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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)

ρ = density of the fluid (m^3 / s)

A = Area of the cross section (m^2)

V = Velocity of the fluid at the section (m/s)

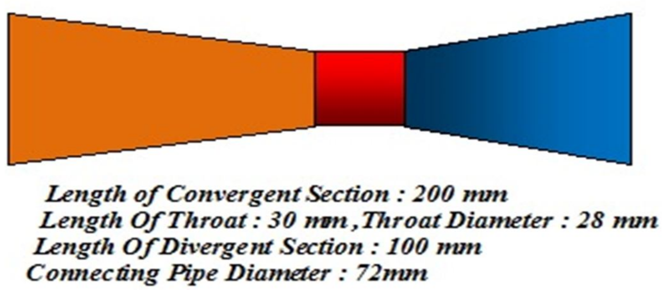

Fig. 1 Nozzle

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

III. FORMULAS USED

1) *Q* = A X V , Where A = Area at the Pressure Tapping Points in m^2 , V = Velocity in m/s
2) *Mach No = V/C , Where* V = Velocity in m/s , C= Velocity Of sound = 347.76 m/s @ 28^0c
3) *Area = (π/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^2	Distance From Initial Point
1	1	72	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

Initial Tube Level In Multi Tube Manometer	Velocity By Anemometer	Pressure Tapping No	Tube Level in Manometer along length of Nozzle In cm	Pressure Head Along Length Of Tube (Initial Level – Final 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

Table III
Experimental Calculated Values over Nozzle

Pressure Tapping No	Pressure Head Along Length Of Tube (Initial Level – Final Level) mm	Pressure in Bar Absolute Pressure	Velocity m/s	Mach No
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

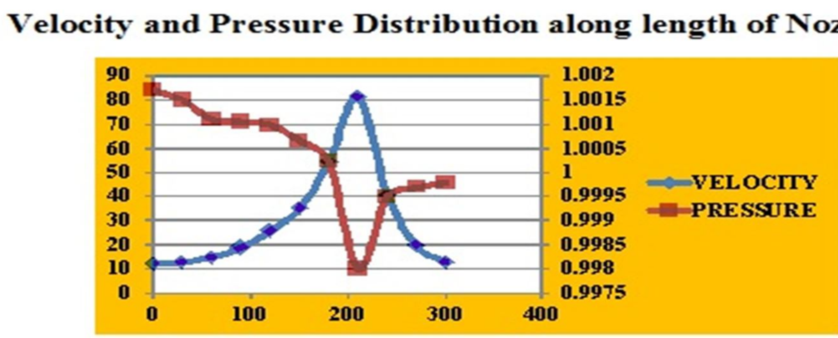

Fig. 2 Length of Nozzle v/s Pressure, Velocity Graph

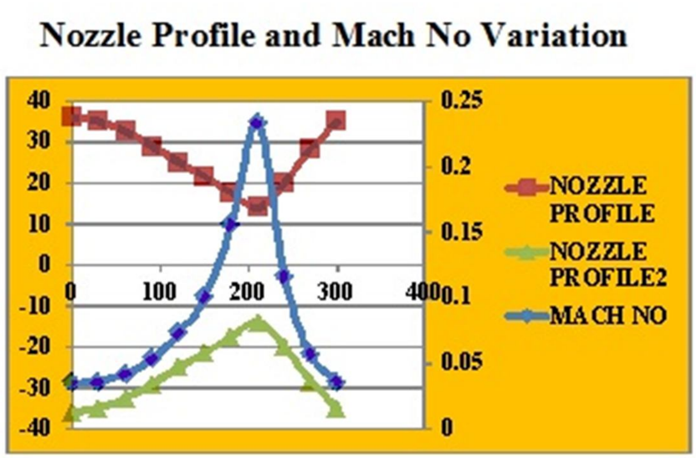

Fig. 2 Nozzle profile and mach no variation

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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