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TEST SERIES A 7

EXPERIMENTAL DETERMINATION OF THE
FRICTION FACTOR FOR THE FORMED TIE ROD LINER
(Title Unclassified)

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by

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INTRODUCTION

The purpose of this memo is to summarize the results of tests on a production type helical tube liner and also a smooth tube liner. The areas which were investigated are:

1. The variation in friction factor as a function of Reynolds number for the helical tube liner.
2. The variation in friction factor as a function of Reynolds number for the smooth tube liner.
3. A comparison of the two friction factors as a function of Reynolds number.

Tests were conducted on both the helical and the smooth tube liners in a fixture of the type shown in Figure 1, using hydrogen at 520 psig and 260 psig at ambient and cryogenic temperatures. Two tubes, one helical with an inside diameter of 0.234 inches and a pitch of 6.0, and one smooth with an inside diameter of 0.235 inches on a pitch of infinity.

METHOD OF OBTAINING RESULTS

Data obtained from the tests was reduced to flow rates, friction factor and Reynolds number by means of a computer program. Tabulated hydrogen properties are introduced into the program to obtain density and viscosity. Values obtained from the tests are presented in Table 1. Calculations of friction factor and Reynolds numbers were based on the inlet conditions of the tube liner.

Friction Factor

The friction factor is defined as:

$$f = \frac{D_e \Delta P D^4 g \rho \pi^2}{L 8 W^2}$$

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$$D^2 = (D_o^2 - D_i^2)$$

$$D_e = \frac{4 \text{ Flow Area}}{\text{Wetted Perimeter}}$$

where

D	= effective tube liner diameter (ft)
D _e	= equivalent diameter (ft)
D _i	= tie rod diameter (ft)
D _o	= inside diameter of the tube liner (ft)
f	= friction factor (dimensionless)
g	= gravitation constant (ft/sec ²)
L	= length of tube liner (ft)
W	= mass rate of flow (FLOW) (lb/sec)
ΔP	= static pressure drop (DP) (lb/ft ²) across the tube liner
ρ	= density (RO) (lb/cu. ft) evaluated at inlet pressure (PIN) and inlet temperature (TIN)

Reynolds Number

The Reynolds number is defined as:

$$Re = \frac{4}{\pi} \frac{W D_e}{\mu D}$$

where

Re	= Reynolds number (RE) (dimensionless)
μ	= viscosity (VISCOSITY) (lb/ft-sec) evaluated at inlet pressure (PIN) and inlet temperature (TIN)

TEST APPARATUS AND INSTRUMENTATION

The flow loop is shown in Figure 2. Hydrogen gas passes through the pressure reducing valve, through the heat exchanger and a copper coil immersed in a dewar of liquid nitrogen and into the inlet plenum of the test fixture. The entire test fixture is immersed in liquid nitrogen in a dewar to obtain isothermal conditions of operation. For ambient tests, the dewars remain empty. From the inlet plenum of the test fixture, Figure 3, the gas passes through the top tie rod centering device into the annulus formed by the tie rod and the tube liner. The flow exhausts from the annulus through the bottom tie rod centering device in the outlet plenum and then through the heat exchanger, a flow control valve, a sonic flow measuring orifice and exhausts to atmosphere. Pressures were measured in the inlet plenum, at the entrance to the tube liner, at the exit of the tube liner, and in the exhaust plenum. The pressure drop across the tube liner was measured by 0-20, 0-50, 0-100 and 0-200 psi differential pressure gauges. Flow rates and the inlet and outlet plenum temperatures were recorded. The outside diameters of the tube liners were measured by means of a micrometer. Measurements were taken 90° apart and 10 points along the length of the tube.

DISCUSSION

Figures 3 and 4, inclusive, present typical friction factor-Reynolds number curves for various test conditions for both the helical and the smooth tube liners. Three areas of interest. The first is the fact that friction factor decreases with increasing Reynolds number. This decrease in friction factor is as expected and is very similar to curves of theoretical basis.

The second area of interest is the fact that the curves of tests on the helical liner lie above the curves of tests on the smooth liner. This is also as expected since the helical liner has a greater relative roughness factor and therefore the friction factor will be higher

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over the same Reynolds number range. The curves for cryogenic tests, Figure 3, and curves for ambient tests, Figure 4, are not in good agreement. No explanation for this discrepancy can be given at this time.

The third area to be considered is shown on Figure 5. The solid curve is taken from Hunsaker and Rightmire*. The data shown on the figure is from smooth tube liner tests. The agreement is very good; the difference is 4% at the maximum deviation.

CONCLUSIONS

1. Friction factor for both the smooth and helical tube liners is dependent on and decreases with increasing Reynolds number for the major part of the Reynolds number range.
2. The friction factor for the helical liner is greater than that for the smooth liner.
3. The friction factor for the smooth liner is in very good agreement with other smooth tube data.

RECOMMENDATIONS

Further investigation should be conducted into the following:

1. The effect of eccentric location of the tie rod on the friction factor for the operating Reynolds number range.
2. The effect of contact between the tie rod and tube liner on the friction factor for the operating Reynolds number range.
3. The effect of bowing the tie rod on the friction factor for the operating Reynolds number range.

*Hunsacker, J. C. and Rightmire, B. G. , "Engineering Applications of Fluid Mechanics".

Figure 1 Tie Rod Tube Liner Test Fixture

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Figure 2 Small Scale Basic Flow System

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Figure 3 Friction Factor vs Reynolds Number for Smooth and Helical Tube Liners

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Figure 4 Friction Factor vs Reynolds Number for Smooth and Helical Tube Liners

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Figure 5 Friction Factor vs Reynolds Number for a Smooth Tube and from Hunsaker & Righire

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TABLE I

HELICAL LINER - LINER DIAMETER 0.224 INCHES

TEST NO.	PIN PSIA	TIN (R)	RO LB/CU FT	VISCOSITY LB/FT-SEC	DP PSI	FLOW LB/SEC	F	RE
8	534.40	543.30	0.180978	6.09296E-06	50.00	1.71073E-02	0.02454	1.17623E 05
	534.40	544.50	0.180586	6.10153E-06	47.70	1.66889E-02	0.02454	1.14585E 05
	534.40	545.00	0.180422	6.10509E-06	43.50	1.58708E-02	0.02473	1.08904E 05
	534.40	545.50	0.180260	6.10866E-06	40.30	1.52194E-02	0.02489	1.04373E 05
	534.40	545.50	0.180260	6.10866E-06	36.50	1.44813E-02	0.02490	9.93119E 04
	534.40	545.00	0.180422	6.10509E-06	29.50	1.29950E-02	0.02501	8.91710E 04
	534.40	544.60	0.180553	6.10224E-06	26.00	1.22555E-02	0.02480	8.41355E 04
	534.40	544.20	0.180684	6.09939E-06	24.00	1.15215E-02	0.02593	7.91338E 04
	534.40	543.40	0.180946	6.09368E-06	20.50	1.07792E-02	0.02534	7.41049E 04
	534.40	542.00	0.181406	6.08368E-06	18.00	1.00437E-02	0.02569	6.91620E 04
	534.40	541.60	0.181538	6.08082E-06	15.60	9.30323E-03	0.02597	6.40929E 04
	534.40	540.70	0.181836	6.07438E-06	13.60	8.55930E-03	0.02679	5.90303E 04
	534.40	540.30	0.181968	6.07152E-06	11.50	7.81326E-03	0.02720	5.39105E 04
	534.40	539.80	0.182134	6.06794E-06	9.60	7.06747E-03	0.02778	4.87934E 04
	534.40	539.30	0.182301	6.06436E-06	7.90	6.32170E-03	0.02860	4.36704E 04
	534.40	538.10	0.182701	6.05576E-06	6.40	5.57935E-03	0.02981	3.85970E 04
	534.40	537.60	0.182868	6.05218E-06	5.00	4.82946E-03	0.03111	3.34291E 04
	534.40	537.60	0.182868	6.05218E-06	3.70	4.08106E-03	0.03224	2.82488E 04
	534.40	537.60	0.182868	6.05218E-06	2.60	3.33090E-03	0.03401	2.30562E 04
	534.40	537.60	0.182868	6.05218E-06	1.70	2.58073E-03	0.03704	1.78636E 04
9	274.40	536.70	0.095037	6.03573E-06	29.00	8.93115E-03	0.02742	6.19892E 04
	274.40	537.20	0.094949	6.03933E-06	26.70	8.58208E-03	0.02732	5.95308E 04
	274.40	538.00	0.094809	6.04509E-06	24.50	8.20097E-03	0.02741	5.68330E 04
	274.40	536.70	0.095037	6.03573E-06	23.30	7.83767E-03	0.02861	5.43996E 04
	274.40	536.40	0.095089	6.03357E-06	20.50	7.46575E-03	0.02776	5.18367E 04
	274.40	536.40	0.095089	6.03357E-06	18.40	7.09021E-03	0.02762	4.92293E 04
	274.40	537.20	0.094949	6.03933E-06	16.60	6.71468E-03	0.02774	4.65774E 04
	274.40	536.70	0.095037	6.03573E-06	15.60	6.41130E-03	0.02862	4.44995E 04
	274.40	537.20	0.094949	6.03933E-06	13.60	5.96087E-03	0.02884	4.13485E 04
	274.40	537.20	0.094949	6.03933E-06	12.20	5.58551E-03	0.02947	3.87447E 04
	274.40	537.20	0.094949	6.03933E-06	10.60	5.21015E-03	0.02942	3.61410E 04
	274.40	537.20	0.094949	6.03933E-06	9.40	4.83479E-03	0.03030	3.35372E 04
	274.40	537.20	0.094949	6.03933E-06	8.00	4.45943E-03	0.03031	3.09335E 04
	274.40	537.20	0.094949	6.03933E-06	7.00	4.08595E-03	0.03159	2.83428E 04
	274.40	537.20	0.094949	6.03933E-06	5.80	3.71213E-03	0.03172	2.57497E 04
	274.40	537.20	0.094949	6.03933E-06	4.50	3.33642E-03	0.03046	2.31436E 04
	274.40	537.20	0.094949	6.03933E-06	3.90	2.96181E-03	0.03350	2.05450E 04
	274.40	537.20	0.094949	6.03933E-06	2.20	2.21012E-03	0.03394	1.53308E 04
	274.40	537.20	0.094949	6.03933E-06	1.70	1.83427E-03	0.03807	1.27237E 04
	274.40	537.20	0.094949	6.03933E-06	1.00	1.45843E-03	0.03543	1.01166E 04

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TABLE I - Continued

SMOOTH LINER - LINER DIAMETER 0.225 INCHES

TEST NO.	PIN PSIA	TIN (R)	RO LB/CU FT	VISCOSITY LB/FT-SEC	DP PSI	FLOW LB/SEC	F	RE
12	534.43	524.10	0.187517	5.95491E-06	35.50	1.81238E-02	0.01796	1.38809E 05
	534.43	523.60	0.187693	5.95128E-06	34.50	1.79118E-02	0.01788	1.37269E 05
	534.43	523.50	0.187728	5.95056E-06	32.00	1.71478E-02	0.01810	1.31430E 05
	534.43	523.75	0.187640	5.95237E-06	29.50	1.63994E-02	0.01824	1.25655E 05
	534.43	523.25	0.187817	5.94875E-06	26.50	1.56346E-02	0.01804	1.19868E 05
	534.43	523.05	0.187887	5.94730E-06	24.00	1.48698E-02	0.01807	1.14033E 05
	534.43	522.75	0.187994	5.94512E-06	21.50	1.41090E-02	0.01799	1.08238E 05
	534.43	522.75	0.187994	5.94512E-06	19.50	1.33440E-02	0.01824	1.02370E 05
	534.43	522.20	0.188189	5.94113E-06	17.00	1.25839E-02	0.01790	9.66026E 04
	534.43	521.80	0.188331	5.93823E-06	15.30	1.18231E-02	0.01826	9.08067E 04
	534.43	522.00	0.188260	5.93968E-06	13.40	1.10575E-02	0.01828	8.49059E 04
	534.43	521.55	0.188420	5.93642E-06	11.80	1.02978E-02	0.01858	7.91162E 04
	534.43	521.50	0.188437	5.93606E-06	10.30	9.52632E-03	0.01895	7.31933E 04
	534.43	521.55	0.188420	5.93642E-06	8.90	8.76576E-03	0.01934	6.73457E 04
	534.43	521.50	0.188437	5.93606E-06	7.60	7.99974E-03	0.01983	6.14642E 04
	534.43	521.00	0.188616	5.93243E-06	6.30	7.23371E-03	0.02012	5.56126E 04
	534.43	521.00	0.188616	5.93243E-06	5.20	6.46768E-03	0.02077	4.97234E 04
	534.43	520.75	0.188705	5.93061E-06	4.20	5.70329E-03	0.02159	4.38602E 04
	534.43	521.00	0.188616	5.93243E-06	3.20	4.93563E-03	0.02195	3.79450E 04
	534.43	520.10	0.188937	5.92589E-06	2.40	4.16720E-03	0.02313	3.20727E 04
	534.43	519.20	0.189259	5.91935E-06	1.80	3.40357E-03	0.02605	2.62244E 04
13	274.43	519.60	0.098151	5.91175E-06	19.20	9.29397E-03	0.01933	7.17017E 04
	274.43	519.60	0.098151	5.91175E-06	18.70	9.14966E-03	0.01942	7.05883E 04
	274.43	519.10	0.098245	5.90810E-06	17.20	8.76913E-03	0.01947	6.76944E 04
	274.43	519.10	0.098245	5.90810E-06	15.70	8.31252E-03	0.01978	6.41696E 04
	274.43	519.10	0.098245	5.90810E-06	14.50	8.00588E-03	0.01969	6.18024E 04
	274.43	519.10	0.098245	5.90810E-06	13.20	7.61964E-03	0.01979	5.88208E 04
	274.43	518.70	0.098320	5.90518E-06	11.80	7.23926E-03	0.01961	5.59120E 04
	274.43	518.40	0.098377	5.90299E-06	10.80	6.85924E-03	0.02001	5.29967E 04
	274.43	518.70	0.098320	5.90518E-06	9.80	6.47575E-03	0.02036	5.00151E 04
	274.43	519.10	0.098245	5.90810E-06	8.70	6.08934E-03	0.02042	4.70074E 04
	274.43	519.10	0.098245	5.90810E-06	7.80	5.70603E-03	0.02085	4.40484E 04
	274.43	520.10	0.098057	5.91540E-06	6.80	5.32068E-03	0.02087	4.10230E 04
	274.43	520.10	0.098057	5.91540E-06	6.00	4.93610E-03	0.02139	3.80578E 04
	274.43	519.60	0.098151	5.91175E-06	5.20	4.55305E-03	0.02181	3.51261E 04
	274.43	519.60	0.098151	5.91175E-06	4.50	4.17000E-03	0.02250	3.21710E 04
	274.43	519.60	0.098151	5.91175E-06	3.70	3.78695E-03	0.02244	2.92158E 04
	274.43	519.60	0.098151	5.91175E-06	3.20	3.40194E-03	0.02404	2.62455E 04
	274.43	519.60	0.098151	5.91175E-06	2.60	3.01911E-03	0.02480	2.32920E 04
	274.43	520.60	0.097964	5.91905E-06	2.00	2.63326E-03	0.02503	2.02902E 04
	274.43	521.10	0.097871	5.92270E-06	1.00	1.86758E-03	0.02486	1.43815E 04

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TABLE I - Continued

SMOOTH LINER - LINER DIAMETER 0.225

TEST NO.	PIN PSIA	TIN (R)	RO LB/CU FT	VISCOSITY LB/FT-SEC	DP PSI	FLOW LB/SEC	F	RE
6	534.24	138.80	0.756012	2.44488E-06	9.00	1.82166E-02	0.01817	3.39823E 05
	534.24	138.80	0.756012	2.44488D-06	8.40	1.76603E-02	0.01804	3.29447E 05
	534.24	138.60	0.757388	2.44278E-06	8.00	1.70246E-02	0.01852	3.17861E 05
	534.24	140.90	0.741907	2.46708E-06	7.20	1.61572E-02	0.01813	2.98694E 05
	534.24	140.90	0.741907	2.46708E-06	6.60	1.54417E-02	0.01819	2.85468E 05
	534.24	141.50	0.737988	2.47346E-06	6.00	1.46332E-02	0.01832	2.69823E 05
	534.24	149.90	0.687744	2.56390E-06	5.50	1.38261E-02	0.01753	2.45949E 05
	534.24	154.60	0.662892	2.61520E-06	5.00	1.29743E-02	0.01744	2.26268E 05
	534.24	187.40	0.529422	2.97535E-06	5.00	1.06065E-02	0.02085	1.62584E 05
	534.24	182.60	0.543830	2.92238E-06	4.50	9.76695E-03	0.02273	1.52429E 05
	534.24	183.70	0.540459	2.93454E-06	3.80	8.99429E-03	0.02249	1.39789E 05
	534.24	184.10	0.539244	2.93896E-06	2.60	7.47285E-03	0.02224	1.15968E 05
	534.24	181.10	0.548496	2.90578E-06	2.20	6.66626E-03	0.02406	1.04632E 05
	534.24	183.00	0.542600	2.92680E-06	1.60	5.80535E-03	0.02282	9.04648E 04
	534.24	184.60	0.537732	2.94448E-06	1.20	5.01194E-03	0.02276	7.76322E 04
	534.24	190.70	0.519953	3.01161E-06	1.00	4.22175E-03	0.02585	6.39349E 04
	534.24	190.20	0.521366	3.00613E-06	0.80	3.43297E-03	0.03136	5.20843E 04
	534.24	190.40	0.520800	3.00832E-06	0.60	2.64978E-03	0.03943	4.01726E 04
	534.24	190.40	0.520800	3.00832E-06	0.30	1.87600E-03	0.03933	2.84416E 04
14	274.52	140.00	0.378753	2.34919E-06	6.30	1.08332E-02	0.01801	2.10321E 05
	274.52	141.35	0.374621	2.36587E-06	5.90	1.03155E-02	0.01840	1.98858E 05
	274.52	140.35	0.377672	2.35352E-06	5.30	9.91729E-03	0.01803	1.92185E 05
	274.52	141.20	0.375075	2.36402E-06	4.90	9.52796E-03	0.01794	1.83820E 05
	274.52	140.60	0.376904	2.35661E-06	4.70	9.13410E-03	0.01881	1.76776E 05
	274.52	141.35	0.374621	2.36587E-06	4.40	8.73530E-03	0.01914	1.68396E 05
	274.52	140.60	0.376904	2.35661E-06	3.90	8.29662E-03	0.01892	1.60568E 05
	274.52	141.95	0.372816	2.37328E-06	3.60	7.93770E-03	0.01887	1.52542E 05
	274.52	142.60	0.370882	2.38130E-06	3.30	7.54282E-03	0.01906	1.44465E 05
	274.52	141.95	0.372816	2.37328E-06	2.90	7.14381E-03	0.01877	1.37286E 05
	274.52	141.95	0.372816	2.37328E-06	2.80	6.75113E-03	0.02029	1.29739E 05
	274.52	142.60	0.370882	2.38130E-06	2.50	6.35175E-03	0.02036	1.21653E 05
	274.52	143.10	0.369410	2.38747E-06	2.30	5.94370E-03	0.02131	1.13544E 05
	274.52	143.75	0.367515	2.39548E-06	2.00	5.54203E-03	0.02120	1.05516E 05
	274.52	143.75	0.367515	2.39548E-06	1.70	5.14343E-03	0.02092	9.79275E 04
	274.52	143.65	0.367805	2.39425E-06	1.50	4.74238E-03	0.02173	9.03382E 04
	274.52	146.00	0.361118	2.42317E-06	1.40	4.34219E-03	0.02376	8.17277E 04
	274.52	145.50	0.362518	2.41703E-06	1.20	3.94152E-03	0.02481	7.43751E 04
	274.52	145.50	0.362518	2.41703E-06	1.00	3.54209E-03	0.02560	6.68378E 04
	274.52	147.10	0.358079	2.43669E-06	0.90	3.14136E-03	0.02893	5.87979E 04
	274.52	147.60	0.356716	2.44282E-06	0.70	2.73715E-03	0.02953	5.11035E 04
	274.52	149.10	0.352695	2.46121E-06	0.60	2.33949E-03	0.03426	4.33527E 04
	274.52	150.25	0.349678	2.47529E-06	0.40	1.93886E-03	0.03297	3.57245E 04

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WANI-TME-522

TABLE I - Continued

HELICAL LINER - LINER DIAMETER 0.224

TEST NO.	PIN PSIA	TIN (R)	RO LB/CU FT	VISCOSITY LB/FT-SEC	DP PSI	FLOW LB/SEC	F	RE
10	534.35	142.00	0.734910	2.47883E-06	16.90	2.03358E-02	0.02383	3.43679E 05
	534.35	139.40	0.752073	2.45126E-06	15.60	1.95159E-02	0.02445	3.33532E 05
	534.35	139.40	0.752073	2.45126E-06	14.20	1.87485E-02	0.02411	3.20417E 05
	534.35	139.40	0.752073	2.45126E-06	11.20	1.63725E-02	0.02494	2.79809E 05
	534.35	139.40	0.752073	2.45126E-06	10.60	1.55713E-02	0.02609	2.66117E-05
	534.35	140.00	0.748030	2.45760E-06	8.50	1.39543E-02	0.02591	2.37867E 05
	534.35	139.40	0.752073	2.45126E-06	9.40	1.47701E-02	0.02572	2.52425E 05
	534.35	141.20	0.740093	2.47032E-06	7.90	1.31539E-02	0.02682	2.23070E 05
	534.35	141.70	0.736844	2.47564E-06	7.00	1.23407E-02	0.02688	2.08829E 05
	534.35	142.20	0.733627	2.48096E-06	6.20	1.15412E-02	0.02710	1.94880E 05
	534.35	142.20	0.733627	2.48096E-06	5.40	1.07417E-02	0.02725	1.81380E 05
	534.35	141.70	0.736844	2.47564E-06	4.80	9.91221E-03	0.02857	1.67734E 05
	534.35	141.70	0.736844	2.47564E-06	4.20	9.11510E-03	0.02956	1.54246E 05
	534.35	143.40	0.726039	2.49378E-06	3.50	8.30251E-03	0.02926	1.39473E 05
	534.35	144.90	0.716805	2.50987E-06	3.00	7.49605E-03	0.03037	1.25118E 05
	534.35	144.90	0.716805	2.50987E-06	2.50	6.69469E-03	0.03173	1.11742E 05
	534.35	146.60	0.706661	2.52819E-06	2.00	5.89014E-03	0.03233	9.76012E 04
	534.35	148.20	0.697412	2.54549E-06	1.60	5.08547E-03	0.03424	8.36946E 04
	534.35	150.90	0.682418	2.57483E-06	1.30	4.28997E-03	0.03826	6.97983E 04
	534.35	154.00	0.666085	2.60868E-06	0.95	3.49714E-03	0.04106	5.61604E 04
	534.35	157.40	0.649164	2.64596E-06	0.70	2.70099E-03	0.04943	4.27639E 04
11	274.35	143.70	0.367432	2.39482E-06	9.50	1.03809E-02	0.02571	1.81594E 05
	274.35	140.60	0.376670	2.35656E-06	8.60	9.88864E-03	0.02629	1.75791E 05
	274.35	140.60	0.376670	2.35656E-06	8.00	9.50577E-03	0.02647	1.68985E 05
	274.35	140.60	0.376670	2.35656E-06	7.20	9.09907E-03	0.02600	1.61755E 05
	274.35	140.60	0.376670	2.35656E-06	6.80	8.70122E-03	0.02685	1.54682E 05
	274.35	140.60	0.376670	2.35656E-06	6.20	8.29822E-03	0.02691	1.47518E 05
	274.35	139.10	0.381328	2.33800E-06	5.80	7.89655E-03	0.02815	1.41492E 05
	274.35	139.10	0.381328	2.33800E-06	5.20	7.49528E-03	0.02801	1.34302E 05
	274.35	140.60	0.376670	2.35656E-06	4.80	7.08787E-03	0.02856	1.26002E 05
	274.35	140.60	0.376670	2.35656E-06	4.30	6.68781E-03	0.02874	1.18890E 05
	274.35	140.60	0.376670	2.35656E-06	3.80	6.29140E-03	0.02870	1.11843E 05
	274.35	140.60	0.376670	2.35656E-06	3.40	5.89256E-03	0.02927	1.04753E 05
	274.35	140.60	0.376670	2.35656E-06	3.10	5.49405E-03	0.03070	9.76682E 04
	274.35	141.70	0.373334	2.37015E-06	2.60	5.08962E-03	0.02974	8.99598E 04
	274.35	141.20	0.374842	2.36397E-06	2.30	4.69034E-03	0.03110	8.31191E 04
	274.35	142.30	0.371541	2.37755E-06	2.00	4.29347E-03	0.03199	7.56513E 04
	274.35	142.30	0.371541	2.37755E-06	1.70	3.89533E-03	0.03304	6.86361E 04
	274.35	143.40	0.368304	2.39112E-06	1.50	3.50069E-03	0.03578	6.13325E 04
	274.35	145.00	0.363705	2.41083E-06	1.20	3.10290E-03	0.03598	5.39187E 04
	274.35	144.60	0.364843	2.40590E-06	1.00	2.70235E-03	0.03965	4.70546E 04
	274.35	145.00	0.363705	2.41083E-06	0.80	2.30368E-03	0.04351	4.00309E 04
	274.35	146.20	0.360338	2.42558E-06	0.60	1.90591E-03	0.04724	3.29174E 04
	274.35	146.10	0.360616	2.42436E-06	0.40	1.51309E-03	0.05000	2.61461E 04

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