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# **Performance of Convergent and Divergent Nozzle**

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Abstract: A converging – Diverging Nozzle is a passage through which fluid gains kinetic energy and loses pressure. It is also called as an accelerating process. To study the performance, Graphs are to be plotted for pressure variation ( $P_n$ ) along the length o the converging – Diverging Nozzle for different exit pressure Keywords: Converging, Diverging, Mach No., Pressure Head, Velocity.

# I. INTRODUCTION

Compressible fluid is one, the density (Specific volume) of it changes with the change in pressure or temperature of velocity. The effect of compressibility is considered in flow problems of gases. The basic equations governing compressible flow are, Conservation of Mass (Continuity Equation ) is given as

 $m = \rho A V$ Where,

m = mass flow rate (kg/s)

- $\rho$  = density of the fluid (m<sup>3</sup>/s)
- A = Area of the cross section  $(m^2)$
- V = Velocity of the fluid at the section (m/s)



Length of Convergent Section : 200 mm Length Of Throat : 30 mm, Throat Diameter : 28 mm Length Of Divergent Section : 100 mm Connecting Pipe Diameter : 72mm

Fig. 1 Nozzle

Convergent – Divergent nozzle consists of two section , first converging where the section of the nozzle goes on decreasing and second diverging, where the section is increasing. The two sections where they meet is know as throat.  $P_I$ ,  $V_I$ , and  $T_I$  are the properties of fluid at the inlet condition which is the stagnation state and are Pressure, Volume and Temperate respectively. The pressure is measured by using the tube.. The readings along the length of converging Diverging Nozzle ( $P_n$ ) are recorded in terms of water columns

To study the performance, Graphs are to be plotted for pressure variation ( $P_n$ ) along the length o the converging – Diverging Nozzle for different exit pressure. Mach number at inlet and exit of the converging-Diverging Nozzle and Co-efficient of discharge are determined using the equations motioned as above.

## II. EXPERIMENTAL SETUP

The experimental setup consist of AC motor (2 hp) coupled to blower. This blower is connected to the convergent – divergent nozzle. Anemometer is used to measure the velocity at exit of the discharge. The flow rate can be controlled by the changing inlet valve.

The pressure tapings (12 nos) are made in the nozzle surface and are connected to the multi-tube manometer. The control panel consists of the mains on indicator, Starter, and multi-tube manometer. The whole instrument is mounted on a self-contained sturdy iron Frame

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# III. FORMULAS USED

- 1) Q = A X V, Where A = Area at the Pressure Tapping Points in m<sup>2</sup>, V = Velocity in m/s
- 2) Mach No = V/C, Where V = Velocity in m/s, C= Velocity Of sound = 347.76 m/s @  $28^{\circ}$ c
- 3) Area =  $(\pi/4)d^2$ , Where d = Diameter at Pressure tapping Point in m

#### TABLE I Nozzle Details

Sr No	Pressure Tapping No	Nozzle Diameter mm	Nozzle Area m <sup>2</sup>	Distance From Initial Point
1	1	72	0.0040	0
1	1	12	0.0040	0
2	2	70	0.0038	30
3	3	65	0.0033	60
4	4	58	0.0026	90
5	5	50	0.0019	120
6	6	43	0.0014	150
7	7	35	0.0009	180
8	8	28	0.0006	210
9	9	40	0.0012	240
10	10	57	0.0025	270
11	11	70	0.0038	300
12	12	72	0.0040	330

TABLE II Static Pressure Values over Nozzle

State ressure values over nozzie								
Initial Tube	Velocity By	Pressure	Tube Level in	Pressure Head Along				
Level In Multi	Anemometer	Tapping No	Manometer along	Length Of Tube				
Tube			length of Nozzle In (Initial Level – Fir					
Manometer			cm	Level ) cm				
30 cm	12.2 m/s	1	18	12				
		2	18.5	11.5				
		3	18.7	11.3				
		4	19.2	18.8				
		5	20	10				
		6	22	8				
		7	28	2				
		8	44	-14				
		9	38	-8				
		10	37	-7				
		11	36.8	-6.8				
		12	36.5	-6.5				



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Pressure Load Along Pressure in Day Velocity m/s Mach No.								
_	Flessure Head Along	Flessule III Dai	velocity III/s	Mach No				
Pressure	Length Of Tube	Absolute						
Tapping No	(Initial Level – Final	Pressure						
	Level ) mm							
1	12	1.00117	12.2	0.035				
2	11.5	1.00115	12.84	0.036				
3	11.3	1.0011	14.78	0.042				
4	18.8	1.00105	18.76	0.053				
5	10	1.00098	25.68	0.073				
6	8	1.00066	34.85	0.1				
7	2	1.000245	54.52	0.156				
8	-14	0.998	81.33	0.233				
9	-8	0.999	40.66	0.116				
10	-7	0.9995	40.66	0.056				
11	-6.8	0.9997	12.84	0.036				
12	-6.5	0.9998	12.2	0.035				

Table III Experimental Calculated Values over Nozzle

Velocity and Pressure Distribution along length of Nozzle



Fig. 2 Length of Nozzle v/s Pressure, Velocity Graph



# Nozzle Profile and Mach No Variation

Fig. 2 Nozzle profile and mach no variation



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## **IV. CONCLUSION**

From the Graph of Pressure Vs/ Nozzle Length, It is observed that pressure is decreasing on the convergent portion while increases along the length of divergent portion of nozzle.

From the Graph of Velocity Vs/ Nozzle Length, It is observed that Velocity is increasing on the convergent portion while decreases along the length of divergent portion of nozzle.

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