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# To Control Die Setting Time by the using of Piston Cylinder Mechanism.

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*Abstract*—**To survive in competition through recent scenario, forging industry needs creativities, innovation & automations to reduced production time as well as accuracy in operating performance & flexibility. Lead time in manufacturer's point of view is the time elapse between placing of an order and actually receipt of good order. Aim of this paper is to control the die setting time by the using of piston cylinder mechanisms which influencing the forging process smoothly and increases productivity & quality of forged products. Thus with aid of automation, the production time will be reduced as well as higher degree of accuracy can be achieved which facilitates ease of operation for making forged components. As die setting time commute gives the faster response to customer requirements make more competitive and aider to mass production. .**

*Keywords— Production leads time, Automation, Flexibility & Accuracy, Piston- cylinder mechanism.*

## I. INTRODUCTION

Forging is the process by which a metallic part is deformed to a final shape with application of pressure which is obtained from hammer or press. In modern eras, forging industries needs developments by increasing production rate, precision & expanding capacity to forged larger & complex parts. Advancement in forging industries can be done by using automation in equipment's [1]. This would be very much useful in increasing efficiency of forging industry. In this paper to control die setting times of forged components by the using of piston-cylinder mechanism. By the using of piston cylinder mechanism two types of motions are generating such as Linear and Rotary motion. Force is the one of the factor which, varying the angle of crank. This mechanism is frequently utilized for getting larger amount of force, velocity, accelerating & shaking force which, is generated and can be determined by analytically also. The crank rotary motion converts into reciprocating motion of piston through connecting rod inside cylinder [2].

Now a day, in current scenario forging industries facing problems are more care & reduction of die setting time is required for increasing productivity of forged components. This difficulty has been resolved with the help of piston cylinder mechanism which is very beneficial to make process smoothly. Piston cylinder mechanism is very beneficial to reduced major defects such as mismatch, Lap fold, Poor Appearance & Worm surface. Forging die life will be increased by implementation of this mechanism. For improving quality of forged components various important parameters has to be considered while doing forging process.

So important parameters like temperature, time, Angle, Stress, Dovail, packing's & facing of dies should be maintained properly. At present, to do modification in design of complex die is very difficult so for optimization of design proper factor has to be considered with taking certain tolerances. While doing machining of forged components major defects occurs likewise sharp edge, burr, chillies etc. These defects can be reduced by proper Pareto & Viva Analysis of machining components. When products are placed in furnace for obtaining required hardness during heat treatment process defects occurs like insufficient hardness, fracturing & cracks. So as a remedy of this defects, proper heat is to be given in the salt bath, select the cooling medium and tempering is done after hardening.

Aim of this paper is to control die setting time of forged components by using piston cylinder mechanism which influencing the forging process smoothly by increasing productivity & quality of forged components. For shake of creativeness & innovations in the forging industries automation is very much useful to increased efficiency. Major problems faced in many of the forging industries they required more time for setting dies in hammer. For optimization of problem piston- cylinder mechanism is beneficial which control die setting time on hammer. It helps to improve the process which is more feasible to forge a part. With help of this mechanism good rate of deformation & temperature condition of forged components can be achieved [1]. This mechanism consist of Electric motor, Gear Assembly, Auxiliary support of crankshaft, crank shaft, connecting rod, Auxiliary guide, Cylinder, piston, Hammer, Base plates, Legs.

Mechanism works on the principle of crank shaft mechanism in which crank rotates by motor at any particular speed so shaft which is connected also the rotates. The spur gears mounted on the shaft transmit power to connecting rod which is connected to piston inside the cylinder. The piston reciprocates with the help of rod at number of strokes as a result of hammer which is connected to the piston strikes the dies as per required force to set die. Therefore die is set with fewer amounts of strokes. This mechanism is movable so easily can be transfer from one place to another by providing wheels at end of base plates. With the beneficial this mechanism, production rate will be increased, less time required to set the die, better quality of products can be achieved with having higher accuracy & Manpower reduces.

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## II. EXPERIMENTAL PROCEDURE

### 2.1 Flow of Process

Before setting of the die first holder is cleaned & die is heated on the ground for proper setting Up to temperature of (100-125˚C).For placing new inserts (round dies) on the hammer, they hit the key with many strokes of striker to remove the old forging dies after production is completely over. First they remove the key from the lower dies as well as upper dies from the holder. After that, they remove the packing's which was supporting to the dies. For placing new dies inside holder on hammer to carry out production, they first fit the dovail in the dies. After dovail is fitted in the dies, with the help of crane bottom die is put on the hammer. Than they fit the key on the bottom die with many strokes of striker. After the key fitted on die, packing is kept near to the dovail as per required thickness. Now after bottom die is placed than top die is placed on hammer with the help of crane. Hitting of top die is done on the hammer until both the dies parting line match with each other. Than they checked the front & Right side faces matching of the dies. If faces are not matching with each other, they put the required thickness of packing in the top die to adjust faces of dies carefully. After dies are properly matched with the parting line they fit the key with many strokes of striker. Than die is heat on the hammer up to 200-300˚C temperature with the help of scraped material to achieved hardness.
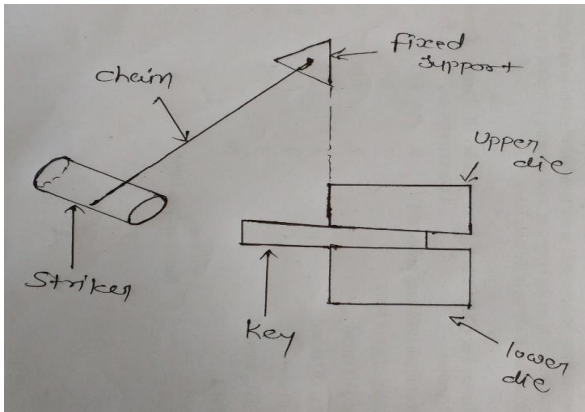


FIGURE 1: To set die with help of striker
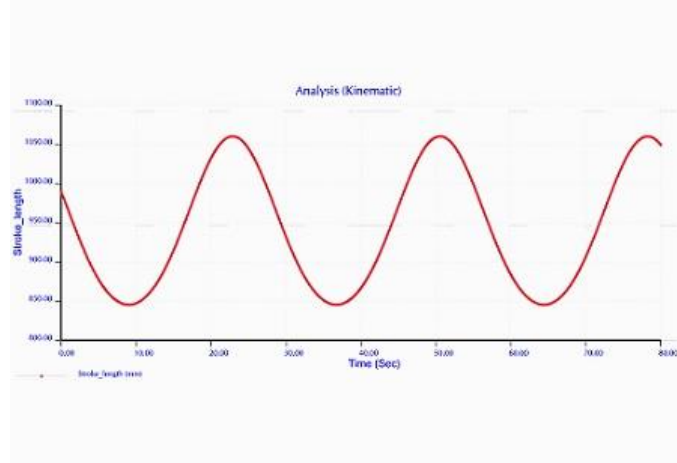
### 2.2 Kinematic analysis of Striker mechanism



FIGURE 2: Kinematic analysis of stroke length vs. Required time

### 2.3 Analytical calculation:-

*For completing 1 stroke with the help of striker:*
Weight of striker = 1000kg
Diameter of striker = 20cm
Displacement of striker = 2.5m
$$\Theta = 45˚$$
Power = 14500w
S0, force obtained by striker = mgcos$\Theta$
$$= 1000*9.81*\cos 45$$
$$= 6936.71N.$$
Therefore; work = Force * Displacement
$$= 7000 * 2.5$$
$$= 17500J.$$
Power = Work/Time
Time = Work/power
$$= 17500/14500$$
$$= 1min\ 20\ sec.$$
So we can say that from analytical calculation; time require to complete 1 stroke is 80sec.

### 2.4 Experimental Reading

TABLE I.

| Step no | Description | Time Required |
|---------|-------------|---------------|
| 1 | Die heat on the ground | 15-20 min |
| 2 | To remove the key | 30 min |
| 3 | Dovail fit in the die | 15-20 min |
| 4 | Die load on the holder | 15-20 min |
| 5 | Heat die on hammer | 10-20 min |
| 6 | Fit the key on hammer | 25-35 min |
| 7 | Matching faces of dies | 15-20 min |
| 8 | Total time required for setting of die | 2hrs & 45 min |

### 2.5 Detail Description of die setting time are as follows:-

First for new die setting procedure; die is heated on the ground at temperature of (100 – 125˚C) for proper setting on hammer up to 15-20min.After that with the help of striker they remove key from the holder, so to carried out this procedure 30min is required. Than they put dovail & packing of required dimension in die so that die cannot be move away while matching faces of dies is carried out for that they required 15-20min. Now they load die on holder for that 10-12min is required. Again they heat die on hammer at temperature of (200-300˚C) with help of scraped particles because to achieved proper hardness of die. After that they fit key for doing this procedure 25-35min are required. Than they match front & left faces of dies by hitting key up to 15-20min. So now production will be start & forging process smoothly carried out.

### 2.6 Design of Components
### 2.6.1 Design of crank shaft



FIGURE 3: Crankshaft

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Table: - II

| Sr.no. | Diameter | length | Pressure |
|---|---|---|---|
| 1 | 240mm | 377mm | 3.15N/mm2 |

Force acting on crank is maximum about 7000N
Assume Gear ratio is 3:1 so speed of crank shaft 400 rpm
Angular Velocity Of Crank=2*3.14*400/60
$\qquad$ = 41.86 rad/sec
Here for maximum velocity theory
Acceleration Become Zero
$V = wr(\sin\Theta + ((\sin 2\Theta)/2n))$
$A = w^2 * r(\cos\Theta + ((\cos 2\Theta)/n))$
So dv/dt=0
So by that $\Theta = 77.01°$
now by trial and error method get crank radius =90mm
So; v= 13.86m/s
Acceleration of crank $= v^2/r = 3.86/0.09 = 165.55 m/s^2$
**Force get by this mechanism**
F=ma = 50*165.55 = 8280N
This much amount of force is capable for setting die.

**2.6.2 Design for Connecting rod**



FIGURE 4: Connecting rod

Table: - III

| Sr.no. | Diameter | length | Stroke length |
|---|---|---|---|
| 1 | 94mm | 455mm | 240mm |

Now, area of the section:-
$A = 2(4t*t) + 3t*t = 11t^2$.
$I_{xx} = 1/12[4t(5t)^3 - 3t*(3t)^3] = 419/12t^4$
$I_{yy} = 2*1/12 * t(4t)^3 + 1/12 * 3t * t^3 = 131/12t^4$
$I_{xx}/I_{yy} = 419/12 * 12/131 = 3.2$.
Since, the connecting rod is designed by taking the force on the connecting rod (Fc) equal to the maximum force on the piston (FL) due to gas pressure, therefore,
$\qquad F_c = F_L = \pi D^2/4 * p$
$\qquad\qquad = \pi(94)^2/4*3.15$
$\qquad\qquad = 21849.219N$.

**2.6.3. Design for piston**



FIGURE 5: Piston

Table: - IV

| Sr.no. | Diameter | Length | Stroke length |
|---|---|---|---|
| 1 | 204mm | 300mm | 240mm |

Thickness piston head on the basis of strength,
$T_h = \sqrt{3}p.D^2/16\sigma t = 25.43mm$.
Since the engine is a four stroke engine, therefore the number of working strokes per minute,
$\qquad n = N/2 = 1200/2 = 600$.
And cross sectional area of the cylinder,
$A = \pi D^2/4 = \pi (206)^2/4 = 33312.26mm^2$.
Indicated Power = pm .L.A.n/60
= (3.15) (0.24)(33312.26)(600)/60
= 251840.68w = 251.47kw
Brake Power = IP * n = 251.84*0.8 = 201.47kw.

**2.6.4 Design for cylinder**
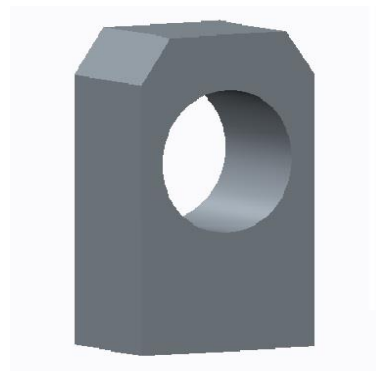


FIGURE 6: Cylinder

Table: - V

| Sr.no. | Diameter | Thickness | Height |
|---|---|---|---|
| 1 | 206mm | 300mm | 500mm |

Here; power = 5000w
$\qquad$ Efficiency = 80%
I.P = B.P / Efficiency
$\qquad$ = 5000/0.8
$\qquad$ = 6250w.
For Diameter of cylinder;
I.P= Pm. l. A. n/60
6250 = 0.35 * 1.5 D * $\pi D^2$ * 600/ 60
D = 206mm.

**2.6.5 Design for Hammer**

Table: - VI

| Sr.no. | Diameter | length | Mass of Hammer |
|---|---|---|---|
| 1 | 200mm | 300mm | 60kg |

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FIGURE 7: Hammer

Force obtained by this hammer;

Acceleration $= \dfrac{v^2}{r} = \dfrac{4.2^2}{0.12} = 147$ m/s2

Force = m*a= 60* 147 = 8820 N

Therefor by using this mechanism we obtained 8820N amount of force which is capable to set the die.

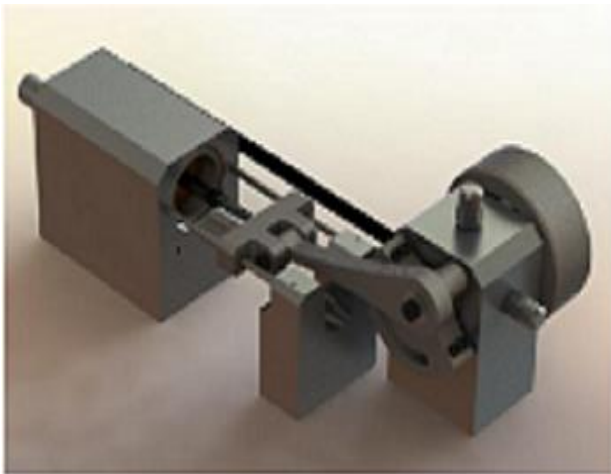### 2.6.6 Demonstration of Piston Cylinder Mechanism



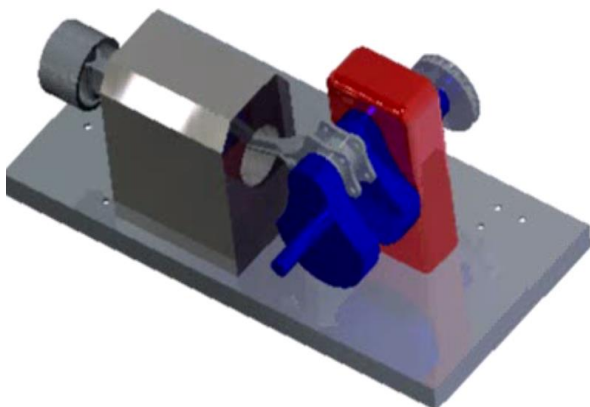FIGURE8: Piston cylinder Mechanism



FIGURE 9: Modelling of Piston cylinder Mechanism

The above diagram represents the mechanism of Piston cylinder mechanism. Forging presses collectively allow a ram that moves in a vertical direction to exert a squeezing action on the work piece.

## III. RESULT AND DISCUSSION
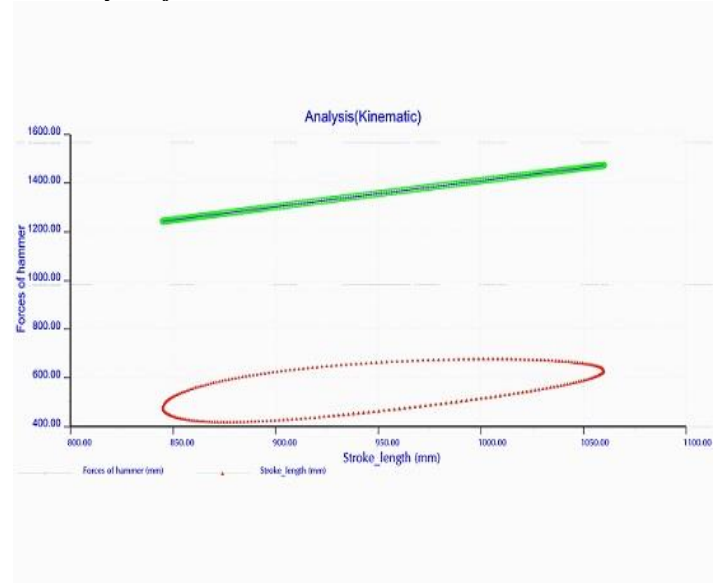### 3.1 Analysis of Mechanism



FIGURE 10: Analysis of stroke length & Forces of hammer

During the analysis between stroke length & forces of hammer; stroke length is taken on X-axis & forces of hammer on Y-axis. In the graph stroke length range taken as ( 800 – 1100mm) & forces of hammer range taken as (400N – 1100N). So by analysis we can determined that as stroke length increases the forces obtained by hammer also increases which is clearly indicate in graph. Due to that forging hammer is continuously working as a mechanism of piston & cylinder and the load can be carry forward for movement of rod & hammer.



FIGURE 11: Analysis between stroke length & Time

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In the analysis on X-axis time is mentioned & o Y-axis stroke length is mentioned. During the time taken is (0-20min) & stroke length taken between (400-700mm).When the crank rotates at particular speed in the piston-cylinder mechanism connecting rod inside cylinder with having hammer attached in it. During analysis from the graph 1 stroke taken equal to 150mm.So to complete 1 stroke it contains 11 sec which is clearly indicates in graph. Therefore by using piston-cylinder mechanism to complete each stroke 11 sec is required.

## IV. CONCLUSION

This paper carries on the die setting time through the analysis of piston cylinder mechanism. By the analytic calculation of piston cylinder mechanism productivity & accuracy of the forging parts is accrue. Through that calculation of this above mention mechanism it is clearly indicates of complete one stroke of the striker in forging industries they required 80 sec and at the another side using the piston cylinder mechanism time required to complete one stroke is 11sec. Therefore time required to set the die is very much more as compared to piston cylinder mechanism. In the mechanism a combination of ram, hammer, striker are used to increasing a pressure on a work piece and solves the impact problem of additional die setting time, less forging defects and better product quality.

## V. REFERENCES

[1] Study of the mechanics of closed die forging by T.Altan, H.J.Henning, and A.M.Salroff of Battelle memorial Institute Columbus, Ohio 43201, Army

[2] Material & Mechanics research center in November 15, 1969.

[3] Slider-crank Mechanism for demonstration & experiments by Eben Cob, Eric Brigham, Chris Destefano & Zacharchy Killoy at April 25, 2013.

[4] Billet sorting mechanism for reducing the rejection rate in forging operation by A.D.Gundka, A.D.Jadhav, A.L.Kirad, J.S.Dimble from JSPM'S Rajarshi school of engineering & research, Pune, India 411041.vol.2,Issue 1,pp:(36- 47), Month:April 2015 – September 2015.

[5] Design & Key technology research of the hydraulic system of large scale Accumulator Blow Molding Machine by Wei – Min , Meng –de Zhou, Young Xeu, Bao – rong Bal , from faculty of Mechanical & Automation, Liaoning University of Technology, Jinzhou 121001,China overhaul centre ,Lingyan Iron & steel co.,LTD., Chaoyang,122500,China.

[6] Mr. Rahul .R. Joshi, Prof .G.R.Naik, "Reduction in setting time", in International Journal of Modern Engineering Research (IJMER).vol2, Issue:1, January – February 2012; pp – 442 -444.