

Table 10-3
Characteristics of Tubing

Tube O.D. Inches	B.W.G. Gage	Thickness In.	Internal Area In. ²	Ft ² External Surface Per Ft Length	Ft ² Internal Surface Per Ft Length	Weight Per Ft Length Steel Lb*	Tube I.D. In.	Moment of Inertia In. ⁴	Section Modulus In. ³	Radius of Gyration In.	Constant C**	O.D. I.D.	Transverse Metal Area In. ²
1/4	22	0.028	0.0296	0.0654	0.0508	0.066	0.194	0.00012	0.00098	0.0791	46	1.289	0.0195
	24	0.022	0.0333	0.0654	0.0539	0.054	0.206	0.00010	0.00083	0.0810	52	1.214	0.0158
	26	0.018	0.0360	0.0654	0.0560	0.045	0.214	0.00009	0.00071	0.0823	56	1.168	0.0131
	27	0.016	0.0373	0.0654	0.0571	0.040	0.218	0.00008	0.00065	0.0829	58	1.147	0.0118
3/8	18	0.049	0.0603	0.0982	0.0725	0.171	0.277	0.00068	0.0036	0.1166	94	1.354	0.0502
	20	0.035	0.0731	0.0982	0.0798	0.127	0.305	0.00055	0.0029	0.1208	114	1.230	0.0374
	22	0.028	0.0799	0.0982	0.0835	0.104	0.319	0.00046	0.0025	0.1231	125	1.176	0.0305
	24	0.022	0.0860	0.0982	0.0867	0.083	0.331	0.00038	0.0020	0.1250	134	1.133	0.0244
1/2	16	0.065	0.1075	0.1309	0.0969	0.302	0.370	0.0021	0.0086	0.1555	168	1.351	0.0888
	18	0.049	0.1269	0.1309	0.1052	0.236	0.402	0.0018	0.0071	0.1604	198	1.244	0.0694
	20	0.035	0.1452	0.1309	0.1126	0.174	0.430	0.0014	0.0056	0.1649	227	1.163	0.0511
	22	0.028	0.1548	0.1309	0.1162	0.141	0.444	0.0012	0.0046	0.1672	241	1.126	0.0415
5/8	12	0.109	0.1301	0.1636	0.1066	0.601	0.407	0.0061	0.0197	0.1865	203	1.536	0.177
	13	0.095	0.1486	0.1636	0.1139	0.538	0.435	0.0057	0.0183	0.1904	232	1.437	0.158
	14	0.083	0.1655	0.1636	0.1202	0.481	0.459	0.0053	0.0170	0.1939	258	1.362	0.141
	15	0.072	0.1817	0.1636	0.1259	0.426	0.481	0.0049	0.0156	0.1972	283	1.299	0.125
	16	0.065	0.1924	0.1636	0.1296	0.389	0.495	0.0045	0.0145	0.1993	300	1.263	0.114
	17	0.058	0.2035	0.1636	0.1333	0.352	0.509	0.0042	0.0134	0.2015	317	1.228	0.103
	18	0.049	0.2181	0.1636	0.1380	0.302	0.527	0.0037	0.0119	0.2044	340	1.186	0.089
	19	0.042	0.2299	0.1636	0.1416	0.262	0.541	0.0033	0.0105	0.2067	359	1.155	0.077
	20	0.035	0.2419	0.1636	0.1453	0.221	0.555	0.0028	0.0091	0.2090	377	1.126	0.065
	10	0.134	0.1825	0.1963	0.1262	0.833	0.482	0.0129	0.0344	0.2229	285	1.556	0.259
	11	0.120	0.2043	0.1963	0.1335	0.808	0.510	0.0122	0.0326	0.2267	319	1.471	0.238
3/4	12	0.109	0.2223	0.1963	0.1393	0.747	0.532	0.0116	0.0309	0.2299	347	1.410	0.219
	13	0.095	0.2463	0.1963	0.1466	0.665	0.560	0.0107	0.0285	0.2340	384	1.339	0.195
	14	0.083	0.2679	0.1963	0.1529	0.592	0.584	0.0098	0.0262	0.2376	418	1.284	0.174
	15	0.072	0.2884	0.1963	0.1587	0.522	0.606	0.0089	0.0238	0.2411	450	1.238	0.153
	16	0.065	0.3019	0.1963	0.1623	0.476	0.620	0.0083	0.0221	0.2433	471	1.210	0.140
	17	0.058	0.3157	0.1963	0.1660	0.429	0.634	0.0076	0.0203	0.2455	492	1.183	0.126
	18	0.049	0.3339	0.1963	0.1707	0.367	0.652	0.0067	0.0178	0.2484	521	1.150	0.108
	20	0.035	0.3632	0.1963	0.1780	0.268	0.680	0.0050	0.0134	0.2531	567	1.103	0.079
	10	0.134	0.2894	0.2291	0.1589	1.062	0.607	0.0221	0.0505	0.2662	451	1.442	0.312
	11	0.120	0.3167	0.2291	0.1662	0.969	0.635	0.0208	0.0475	0.2703	494	1.378	0.285
	12	0.109	0.3390	0.2291	0.1720	0.893	0.657	0.0196	0.0449	0.2736	529	1.332	0.262
7/8	13	0.095	0.3685	0.2291	0.1793	0.792	0.685	0.0180	0.0411	0.2778	575	1.277	0.233
	14	0.083	0.3948	0.2291	0.1856	0.703	0.709	0.0164	0.0374	0.2815	616	1.234	0.207
	15	0.072	0.4197	0.2291	0.1914	0.618	0.731	0.0148	0.0337	0.2850	655	1.197	0.182
	16	0.065	0.4359	0.2291	0.1950	0.563	0.745	0.0137	0.0312	0.2873	680	1.174	0.165
	17	0.058	0.4525	0.2291	0.1987	0.507	0.759	0.0125	0.0285	0.2896	706	1.153	0.149
	18	0.049	0.4742	0.2291	0.2034	0.433	0.777	0.0109	0.0249	0.2925	740	1.126	0.127
	20	0.035	0.5090	0.2291	0.2107	0.314	0.805	0.0082	0.0187	0.2972	794	1.087	0.092
	10	0.165	0.3526	0.2618	0.1754	1.473	0.670	0.0392	0.0784	0.3009	550	1.493	0.433
	11	0.150	0.4208	0.2618	0.1916	1.241	0.732	0.0350	0.0700	0.3098	656	1.366	0.365
	12	0.140	0.4536	0.2618	0.1990	1.129	0.760	0.0327	0.0654	0.3140	708	1.316	0.332
	13	0.120	0.4803	0.2618	0.2047	1.038	0.782	0.0307	0.0615	0.3174	749	1.279	0.305
1	14	0.095	0.5153	0.2618	0.2121	0.919	0.810	0.0280	0.0559	0.3217	804	1.235	0.270
	15	0.083	0.5463	0.2618	0.2183	0.814	0.834	0.0253	0.0507	0.3255	852	1.199	0.239
	16	0.072	0.5755	0.2618	0.2241	0.714	0.856	0.0227	0.0455	0.3291	898	1.168	0.210
	17	0.065	0.5945	0.2618	0.2278	0.650	0.870	0.0210	0.0419	0.3314	927	1.149	0.191
	18	0.049	0.6390	0.2618	0.2361	0.498	0.902	0.0166	0.0332	0.3367	997	1.109	0.146
	20	0.035	0.6793	0.2618	0.2435	0.361	0.930	0.0124	0.0247	0.3414	1060	1.075	0.106
	10	0.180	0.6221	0.3272	0.2330	2.059	0.890	0.0890	0.1425	0.3836	970	1.404	0.605
	11	0.165	0.6648	0.3272	0.2409	1.914	0.920	0.0847	0.1355	0.3880	1037	1.359	0.562
	12	0.150	0.7574	0.3272	0.2571	1.599	0.982	0.0742	0.1187	0.3974	1182	1.273	0.470
	13	0.140	0.8012	0.3272	0.2644	1.450	1.010	0.0688	0.1100	0.4018	1250	1.238	0.426
	14	0.120	0.8365	0.3272	0.2702	1.330	1.032	0.0642	0.1027	0.4052	1305	1.211	0.391
1 1/4	15	0.095	0.8825	0.3272	0.2775	1.173	1.060	0.0579	0.0926	0.4097	1377	1.179	0.345
	16	0.083	0.9229	0.3272	0.2838	1.036	1.084	0.0521	0.0833	0.4136	1440	1.153	0.304
	17	0.065	0.9852	0.3272	0.2932	0.824	1.120	0.0426	0.0682	0.4196	1537	1.116	0.242
	18	0.049	1.0423	0.3272	0.3016	0.629	1.152	0.0334	0.0534	0.4250	1626	1.085	0.185
	20	0.035	1.0936	0.3272	0.3089	0.455	1.180	0.0247	0.0395	0.4297	1706	1.059	0.134
	10	0.134	1.1921	0.3927	0.3225	1.957	1.232	0.1354	0.1806	0.4853	1860	1.218	0.575
	11	0.120	1.2908	0.3927	0.3356	1.621	1.282	0.1159	0.1545	0.4933	2014	1.170	0.476
	12	0.109	1.3977	0.3927	0.3492	1.257	1.334	0.0931	0.1241	0.5018	2180	1.124	0.369
	13	0.083	1.4741	0.3927	0.3587	0.997	1.370	0.0756	0.1008	0.5079	2300	1.095	0.293
	14	0.065	1.5236	0.3927	0.3668	0.760	1.404	0.0644	0.0833	0.5136	2400	1.070	0.260
	15	0.049	1.5730	0.3927	0.3749	0.586	1.436	0.0544	0.0700	0.5196	2500	1.045	0.227
2	11	0.120	2.4328	0.5236	0.4608	2.412	1.760	0.3144	0.3144	0.6660	3795	1.136	0.709
	12	0.109	2.4941	0.5236	0.4665	2.204	1.782	0.2904	0.2904	0.6697	3891	1.122	0.648
	13	0.095	2.5730	0.5236	0.4739	1.935	1.810	0.2586	0.2586	0.6744	4014	1.105	0.569
	14	0.083	2.6417	0.5236	0.4801	1.701	1.834	0.2300	0.2300	0.6784	4121	1.091	0.500

Table 10-9
Heat Exchanger Tubesheet Layout Tube Count Table

Note the right column for tubesheet and number of passes per configuration.																
37	35	33	31	29	27	25	23 1/4	21 1/4	19 1/4	17 1/4	15 1/4	13 1/4	12	10	8	I.D. of Shell (in.)
1,269	1,143	1,019	881	763	663	553	481	391	307	247	193	135	105	69	33	3/4 in. on 15/16 in. Δ
1,127	1,007	889	765	667	577	493	423	343	277	217	157	117	91	57	33	3/4 in. on 1 in. Δ
965	865	765	665	587	495	419	355	287	235	183	139	101	85	53	33	3/4 in. on 1 in. □
699	633	551	481	427	361	307	247	205	163	133	103	73	57	33	15	1 in. on 1 1/4 in. Δ
595	545	477	413	359	303	255	215	179	139	111	83	65	45	33	17	1 in. on 1 1/4 in. □
1,242	1,088	964	846	734	626	528	452	370	300	228	166	124	94	58	32	3/4 in. on 15/16 in. Δ
1,088	972	858	746	646	556	468	398	326	264	208	154	110	90	56	28	3/4 in. on 1 in. Δ
946	840	746	644	560	486	408	346	280	222	172	126	94	78	48	26	3/4 in. on 1 in. □
688	608	530	462	410	346	292	244	204	162	126	92	62	52	32	16	1 in. on 1 1/4 in. Δ
584	522	460	402	348	298	248	218	172	136	106	76	56	40	26	12	1 in. on 1 1/4 in. □
1,126	1,008	882	768	648	558	460	398	304	234	180	134	94	64	34	8	3/4 in. on 15/16 in. Δ
1,000	882	772	674	566	484	406	336	270	212	158	108	72	60	26	8	3/4 in. on 1 in. Δ
884	778	688	586	506	436	362	304	242	188	142	100	72	52	30	12	3/4 in. on 1 in. □
610	532	466	396	340	284	234	192	154	120	84	58	42	26	8	XX	1 in. on 1 1/4 in. Δ
526	464	406	356	304	256	214	180	134	100	76	58	38	22	12	XX	1 in. on 1 1/4 in. □
1,072	1,024	904	788	680	576	484	412	332	266	196	154	108	84	48	XX	3/4 in. on 15/16 in. Δ
1,024	912	802	692	596	508	424	360	292	232	180	134	96	72	44	XX	3/4 in. on 1 in. Δ
880	778	688	590	510	440	366	308	242	192	142	100	72	52	30	12	3/4 in. on 1 in. □
638	560	486	422	368	308	258	212	176	138	104	78	60	44	24	XX	1 in. on 1 1/4 in. Δ
534	476	414	360	310	260	214	188	142	110	84	74	48	40	24	XX	1 in. on 1 1/4 in. □
1,092	976	852	740	622	534	438	378	286	218	166	122	84	56	28	XX	3/4 in. on 15/16 in. Δ
968	852	744	648	542	462	386	318	254	198	146	98	64	52	20	XX	3/4 in. on 1 in. Δ
852	748	660	560	482	414	342	286	226	174	130	90	64	44	24	XX	3/4 in. on 1 in. □
584	508	444	376	322	266	218	178	142	110	74	50	36	20	XX	XX	1 in. on 1 1/4 in. Δ
500	440	384	336	286	238	198	166	122	90	66	50	32	16	XX	XX	1 in. on 1 1/4 in. □
1,106	964	844	732	632	532	440	372	294	230	174	116	80	XX	XX	XX	3/4 in. on 15/16 in. Δ
964	852	744	640	548	464	388	322	258	202	156	104	66	XX	XX	XX	3/4 in. on 1 in. Δ
818	724	634	536	460	394	324	266	212	158	116	78	54	XX	XX	XX	3/4 in. on 1 in. □
586	514	442	382	338	274	226	182	150	112	82	56	34	XX	XX	XX	1 in. on 1 1/4 in. Δ
484	430	368	318	268	226	184	154	116	88	66	44	XX	XX	XX	XX	1 in. on 1 1/4 in. □
1,058	944	826	716	596	510	416	358	272	206	156	110	74	XX	XX	XX	3/4 in. on 15/16 in. Δ
940	826	720	626	518	440	366	300	238	184	134	88	56	XX	XX	XX	3/4 in. on 1 in. Δ
820	718	632	534	458	392	322	268	210	160	118	80	56	XX	XX	XX	3/4 in. on 1 in. □
562	488	426	356	304	252	206	168	130	100	68	42	30	XX	XX	XX	1 in. on 1 1/4 in. Δ
478	420	362	316	268	224	182	152	110	80	60	42	XX	XX	XX	XX	1 in. on 1 1/4 in. □
1,040	902	790	682	576	484	398	332	258	198	140	94	XX	XX	XX	XX	3/4 in. on 15/16 in. Δ
902	798	694	588	496	422	344	286	224	170	124	82	XX	XX	XX	XX	3/4 in. on 1 in. Δ
760	662	576	490	414	352	286	228	174	132	94	XX	XX	XX	XX	XX	3/4 in. on 1 in. □
542	466	400	342	298	240	190	154	120	90	66	XX	XX	XX	XX	XX	1 in. on 1 1/4 in. Δ
438	388	334	280	230	192	150	128	94	74	XX	XX	XX	XX	XX	XX	1 in. on 1 1/4 in. □
1,032	916	796	688	578	490	398	342	254	190	142	102	68	XX	XX	XX	3/4 in. on 15/16 in. Δ
908	796	692	600	498	422	350	286	226	170	122	82	52	XX	XX	XX	3/4 in. on 1 in. Δ
792	692	608	512	438	374	306	254	194	146	106	70	48	XX	XX	XX	3/4 in. on 1 in. □
540	464	404	340	290	238	190	154	118	90	58	38	24	XX	XX	XX	1 in. on 1 1/4 in. Δ
456	396	344	300	254	206	170	142	98	70	50	34	XX	XX	XX	XX	1 in. on 1 1/4 in. □
37	35	33	31	29	27	25	23 1/4	21 1/4	19 1/4	17 1/4	15 1/4	13 1/4	12	10	8	I.D. of Shell (in.)

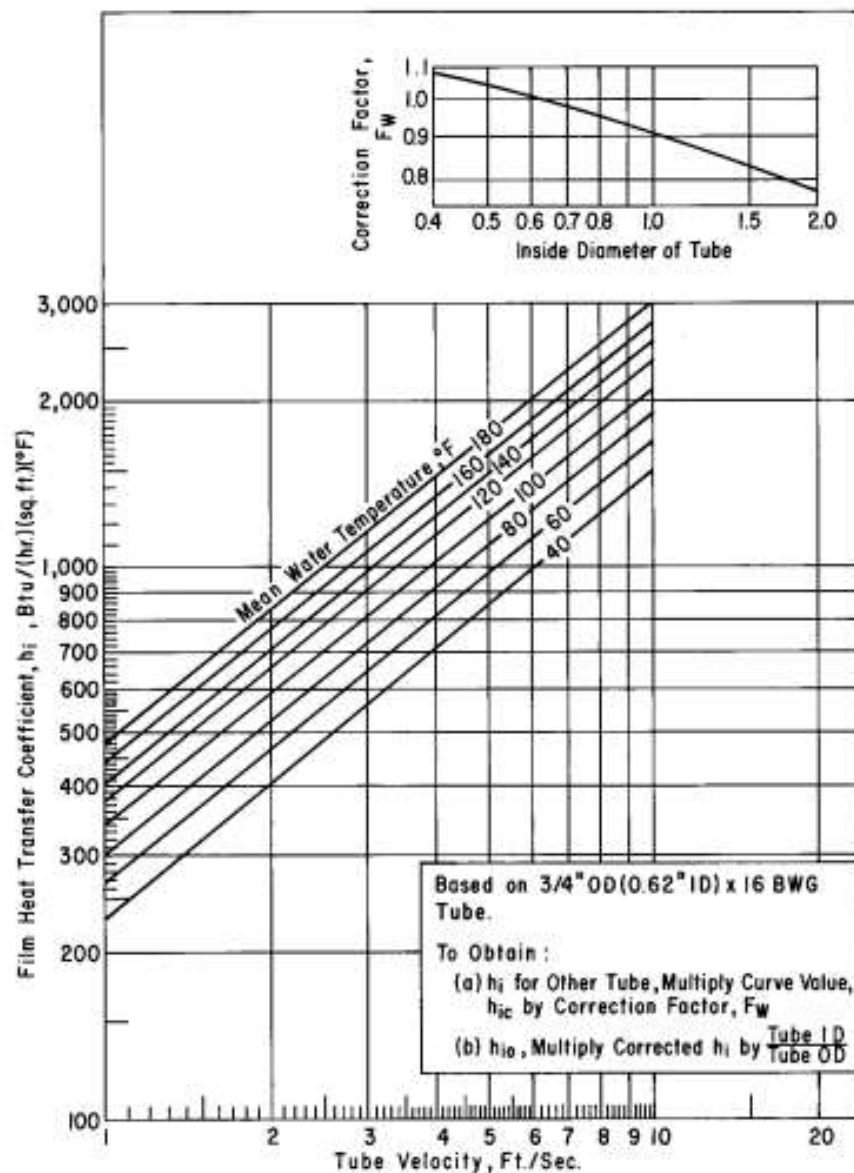
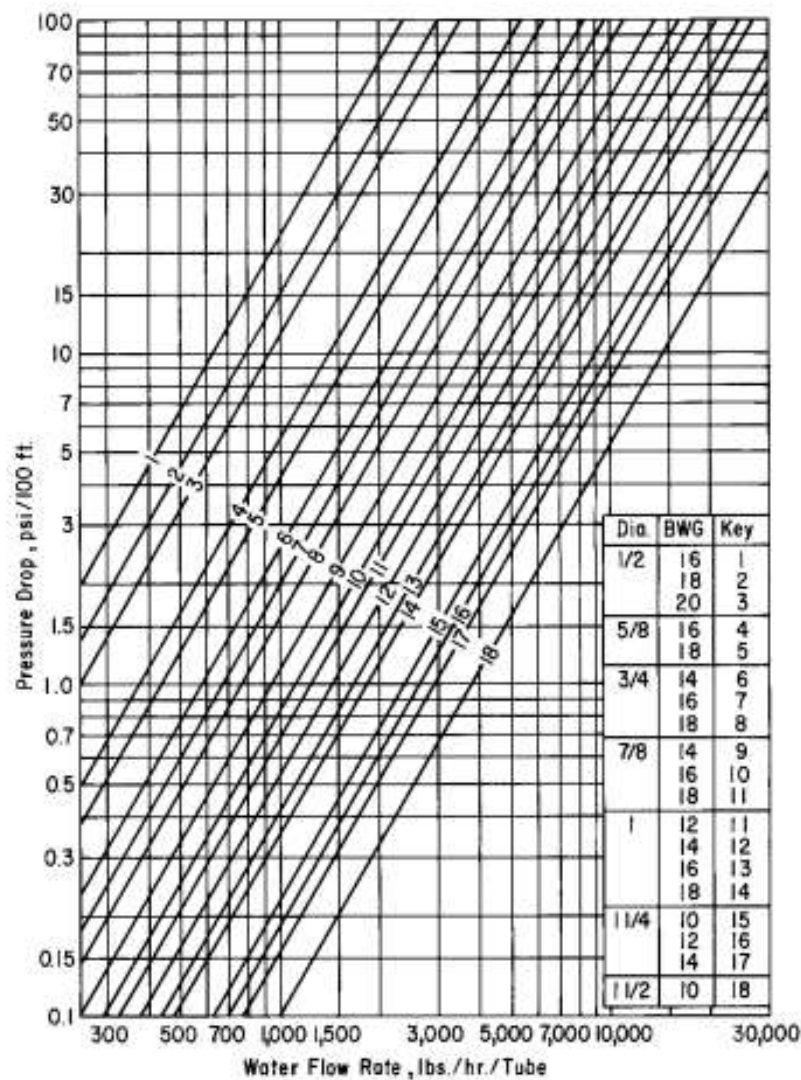


Figure 10-50A. Tube-side film heat transfer coefficient for water. (Used by permission: Kern, D. Q., *Process Heat Transfer*, 1st Ed., ©1950. McGraw-Hill, Inc. All rights reserved. Original adapted from Eagle and Ferguson, *Proc. Royal Society A* 127, 450, ©1930.)

Figure 10-54. Shell-side heat transfer curve for segmental baffles. (Used by permission: Engineering Data Book Section II, ©1959, Wolverine Tube, Inc.)



- (1) For Water Temperature of 120°F, ΔP_t Decreases about 6%.
 For Most Applications Temperature Correction is not Significant.
 (2) Increase ΔP_t by 20% to Allow for Effect of Usual Fouling.

Figure 10-138. Pressure drop for water in smooth tubes at 68°F.
 (Used by permission: *Scovill Heat Exchanger Tube Manual*, 3rd Ed.
 Scovill Manufacturing Co.)

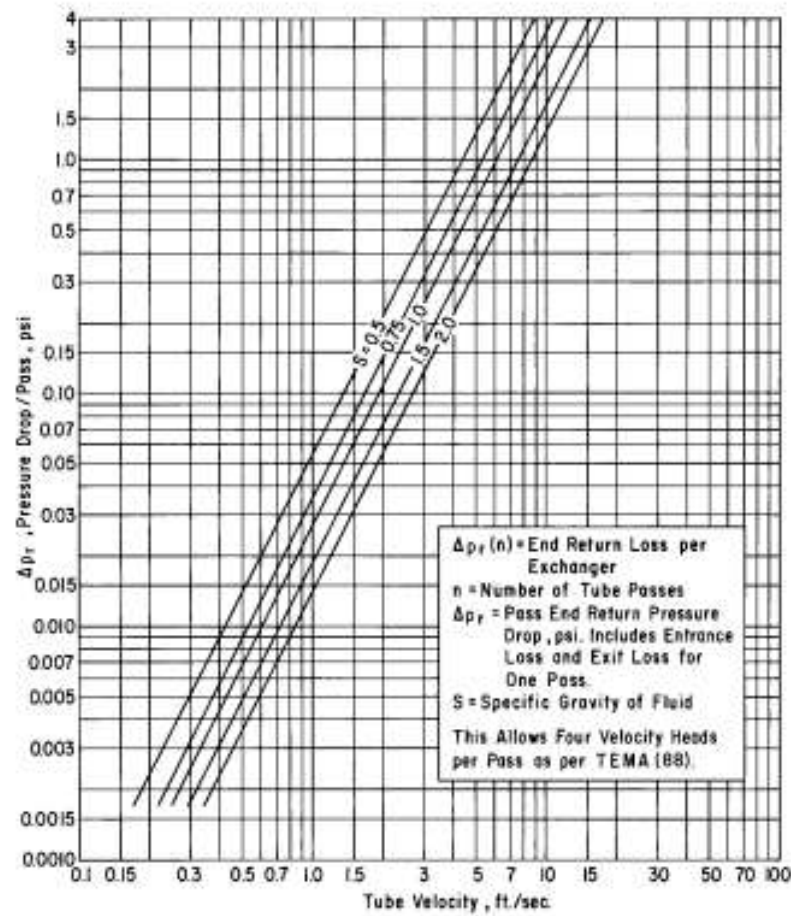


Figure 10-139. Tube side end return pressure drop per tube pass; viscosity close to water.

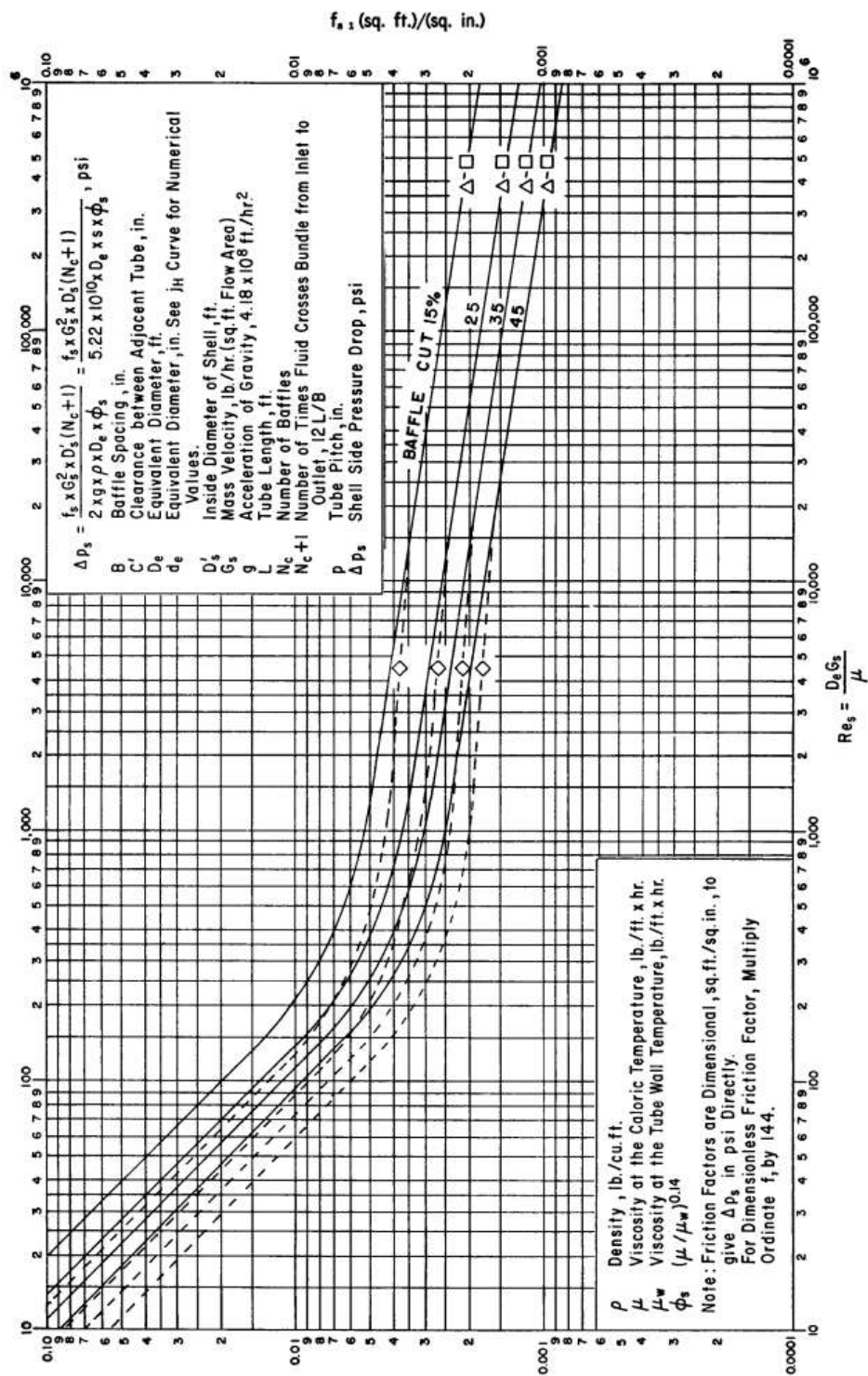


Figure 10-140. Shell-side friction factors for low-finned and plain tubes. (Used by permission: Engineering Data Book, © 1960, Wolverine Tube, Inc.)

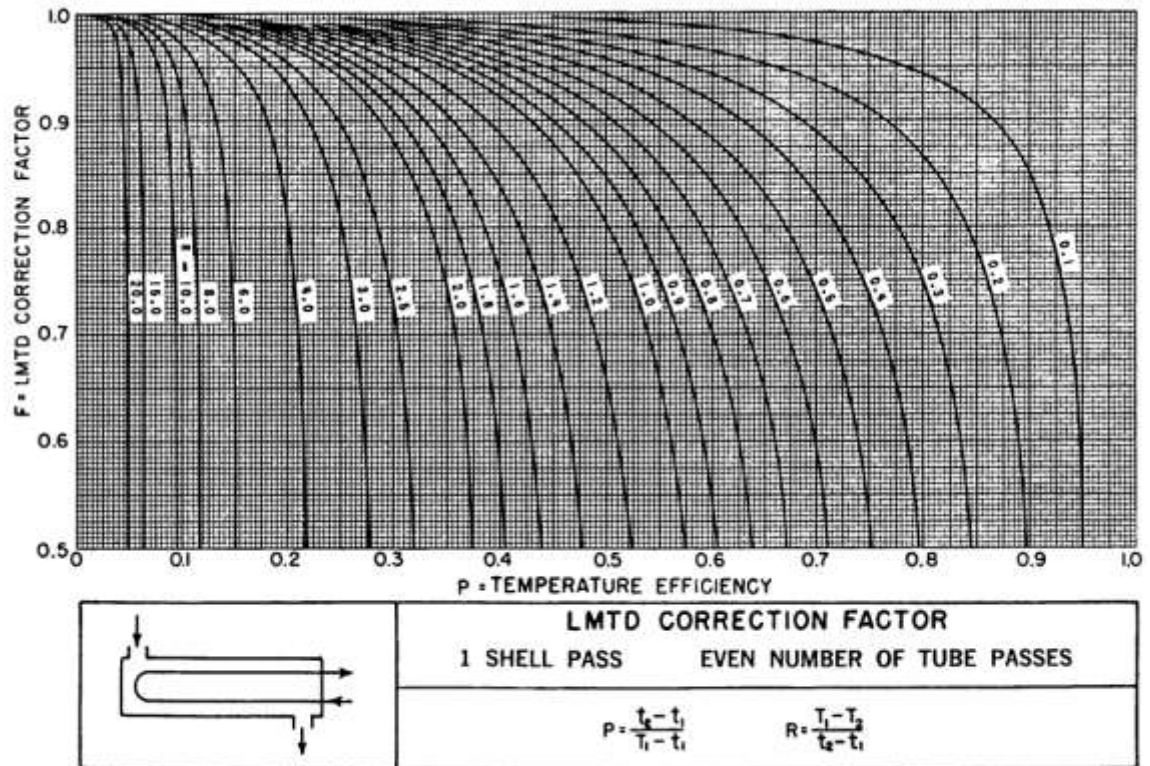


Figure 10-34A. MTD correction factor, 1 shell pass, even number of tube passes. (Figures 10-34A–10-34J used by permission: Standards of Tubular Exchanger Manufacturers Association, 7th Ed., Figure T-32, ©1988, Tubular Exchanger Manufacturers Association, Inc.)