



Modeling Control and Analysis between Force and Time, Length, Diameter & Stress in Forging Process of Screw

Run Xu*

Gyeongsang National University, Metallurgical Materials Engineering, Chinju, Gyeongnam, Korea

*Corresponding author: Xu Run, Gyeongsang National University, Metal Materials Engineering, Chinju, Gyeongnam, Korea; Email: 13953575073@163.com

Abstract

In forging process the model is established so as to analyse the force with diameters and stresses. It is found that the force inclines with the inclining diameter and stamping stress with nonlinear curve. Meantime it inclines with the stress and diameter inclining with linear curve. It shows that the efficiency will be big in low stress and diameter because it is minimum. At 2mm of diameter the force will maintain a value of 1.5KN no matter what the stress is. It is good condition to save cost with low stress. With inclining the diameter above 2mm the curve will gradually be bigger so if it is chosen under 4mm it is valuable to save cost. The power will incline as well when the length L inclines from 3 mm to 5mm in second punch. If the depth is enough it is chosen that the low one with 3mm for the purpose of saving energy. The largest power is 0.48KW at the $d=2\text{mm}$ and $P=295\text{MPa}$ on $L=5\text{mm}$ and then the smallest is 0.28KW on $L=3\text{mm}$. The power declines when the time inclines and it inclines when the diameter & stress inclines in first punch. When the screw length is about 220mm~350mm the chosen power of motor will be 20KW~15KW for some security. The efficient time is short within 0.1s and there is very small difference between these three parameters so it is above value.

Keywords: Modelling control; Forging process; Screw; Analysis; First punch; Second punch

Introduction

The screw process has first one is forging process. It is drawn from steel circle and cut with a length then stamping it three times for completing forging. The screw will be here automatically proceeded by forging machine. So it is important one in manufacture [1-5]. In factory the worker will regulate the machine when each new production is designed like coaxial error. It is since the size is changed so as to guarantee the tolerance of screw. It has been demanded that the machine is strict. The big error is not tolerated in forge. Any deviation happens they are abandoned so the cost will be large. It must conform to the tolerance scope in design draw. On the other hand the speed is not so rapid which cause the cost promotion due to cheap price. There must be a mount of machine to work to guarantee the speed and quantity. So the decreasing time in stamping is necessary or increasing double ones synchronously or double machines is

adopted as so on. The scientific management shall be adopted like same diameter and type. It is adopted the criterion management to prevent different diameters from confused. So the time will be saved to do normal produce. So the modelling control will be necessary to simulate the whole course to investigate the different phenomena. In this paper it is investigated that the effect of force and diameter & stress is proceeded. To save time it is adopted that the efficiency time during punch so within efficiency power we can choose the short time for every punch. The fast speed is investigated in this paper with establishing curve between power and time in order to see the intrinsic relation of them. This is a destination of this paper too. As we knew the first and second punch is important since others is analogue to it so in punch process it is observed through relation curve in every stamping with deep length of punch. So we choose the second punch to simulate in this study because the first punch is longer. Here the deep length will play an important role so it is investigated firstly.

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To choose the reasonable deep length is our level with punch. If it is too big the force will incline the work hardening will increase and if it is too small the force will decline the punch is not satisfied. It is one factor to be considered further in mold design.

Modelling and Discussion

As seen in it is three stamping course in forging process (Figure 1). There are five processes as follow: cutting material; the first and second & fourth stamping; rush complete part. Cutting

Table 1: The parameters of the first screw heading process.

parameters	t/step, s	σ , MPa	d, mm	L, mm
Value	<1	295,320,350	2,3,4	350, 280,220; 3,4,5

As seen in Table 1 it shows the forging condition. Here t is time; σ is stress; d is screw diameter; C steel is material; L is deep length (Figure 1) [1]. The schematic of stamping screw with steel coil in screw manufacture. It divides into a cutting and three times punch like (a~d) to form the screw in forging manufacture. d1 and l1 is the raw material diameter and length. Here Figure 1(a) is raw material, (b),(c) & (d) is the first second and third stamping semi-finished screw respectively. Figure 1 (d) is cross punch mentioned as the fourth stamping.

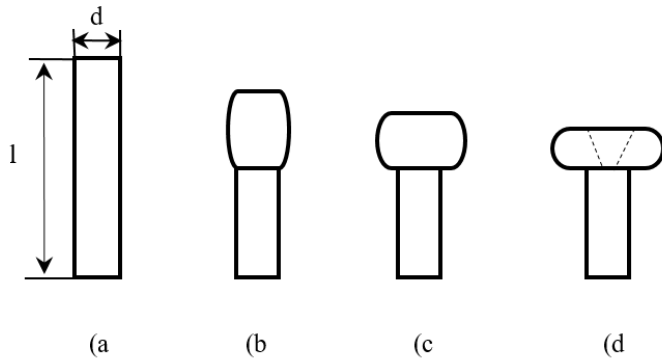


Figure 1: The structural stamping screw semi-finished process of steel circles in manufacturing screws.

When the stamping pressure is 350MPa, 320MPa and 295MPa as seen in (Figure 2).The relation between force and diameter inclines with the inclining diameter. When the pressure inclines the force will incline as well. However the value between them are small so it is available to choose smaller force like 295MPa etc. The maximum force is 5.8KN on 350MPa and the minimum one is 4.3KN on 295MPa at d=4.5mm. At d=2.5mm the same value is formed with 1.5KN. In the force will incline when stress and diameter inclines. It is chosen that the lowest stress is d=3mm and 290MPa for the saving energy if the demand is above 1 ton. If regulation can be done in a machine the force will decrease too, we can choose the little one with d=2mm. And if it is not chosen

process need bigger force since it is in very short time. It needs beyond plastic value of screw materials somewhat.

According to energy conservation law it has

$$dF = \pi d^2 d\sigma / 4 \dots\dots (1)$$

And it has too

$$dP = Fld(1/t) \dots\dots (2)$$

Here F is punch force; P is power; t is time in one circle; d is diameter of screw; L is deep length and σ is stress in the punch. These parameters in forging process is as seen in (Table 1).

to be smaller the d=3mm even d=4mm has to be chosen. Since the material is used #27 steel the yield stress is 275MPa so it is chosen above three pressures to be proceeded. Lower carbon steel has low stress and good ductility so it is fit one for forging. The less steel number results higher ductility and less stress as we knew so feasible steel is key to make screw. No need bigger than 360MPa is observed through Figure 2(b) since the 4KN, 2KN and 1KN which is enough force to punch screw is formed at lower stress field for saving cost at the diameter of 4mm, 3mm and 2mm.

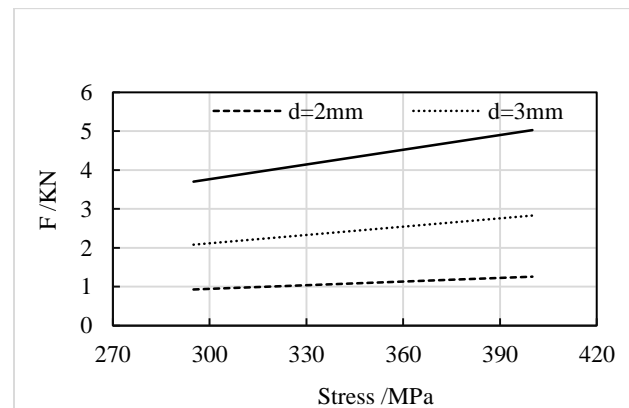
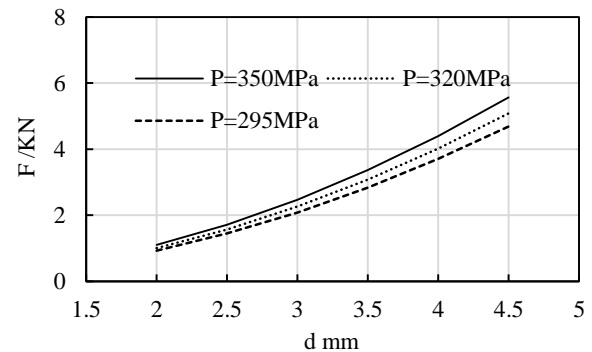
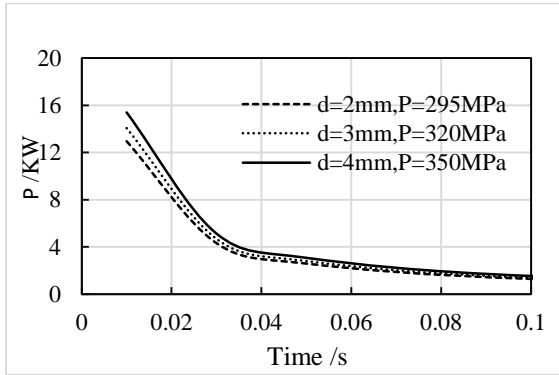
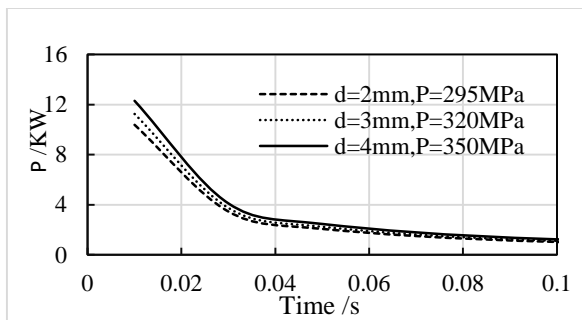


Figure 2: The relation between force and diameters & stress of screw in screw forging.

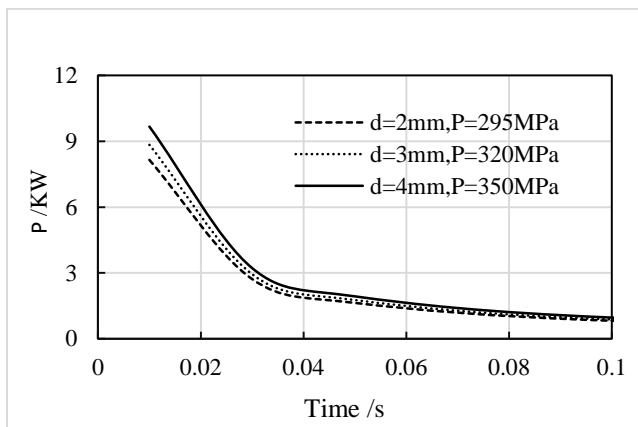
In it shows that the power declines when the time inclines and it inclines when the diameter & stress inclines (Figure 3). Because it is the first punch the whole power is big which attains 16KW at 0.01s of initial stage with 4mm and 350MPa & L=350mm as shown in (Figure 3).



(a) L=350mm



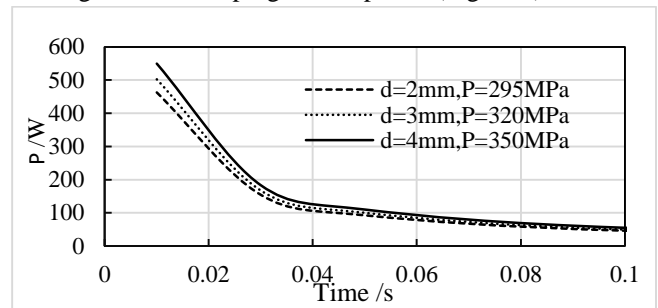
(b) L=280mm



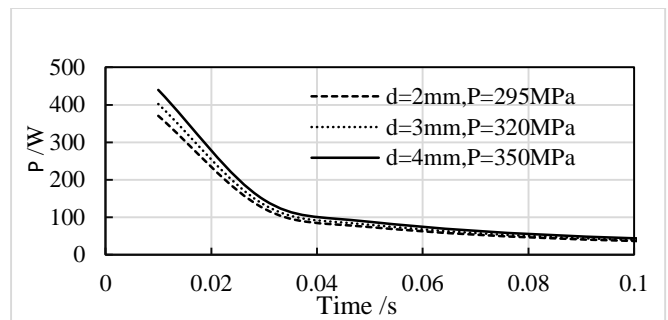
(a) L=220mm

Figure 3: The relation between power and length of stamping pole with first stamping process and length of punch in screw forging.

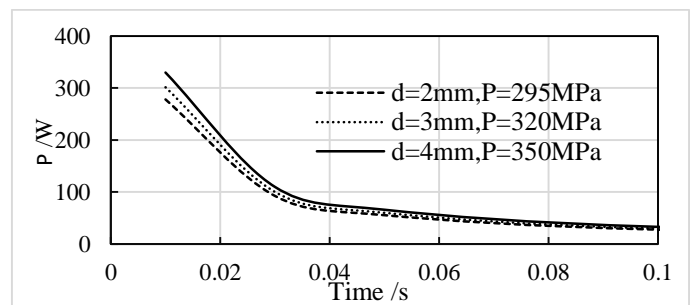
It becomes the criterion to choose motor which is bigger than 16KW. The small one is 10KW at L=220mm. If the screw length is about 220mm~350mm the chosen power of motor will be 20KW~15KW for some security. The efficient time is short within 0.1s and there is very small difference between these three parameters so it is above value. Here 0.4 times is used to calculate the cross area since it is not complete screw cross area which is formed in the first punch. In additional the B type which is like triangle on cross has been made so the surround material is main formed part, not all the cross. In forging the relation between power and time inclines when the time inclines as seen in from initial stage to end stamping in first punch (Figure 4).



(a) L=5mm



(b) L=4mm



(b) L=3mm

Figure 4: The relation between power and length of stamping pole with second stamping process and length of punch in screw forging.



Here L is the length from contact to end stamping in one circle of punch. It is proposed that length is 3~5mm in each circle. We observe that the power will incline as well when the length L inclines from 3 mm to 5mm. If the depth is enough it is chosen that the low one with 3mm for the purpose of saving energy. We can see the largest power is 0.28KW at the $d=2\text{mm}$ and $P=295\text{MPa}$ and then the smallest is 0.02KW on $L=3\text{mm}$. If it locates in the middle of these two position we will decrease the time of punch to satisfy the demand of the least one, 0.3KW~0.09KW is here available the middle of 0.05s for regulating the machine or redesign technique staff. Overviews the power will increase with length being big and the smallest is the condition turn of $d=2\text{mm}$ and $P=295\text{MPa}$, then $d=3\text{mm}$ and $P=320\text{MPa}$ finally $d=4\text{mm}$ and $P=350\text{MPa}$. The biggest power happens to with 0.01s or less it when the efficiency yields mostly so within this period it is paid attention to mostly. The power in the first punch is bigger than that in the second punch. It is about three times of second punch in first punch.

Conclusions

The force inclines with the inclining diameter and stamping stress with non-linear curve. Meantime it inclines with the stress and diameter inclining with linear curve. It shows that the efficiency will be big in low stress and diameter because it is minimum. The chosen power of motor will be 20KW~15KW for some security in screw length of 350mm~220mm. The power is the biggest within 0.01s then it declines sharply. It arrives more than 0.5KW at the initial stage during one stamp. Then it declines sluggishly after 0.03s. It attains 0.1KW. So the time is shortened a little to proceed fast and it is available because the lose time with above 0.05s~0.1s is too long. The power in the first punch is bigger than that in the second punch.

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