

Air flows in a 2-inch diameter circular tube. The tube wall is adiabatic, but friction acts. The adiabatic wall temperature is measured at two stations 1 and 2: $(T_{aw})_1 = 531.62^\circ R$ and $(T_{aw})_2 = 528.98^\circ R$. Station 2 is situated at a distance L downstream of station 1. In addition, at station 1: $p_1 = 63.27$ psia and $M_1 = 0.46$. The recovery factor R at both stations is 0.888. Find: (a) L , (b) p_2 , and (c) Po_2 .

Given

D	2 in	M1	0.46
Taw1	531.62 R	P1	63.27 psi
Taw2	528.98 R	R	53.35 ft-lbf/lbm-R
R	0.888		

At Station 1

4fLmax/D	1.45091		
P1/P**	2.3326	P**	27.125 psi
To	534.05 R		
T1	512.37 R		52.695 F
rho1	0.33331 lbm/ft ³		
V1	510.41 ft/sec		
m*	3.7114 lbm/sec		

At Station 2

T2	488.78 R	488.78	29.112 F
M2	0.68049		* Table B2
R	0.88800	check	
T2/To	0.91524		
To	534.05		
4fLmax/D	0.2487		
P2/P**	1.540		
P2/Po	0.7334		
4fL/D	1.20221		
Tbar	40.904 F		500.6 R
mu	1.1713E-05 lbm/ft-sec		1.844E-05 wrong mu
Re	2.421E+06		
4f	1.004E-02		

L/D	119.8
L	239.5 in
	19.96 ft

P2	41.77 psi
Po2	56.96 psi

Grading

Using constant P_o , P_2/P_o incorrect -3

No P_2/P_o -6.5

Wrong units in calculation -1

Adiabatic wall temperature measurements are made at two surface locations in an adiabatic airflow with friction in a constant-area circular pipe. At location 1, $T_{aw} = 543.01\text{ R}$ and at location 2, $T_{aw} = 539.12$. The value of $4fL/D$ between the locations is 1.9783. The recovery factor $R = 0.888$ at both stations. Other information: $p_1 = 49.8\text{ psi}$, pipe cross-sectional area $A = 2.84\text{ in}^2$.

(a) $M_1 = ?$, (b) $M_2 = ?$, (c) $L = ?$

Given

A	2.84 in ²	
D	1.9016 in	2.84
T_{aw1}	543.01 R	
T_{aw2}	539.12 R	
$4fL/D$	1.9783	
R	0.888	
P1	49.8 psi	
R_{gas}	53.35 ft-lbf/lbm-R	

Calculations

M1	0.41	Guess
$4fL_{max}/D _1$	2.13436	
T_0	545.00 Match	
$4fL_{max}/D _2$	0.15606	
M2	0.73	
T_0	545.00 Match	
T_1/T_0	0.96747	
T_1	527.29 R	
T_2/T_0	0.90368	
T_2	492.52 R	
ρ_1	0.25492 lbm/ft ³	
V1	461.51 ft/sec	
P_1/P^{**}	2.6280	
P^{**}	18.950 psi	
m^*	2.3203 lbm/sec	
$4fL/D$	1.9783	
Tbar	50.232 F	
μ	1.188E-05 lbm/ft-sec	
Re	1.569E+06	
4f	0.010756	
L	349.75 in	
	29.146 ft	

No unit conversion -1