (Except Hardness)
ASTM B68
ASTM B75

Product Formats Available
Level Wound Coils on Fiberboard Reels, or Bulk Pack and Banded. Coils are stacked on pallets and packaged in Tubular Corregated Fiberboard Containers, or may be shrink wrapped.

Tempers Available
ASTM H58
ASTM O60
ASTM O50
General Purpose Temper Skin Temper (Straight Only) wooden boxes and shipping frames.

Testing
All Turbo-A is 100% eddy current tested, expansion tested and visually checked for ridge deformities.

Contact us at (256) 353-1310 or mkt@wlv.com

TURBO-A®

Turbo-A and Turbo-ASG Performances

Tube Size inch (mm)	Refrigerant
0.28 (7.0)	22
5/16 (7.94)	22
5/16 (7.94)	410a
3/8 (9.53)	22
3/8 (9.53)	410a

EXPERIMENTAL APPARATUS:

Water cooled counter flow type Coaxial Heat Exchanger

Effective length:	13.3 ft
Refrigerant inside test tube:	R-22
Fluid on Annulus:	Water

TEST CONDITIONS

	Evaporation	Condensation
Test Temperature (° F)	33 - 37	100 - 105
Inlet Vapor Quality (%)	10, ± 1	80, ± 3
Exit Vapor Quality (%)	80, ± 3	10, ± 3
Test flow rate (lb/hr)	60 - 200 in steps of 20 for 3/8” 40 - 160 in steps of 20 for 5/16” 30 - 150 in steps of 30 for 7 mm	100 - 500 in steps of 100 for 3/8” 80 - 400 in steps of 80 for 5/16” 60 - 300 in steps of 60 for 7 mm
Water flow rate (lb/hr)	900 - 1800	1200 - 2400
Minimum water temperature difference (° F)	3	3

CALCULATION OF INTUBE HEAT TRANSFER COEFFICIENT:

Heat Transfer Rate:	$Q = [m\ Cp\ (T_i - To)]water$
Overall Coefficient:	$U_o = Q / A_o / LMTD$
Annulus Coefficient:	$h_o = C_o\ (k / D_h)\ (Re)^{0.8}\ (Pr)^{1/3}\ (m / m_w)$
Intube Heat Transfer Coefficient:	$h_i = [1 / (1 / U_o - 1 / h_o - R_w)]\ (A_o / A_i)$

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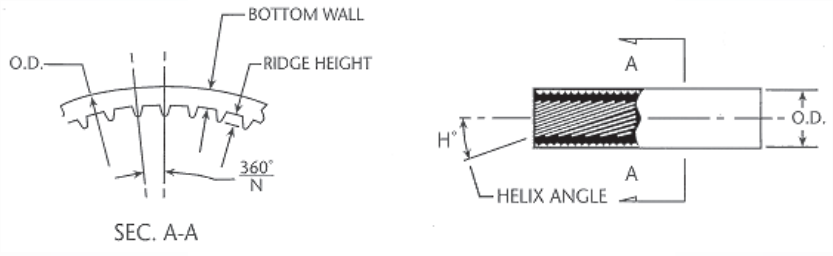
STANDARD SIZES

Catalog Number	Outside Diameter inch (mm)	Bottom Wall inch (mm)	Number of Ridges	Ridge Height inch (mm)	Helix Angle degree	Weight Per Unit Length lb/ft (kg/m)
Turbo-A - UNS C12200						
36-23121208	0.312 (7.92)	0.012 (0.305)	50	0.008 (0.203)	18	0.052 (0.077)
36-23121258	0.312 (7.92)	0.013 (0.318)	50	0.008 (0.203)	18	0.055 (0.082)
36-23131258	0.313 (7.95)	0.013 (0.318)	50	0.008 (0.203)	18	0.055 (0.082)
36-23151208	0.315 (8.00)	0.012 (0.305)	50	0.008 (0.203)	18	0.052 (0.077)
36-23151258	0.315 (8.00)	0.013 (0.318)	50	0.008 (0.203)	18	0.055 (0.082)
36-33651208	0.365 (9.27)	0.012 (0.305)	60	0.008 (0.203)	18	0.062 (0.092)
36-33651608	0.365 (9.27)	0.016 (0.406)	60	0.008 (0.203)	18	0.077 (0.115)
36-33731408	0.373 (9.47)	0.014 (0.356)	60	0.008 (0.203)	18	0.071 (0.106)
36-33741208	0.374 (9.50)	0.012 (0.305)	60	0.008 (0.203)	18	0.063 (0.094)
36-33751208	3/8 (9.53)	0.012 (0.305)	60	0.008 (0.203)	18	0.063 (0.094)
36-33751258	3/8 (9.53)	0.013 (0.318)	60	0.008 (0.203)	18	0.065 (0.097)
36-33751308	3/8 (9.53)	0.013 (0.330)	60	0.008 (0.203)	18	0.067 (0.100)
36-33751408	3/8 (9.53)	0.014 (0.356)	60	0.008 (0.203)	18	0.071 (0.106)
36-33751508	3/8 (9.53)	0.015 (0.381)	60	0.008 (0.203)	18	0.077 (0.115)
36-33751608	3/8 (9.53)	0.016 (0.406)	60	0.008 (0.203)	18	0.079 (0.118)
36-33761208	0.376 (9.55)	0.012 (0.305)	60	0.008 (0.203)	18	0.063 (0.094)
36-33761258	0.376 (9.55)	0.013 (0.318)	60	0.008 (0.203)	18	0.065 (0.097)
36-33761308	0.376 (9.55)	0.013 (0.330)	60	0.008 (0.203)	18	0.067 (0.100)
36-33761358	0.376 (9.55)	0.014 (0.343)	60	0.008 (0.203)	18	0.070 (0.104)
36-33761408	0.376 (9.55)	0.014 (0.356)	60	0.008 (0.203)	18	0.071 (0.106)
36-33761608	0.376 (9.55)	0.016 (0.406)	60	0.008 (0.203)	18	0.079 (0.118)
36-34851710	0.485 (12.32)	0.017 (0.432)	60	0.010 (0.254)	18	0.114 (0.170)
36-35001510	1/2 (12.70)	0.015 (0.381)	60	0.010 (0.254)	18	0.105 (0.156)
36-35001550	1/2 (12.70)	0.016 (0.394)	60	0.010 (0.254)	18	0.107 (0.160)
36-35001610	1/2 (12.70)	0.016 (0.406)	60	0.010 (0.254)	18	0.110 (0.164)
36-35001710	1/2 (12.70)	0.017 (0.432)	60	0.010 (0.254)	18	0.116 (0.172)
36-35001810	1/2 (12.70)	0.018 (0.457)	60	0.010 (0.254)	18	0.122 (0.181)
36-35001910	1/2 (12.70)	0.019 (0.483)	60	0.010 (0.254)	18	0.133 (0.198)
36-53761206	0.376 (9.55)	0.012 (0.305)	65	0.006 (0.152)	25	0.063 (0.094)
36-53761256	0.376 (9.55)	0.013 (0.318)	65	0.006 (0.152)	25	0.065 (0.097)
36-45001310	1/2 (12.70)	0.013 (0.330)	75	0.010 (0.254)	18	0.100 (0.149)
36-45021310	0.502 (12.75)	0.013 (0.330)	75	0.010 (0.254)	18	0.100 (0.149)



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TURBO-A®

Tolerances:	Outside Diameter		± 0.002” Average
	Bottom Wall	Up to 0.017”, inclusive	± 0.001” AAP
		Over 0.017” to 0.024”, inclusive	± 0.002” AAP
	Ridge Height		± 0.002” AAP
	Helix Angle		+ 0, ± 3°
	Weight		± 4%

Other sizes and wall thickness may be available.
Tube Form: Straight length or level wound coil.

SPECIFICATIONS FOR TURBO-A INNER RIDGED COPPER TUBE

Mechanical Properties:

Tensile Strength	Minimum psi - 30,000 (207 MP_a)
Yield Strength	Minimum psi - 9,000 (62 MP_a)
Elongation in 2” (50.8 mm)	Minimum 40%
Grain Size	0.015 - 0.040 mm

Cleanliness and Appearance:

Tubes are clean and bright on the inside and outside surfaces, free from silvers, scale, open grain and major metal defects, such as inclusions. Any residue on the inside of the tube will not exceed 0.0035 g/ft² (0.0377 g/m²).

Dimensions:

24” (609.6mm) ID x 33/38” (838/965 mm) OD x 10” (254.0 mm) wide coil. Reels have arbor hole with 5” (127.0 mm) diameter. Overall reel diameters are 38” (965.2 mm) or 41” (1041.4 mm).

Marking:

Shipping Labels on the outside of each package include the following items.

Dimensions of the tube	Customer’s part number or tagging information
Weight of tube	Name of manufacturer
Customer’s order number	Production order number

NOMENCLATURE:

A_i	Inside area of test tube on inside diameter	(ft2)	**m**	Viscosity of water at average water temperature	[lb/(ft hr)]
A_o	Outside area of test tube	(ft2)	m_w	Viscosity of water at wall temperature	[lb/(ft hr)]
C_o	Sieder & Tate Constant for annulus found by using a Wilson plot method		**Pr**	Prandtl number of water at average water temperature	
C_p	Specific Heat	[Btu/(lb o F)]	**Q**	Heat Rate	(Btu/hr)
D_h	Annulus hydraulic diameter	(ft)	**Re**	Reynolds number of water at average water temperature	
h_i	Inside heat transfer coefficient	[Btu/(hr ft2 o F)]			
h_o	Annulus heat transfer coefficient	[Btu/(hr ft o F)]	R_w	Wall Resistance	(hr ft2 o F/Btu)
k	Thermal conductivity of water	[Btu/(hr ft o F)]	T_i	Water inlet temperature	(o F)
LMTD	Logarithmic Mean Temperature Difference	(o F)	T_o	Water outlet temperature	(o F)
			U_o	Overall heat Transfer coefficient	[Btu/(hr ft2 o F)]
m	Flow Rate	(lb/hr)			

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