SOLUTIONS MANUAL

Aerodynamics for Engineering Students

Seventh Edition

E.L. Houghton

P.W. Carpenter

S.H. Collicott

D.T. Valentine

AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

Butterworth-Heinemann is an imprint of Elsevier

SOLUTIONS MANUAL

for

Aerodynamics for engineering students, seventh edition

E. L. Houghton, P. W. Carpenter, Steven H. Collicott

and

Daniel T. Valentine

Chapter 4 solutions

1 Solutions to Chapter 4 problems

Problem 4.1: The pressure and temperature are given at the maximum diameter section of a converging-diverging nozzle. In addition, the pressure difference as measured by a Pitot-static tube is gven for two measurement conditions at the throat of the flow passage. We assume that the maximum diameter is well upstream of the throat and that the flow from this section to the throat is isentropic. We also know that $M_t \leq 1$ at the throat. The problem has two parts. The solution via MATLAB is as follows:

```
% P 4.1:
clear;clc
D = 150/1000; % m
Am = pi*D^2/4;
% (a)
% pm = 101000; % N/m/m
% rhom = 1.2256; % kg/m/m/m
% R = 0.286;
% Tm = pm/R/rhom; % K
% dp = (127/1000) * 1000*9.81; % N/m/m, dp = (po - p2) = po*(1-p2po)
% po = 1.009*pm;
% p2 = po - dp;
% ppo = p2/po
% Y=1.4;
% AAstrt = (1/ppo)^(1/Y) * sqrt( ((Y-1)/2)*(2/(Y+1))^((Y+1)/(Y-1)) ...
%    * 1/( 1 - (ppo)^((Y-1)/Y) ) );
% ppo1 = pm/po;
% AAstrm = (1/ppo1)^(1/Y) * sqrt( ((Y-1)/2)*(2/(Y+1))^((Y+1)/(Y-1)) ...
%    * 1/( 1 - (ppo1)^((Y-1)/Y) ) );
% AmAt = AAstrm/AAstrt;
% Dt = sqrt(Am/AmAt)*1000
% (b)
pm = 100300; % N/m/m
R = 0.286;
Tm = 100 + 273;  % K
rhom = pm/R/Tm;
dp = (127/1000) * 13534*9.81; % N/m/m, dp = (po - p2) = po*(1-p2po)
po = 1.009*pm;
p2 = po - dp;
ppo = p2/po
Y=1.4;
AAstrt = (1/ppo)^(1/Y) * sqrt( ((Y-1)/2)*(2/(Y+1))^((Y+1)/(Y-1)) ...
   * 1/( 1 - (ppo)^((Y-1)/Y) ) );
ppo1 = pm/po;
AAstrm = (1/ppo1)^(1/Y) * sqrt( ((Y-1)/2)*(2/(Y+1))^((Y+1)/(Y-1)) ...
   * 1/( 1 - (ppo1)^((Y-1)/Y) ) );
AmAt = AAstrm/AAstrt;
Dt = sqrt(Am/AmAt)*1000
```

Problem 4.2: The MATLAB script developed to solve this problem is as follows:

```
% Problem 4.2
M = 0.87;
p = 46500; % N/m/m
T = 273 - 24.6; % K
R = 286;
Y = 1.4;
a = sqrt(Y*R*T)
rho = p/R/T; % kg/m/m/m
Cpm = -0.5;
dp =  Cpm*0.7*M^2*p
pt = p+dp
ppo = pt/p/2
```