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Experimental Analysis of Vacuum Damped Recoil System

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Abstract: ***Vacuum damped recoil system is simple and reliable one, for its study an experimental model is developed by using the various components like pneumatic cylinder, barrel, vacuum gauge, load cell and indicator. The experimentation is carried out for two different pneumatic cylinders. The experimental analysis is carried out. The result obtains through experimentation and its analysis establishes relation between force, vacuum and recoil time which discuss in this paper.***
Key Words: ***Recoil time, Recoil length, in-battery position, experimental analysis.***

I. INTRODUCTION

The primary purpose of a recoil system is to eliminate weight and at the same time retain stability. It also minimizes the requirement for ruggedness. A recoil system is designed to absorb the energy of recoil gradually, thus avoiding violent shock to, or movement of the carriage and to return the recoiling parts to original position with a minimum of shock. It must also hold the recoiling parts in battery until the weapon is fired again. The four functions of the recoil system are to –

A. Stop the recoiling parts.
B. Return the recoiling parts to the firing position that is to the in-battery position.
C. Perform the above action without excessive shock to carriage.
D. Hold the tube and recoiling parts in the firing position throughout all angles of elevation.

Use of recoil mechanism has greatly enhanced the performance of the gun. In recent years, the development trends of artillery weapons with recoil mechanisms focus on the vehicular integration. It can increase the mobility of artillery weapons. Therefore, a small volume, high recoil efficiency, and low cost of the recoil mechanism which can be easily developed are very important.

II. EXPERIMENTAL SETUP

An experiment model of vacuum damped recoil system is shown in fig. 1. An experiment model is consist of following main parts –
Pneumatic Cylinder: It is main part of vacuum damped recoil system, in which vacuum is generated. The two different pneumatic cylinders of size 30*160 and 40*300 are used.
Vacuum Gauge: It is used to measure vacuum generated in pneumatic cylinder.
Barrel: Is connected to piston rod of cylinder and which is of 2 kg in mass.
Load Cell: Load cell is used to measure force exerted on barrel.
Indicator: Indicator is used to indicate force measured by load cell.

Fig. 1 Experimental Model of vacuum damped recoil system

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III. ARRANGEMENTS OF EXPERIMENTAL MODEL

For experimentation following arrangements are carried out-

A. To avoid the movement of experimental model fixed the stand rigidly on table.
B. After fixing the stand pneumatic cylinder is connected at one end to the stand by using arrangement provided on stand.
C. Vacuum gauge is fixed to port 1 of cylinder to measure vacuum generated.
D. Barrel is connected to the end of piston rod of cylinder.
E. Load cell is connected to the one end of barrel. The magnitude of force is shown by indicator which is connected to load cell.
F. After arranging all the component of experimental model experimentation is carried out.

IV. EXPERIMENTATION PROCEDURE

The procedure for experimentation is as below
The barrel is pulled manually, the value of vacuum record by vacuum gauge the length of the stroke simultaneously measured, so also the force requires to pull the barrel is also recorded. The time required by the barrel to reach its original position is measure by using MPC-HC video player in millisecond by playing the video which is taken during the experimentation.40 readings are taken for each setup of vacuum cylinder.

V. OBSERVATION AND READINGS

From experimentation there are 40 readings take for each cylinder of size 32*160 and 40*300. In the following tables 10 sample readings for each cylinder are tabulated.
For 32*160

Table I
Sample readings of cylinder 32*160

Sr. No	Cylinder (Dia.*Stroke)	Force (N)	Displacement (mm)	Recoil time (sec.)	Vacuum pressure (N/mm2)
1	32*160	56.686	62	0.116	0.0704
2	32*160	57.184	66	0.118	0.0711
3	32*160	57.623	70	0.12	0.0716
4	32*160	58.224	72	0.122	0.0723
5	32*160	58.689	75	0.124	0.0729
6	32*160	59.233	77	0.126	0.0736
7	32*160	59.721	78	0.128	0.0742
8	32*160	60.223	80	0.13	0.0748
9	32*160	60.618	82	0.132	0.0753
10	32*160	61.113	84	0.134	0.0759

From the above readings the relation observed between parameters such as recoil time, displacement, vacuum pressure and force are more clear from the following graphs.

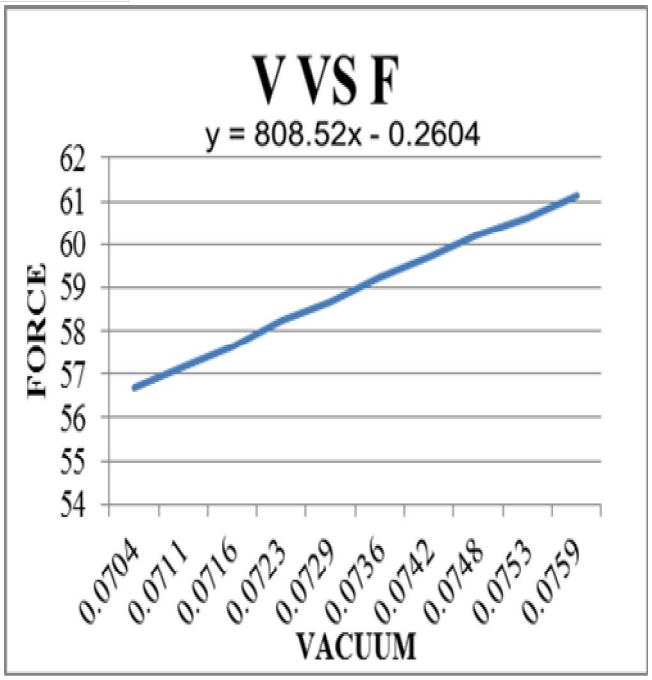

Fig. 2 Vacuum pressure Vs. Force

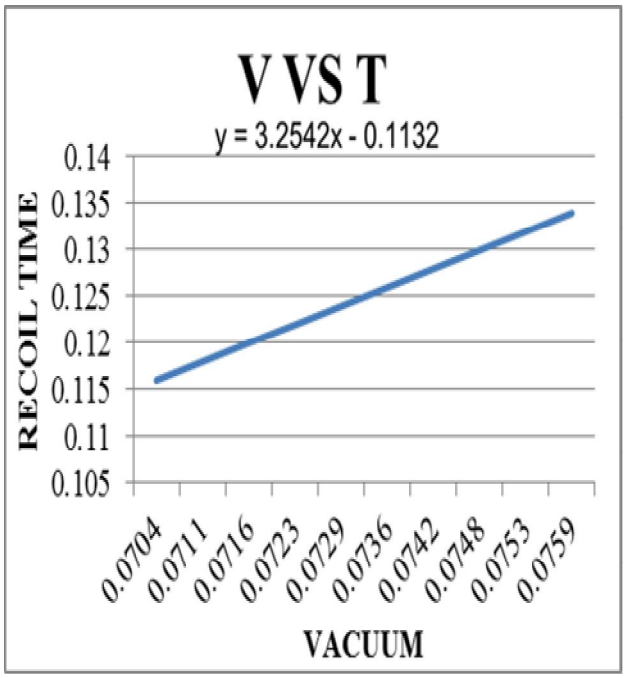

Fig. 3 Vacuum pressure Vs Recoil Time

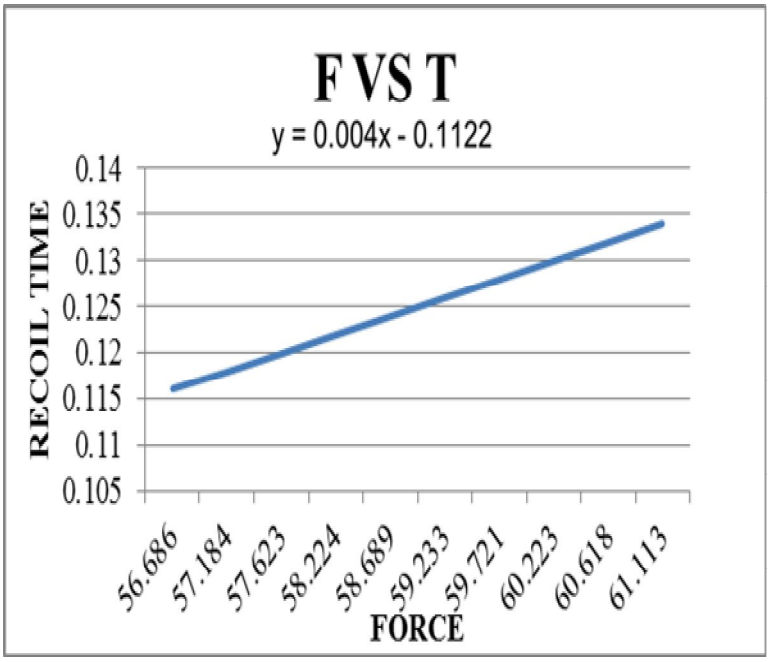

Fig. 4 Force Vs Recoil Time

From the above graphs it comes to understand relation between parameters of vacuum damped recoil system as follow –

A. *Vacuum pressure Vs. Force :* with the increase of vacuum pressure the force is goes on increasing.
B. *Vacuum pressure Vs Recoil Time:* with the increase of Vacuum pressure the Recoil Time is goes on increasing.
C. *Force Vs Recoil Time:* with the increase of Force the Recoil Time is goes on increasing.

For 40*300

Table II
Sample readings of cylinder 40*300

Sr. No	Cylinder (Dia.* Stroke)	Force (N)	Displacement (mm)	Recoil time (sec.)	Vacuum pressure (N/mm2)
1	40*300	84.366	105	0.108	0.0671
2	40*300	86.238	110	0.113	0.0686
3	40*300	86.938	112	0.115	0.0691
4	40*300	91.723	131	0.132	0.0729
5	40*300	93.119	133	0.135	0.0741
6	40*300	93.543	134	0.137	0.0744
7	40*300	97.119	145	0.148	0.0772
8	40*300	97.606	147	0.15	0.0776
9	40*300	99.8	150	0.151	0.0794
10	40*300	103.299	156	0.157	0.0822

From the above readings the relation observed between parameters such as recoil time, displacement, vacuum pressure and force can be understood.

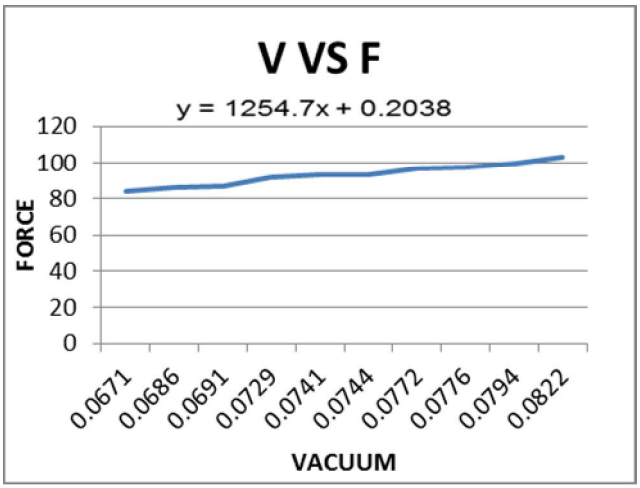

Fig. 5 Vacuum Pressure Vs Force

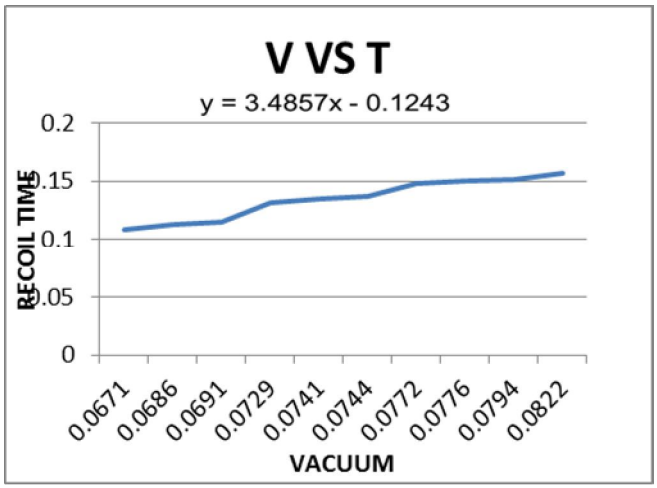

Fig. 6 Vacuum Pressure Vs Recoil Time

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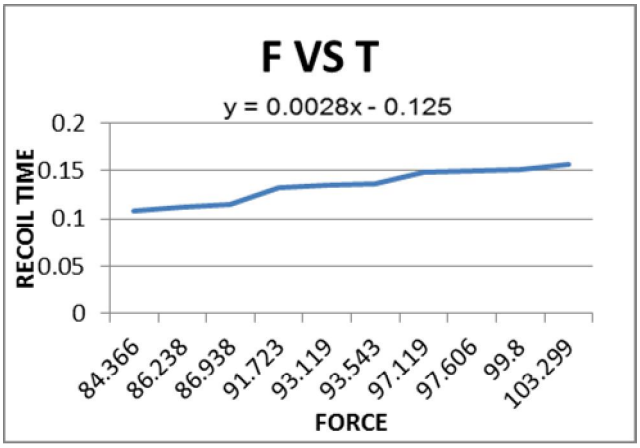

Fig. 7 Force Vs Recoil Time

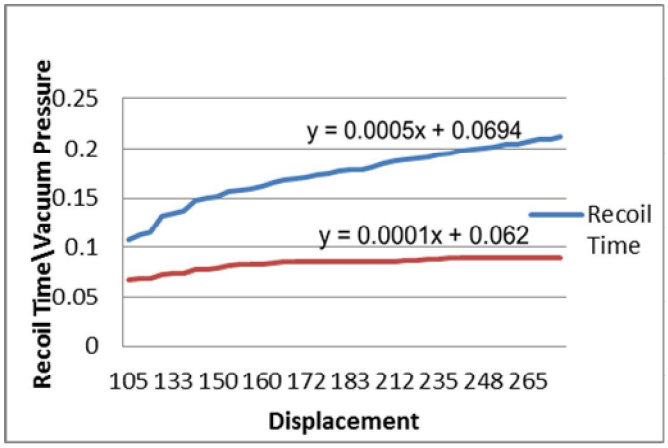

Fig. 8 Displacement Vs. Recoil Time and Vacuum Pressure

From the above graphs it comes to understand relation between parameters of vacuum damped recoil system as follow – All the following have linear relationship.

1) *Vacuum Pressure Vs Force:* with the increase of Vacuum Pressure the Force is goes on increasing.
2) *Vacuum Pressure Vs Recoil Time:* with the increase of Vacuum pressure the Recoil Time is goes on increasing.
3) *Force Vs Recoil Time:* with the increase of force the Recoil Time is goes on increasing.
4) From the figure 8 relation among displacement, recoil time and vacuum pressure can be interpreted as, with the increase of displacement the time required to barrel to get initial position goes on increases. Similarly it also interpreted that with the increase of displacement of piston the vacuum generated in the cylinder goes on increases.

VI. RESULT ANALYSIS

The result analysis is as below

The graph no. 2 and 5 shows relationship between the force required to pull the barrel and vacuum generate inside the cylinder.
The graph no. 3 and 6 shows relationship between the recoil time and the vacuum generate inside the cylinder.
The graph no. 4 and 7 shows relationship between the recoil time and the force to pull the barrel.
The graph no. 8 shows relationship between displacement versus recoil time and vacuum generate inside the cylinder.
The line equation for graph no. 2 to 8 are as below

Graph no. 2: y = 808.52x - 0.2604
Graph no. 3: y = 3.2542x - 0.1132
Graph no. 4: y = 0.004x - 0.1122
Graph no. 5: y = 1254.7x + 0.2038
Graph no. 6: y = 3.4857x - 0.1243
Graph no. 7: y = 0.0028x - 0.125
Graph no. 8: y = 0.0005x + 0.0694 and y = 0.0001x + 0.062

VII. CONCLUSION

Following conclusion can be draw

A. The vacuum generated and force required will increase with displacement of the piston.
B. All the parameters have linear relationship.
C. A clearcut mathematical relationship can be calculated for any particular vacuum damped setup.
D. The vacuum damped system is a very viable option for static damping system.

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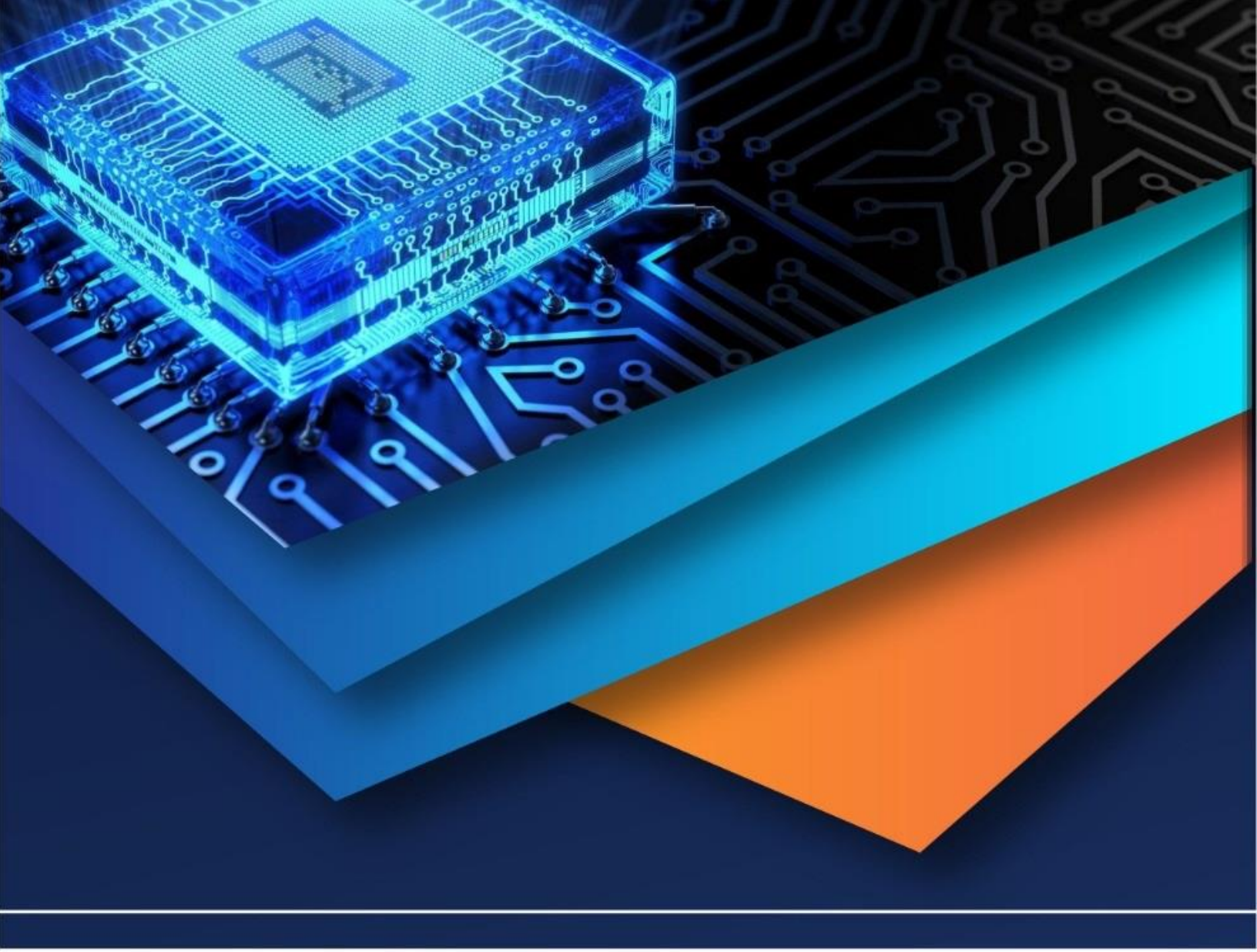

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