To: Professor Benjamin Shaw
From: Miguel Cuaycong
Date: November 20, 2025
Subject: EME 109 LAB 3 Report - Compressible Flow Nozzle Experiment

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Equations

$$P_{\text{crit ratio}} = \frac{\text{Absolute chamber } P_c}{\text{Absolute inlet } P_I}$$

$$V_{\text{exit}} = \frac{F}{\dot{m}}$$

$$V_{\text{exit}} = c_p * T_0 \left[1 - \frac{P_e}{P_0}^{\frac{k-1}{k}}\right]$$

$$P_b \equiv \text{chamber pressure}$$

$$P_0 \equiv \text{inlet pressure}$$

$$\dot{m} = \rho A V$$

$$\text{speed of sound } C = \sqrt{kRT}$$

$$M_a = \frac{V}{C}$$

$$\frac{T_0}{T} = 1 + \frac{k-1}{2} M_a^2$$

$$\frac{P_0}{P} = \frac{T_0}{T}^{\frac{k}{k-1}} = (1 + \frac{k-1}{2} M_a^2)^{\frac{k}{k-1}}$$

$$\frac{\rho_0}{\rho} = \frac{T_0}{T}^{\frac{1}{k-1}} = (1 + \frac{k-1}{2} M_a^2)^{\frac{1}{k-1}}$$

Can assume ideal gas:

$$P = \rho R T$$

Choked flow occurs when:

$$\frac{P}{P_0} = P_{\text{crit ratio}}$$

$$\frac{T^*}{T_0} = 0.833$$
$$\frac{P^*}{P_0} = 0.528$$
$$\frac{\rho^*}{\rho_0} = 0.634$$

Opening

Findings/Summary

Discussion

0.1 Requirements

table of experimental and theoretical mass flow rate nozzle 1	y/n
table of experimental and theoretical mass flow rate nozzle 3	y/n
plot of experimental and theoretical mass flow rate nozzle 1	y/n
plot of experimental and theoretical mass flow rate nozzle 3	y/n
flow choked?	y/n
table of force calibration data	y/n
plot of force calibration data	y/n
Hysterisis present	y/n
polynomial fit if force cal. data using lm()	y/n
table of the thrust force vs abs chamber pressure nozzle 1	y/n
plot of the thrust force vs abs chamber pressure nozzle 1	y/n
table of the thrust force vs abs chamber pressure nozzle 3	y/n
plot of the thrust force vs abs chamber pressure nozzle 3	y/n
table of theoretical thrust force F	–
a. for the critical pressure ratio	y/n
b. for the condition where a normal shock is predicted at exit	y/n
c. design pressure ratio	y/n
calculate experimental isentropic efficiency of nozzle 1 for crit pressure ratio	y/n
calculate experimental isentropic efficiency of nozzle 1 for crit pressure ratio	y/n
calculate experimental isentropic efficiency of nozzle 3 for crit pressure ratio	y/n
calculate experimental isentropic efficiency of nozzle 3 for crit pressure ratio	y/n

0.2 Theoretical mass flow rate

Governing eq:

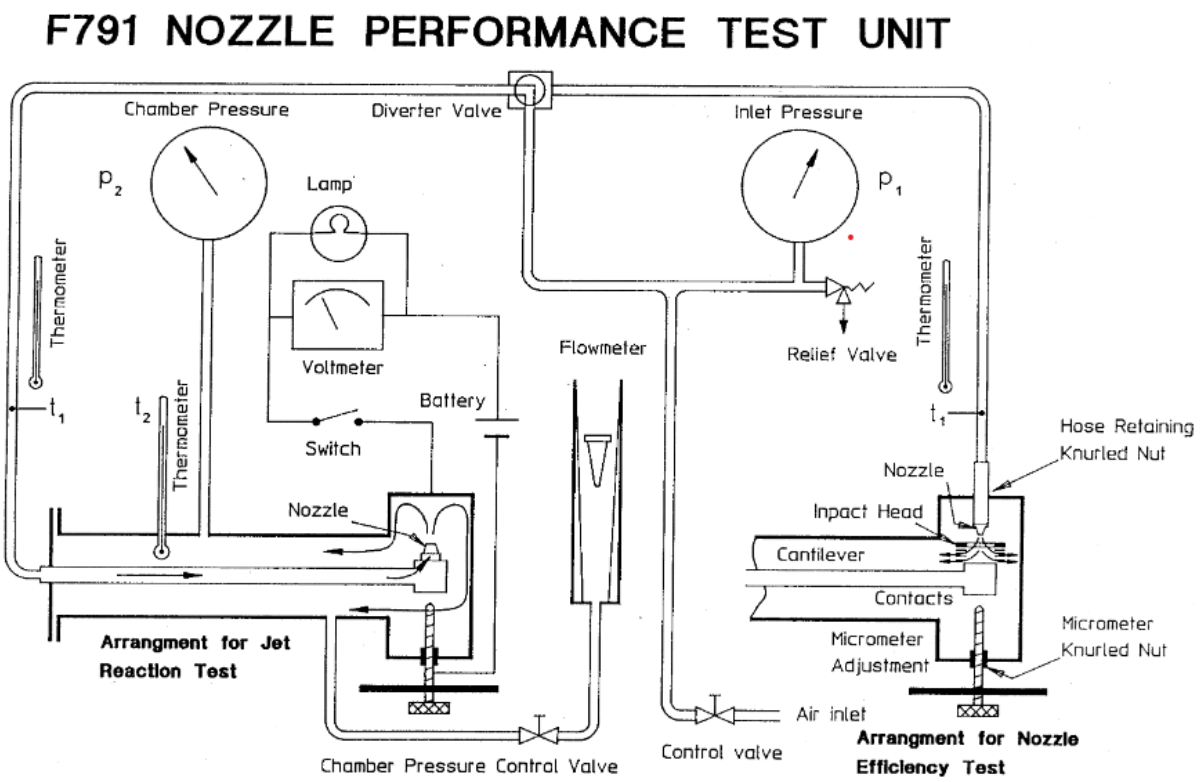
$$\dot{m} = \rho A V$$

The mass flow rate of a converging nozzle can be determined at exit state where:
$\rho = \frac{P_{\text{exit}}}{RT}$
$A = A_{\text{exit}}$
$V =$

Results

Closing

1 Photos


F791 NOZZLE PERFORMANCE TEST UNIT
Chamber Pressure
Diverter Valve
Inlet Pressure
p_2
p_1
Lamp
Thermometer
Voltmeter
Flowmeter
Relief Valve
Thermometer
t_1
t_2
Thermometer
Battery
Switch
t_1
Hose Retaining Knurled Nut
Nozzle
Inpact Head
Nozzle
Cantilever
Contacts
Micrometer Adjustment
Micrometer Knurled Nut
Arrangment for Jet Reaction Test
Air inlet
Chamber Pressure Control Valve
Control valve
Arrangment for Nozzle Efficiency Test


P.A.Hilton Ltd.
F791 Nozzle Performance Test Unit
P.A.Hilton Ltd.