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Setup time reduction in case hardening of synchro rings

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ABSTRACT

In the case hardening of synchro rings, the synchro rings are taken to a sealed quench machine from rotary hearth furnace, where synchro rings of various diameter are quenched. In this process the productivity of the synchro rings are effected due to the set-up time required for placing the die of varying diameter with respect to the syncro rings machined. Our goal of this project is to reduce the setup time required for case hardening of sychro rings by providing some design changes in the die and incorporating a new part which comprehends the reduction in the process.

KEYWORDS: Quenching, Dies, Case Hardening, Hearth Furnace.

1. INTRODUCTION

In the previous two decades, setup time lessening and quality change programs have ended up predominant in fabricating industry. At present producers must have the capacity to produce a wide assortment of profoundly separated and high quality items in a financially savvy way, and react rapidly to changes in the item outlines and volumes all together to contend, Byrne et al., 1995, Johansen et al., 1986, Cruz et al., 2008. viably. Sigl et al., 2003 discussed manual transmissions for traveler autos and trucks are outfitted with synchromesh frameworks for the smooth what's more, simple changing of gears. For the right operation of a transmission and additionally for the driver's moving solace, the execution of such synchronizer units is basic. Fujiki et al., 2001, Fernandezet al., 1996, Synchro-rings have been produced set up of metal parts to increment firmness and lower costs in Car industry furthermore for the assembling of synchro rings utilized as a part of manual apparatus boxes. A Parametric relationship can be constructed which incorporate movement power, particular force dissemination of ring, constrained detent power of spring, max rubbing speed and hassles in ring Socin et al., 1968, Razzacki et al., 2004.

Project is under taken in the shop Heat treatment, which is basically case hardening and machining of various gear parts such as toothed gears, synchro rings main shaft and layout shaft.

In this shop there is a rotary hearth machine and a nearby quenching machine, where the synchro rings are case hardened and to maintain the original diameter the rings are quenched as the rings are under heat and cooled using oil while they are in the quenching machine. There are totally three different types of synchro rings namely one by two(1/2), two by three(2/3) and three by four(3/4) which means the rings fixed between the first and second gear, second and third gear, third and fourth gear respectively and for each of the rings there are quencing dies of varying size and diameter. At a time, three dies are fixed inside the quenching machine. It nearly takes around 60 minutes for only fixing the dies inside the machine and two labours are needed for this die fixing porcess.If one type of rings are manufactured the die is to be removed from the machine and replaced by another three dies for the next set of syncro rings. Thus the rings are case hardened, the setting and removing is a tedious process.

Our project mainly focuses on reducing the die fixing time so to increase the productivity and reduce the workers effort. Thus by suggesting a new design for one the die component part the setup process is simplified. A new component of 5/6 die is designed as it can be fixed onto the 1/2or 3/4 dies. After fixing the 3/4 or 1/2 in the quenching machine we need not to remove the dies the small designed component for 5/6 die is fixed inside with a simple locking mechanism. Making the setup time of two (1/2 & 5/6) dies from overall 120 minutes to 86 minutes.

Figure.1. Three by four die

Figure.2.One by two die

Figure.3.Five by six die

Tal Press Quenching Machine: During operation, the component to be quenched is removed from the rotary hearth furnace and is placed onto the tooling of the lower die assembly. After the part is successfully loaded onto the lower die assem- bly, the machine is actuated and the part is retracted into the machine where it is centered below the upper hydraulic ram assembly. As the assembly descends, the center ram actuates one or more internal expanders that make contact with the inner diameter of the component at specified points to maintain roundness at these locations. Each component of the ram assembly (the center expander, inner and outer dies) is controlled independently through three

separate, proportional valves. A predetermined pressure level of about 70 to 80 bar is usually maintained by the expander throughout the quench cycle. The inner and outer dies are lowered to make physical contact with the upper surfaces of the component being quenched in order to control alignment, dish and part flatness during the course of the quenching cycle.

Table.1.Specifications of TAL

Quenching Operations	3 cycle
Loading/Un Loading of Components	Manual
Multiple Loading/Unloading of Components	Yes
Pressure	70-80 bar
Maximum Diameter of Work Piece	700 mm
Maximum Diameter of Bore	150 mm
Height of Component	200 mm
Closed Distance Between Closed Die and Upper Die	250 mm
Open Distance Between Bottom Die and Upper Die	550 mm

Table.2. Setup reduction worksheet

Setup Reduction Worksheet

Team: Project | Machine/Tool: TAL Press | Date: 20/02/2016

No.	Setup Element	Internal	External	Waste (#)	Total Time	Net Time	Comments/Improvement Ideas
1	Switching ON the Furnace		■		5		
2	Furnace setting temperature upto 850°C		■		85		
3	Tool Transport from Maintanence room		■	1	7		
4	Loading 1/2 Die Tool in Quenching Machine	■			36		
5	Hardening Rings inside Furnace		■		1.67	28	For 17 trays of rings (1 tray= 3 rings)
6	Placingheated 1/2 Rings in bottom die	■					
7	1/2 Rings Press Quenched	■			1.13	19	
8	Quenched Rings Replaced	■					
9	Removal of Old tool from machine	■			20		
10	Loading 5/6 Die Tool in Quenching Machine	■			36		
11	Hadening Rings inside Furnace		■		1.67	28	For 17 trays of rings
12	Placing heated 5/6 Rings in bottom die	■					
13	5/6 Rings Press Quenched	■			1.13	19	
14	Quenched Rings Replaced	■					

Waste Categories:

1. **Setup waste, external** - activities such as searching, finding, or transporting tools, jigs, fixtures, bolts, instructions.
2. **Setup waste, internal** - alignment activities required to remove or install tools (example - using a fork truck to remove/install tools)
3. **Replacement waste** - activities related to removing items from the "A" tool to be placed in the "B" tool (example - fasteners, etc.).
4. **Adjustment waste** - any activity which would require the machine to cycle without producing a good part (stroke/stop adjustments, etc.).

2. EXISTING METHODOLOGY

In the heat treatment shop the gearbox components namely shafts and synchro components are heat treated and surface finished. In case of sychro rings first case hardening is carried out before machining process In case hardening process the ring are first placed into a rotary hearth furnace which is preheated to 850oc for one and half hour and heating it for about 100 seconds and then placing it in quench press, where quenching is done for next 60 seconds. In the quenching press there is a top die and a bottom die corresponding to the rings to be quenched. The quench has a tray consist of three dies where three rings can be machined at a time. There are three types of synchro rings which are machined in heat treatment shop they are one by two, three by four, five by six synchro rings. Each rings are of different dimensions, so the die has to be changed every time when different die has to be quenched, the bottom die can be removed easily as the tray pops out and could be replaced but the replacement of top is a tedious and time consuming process also has to be removed manually .The setting up time take up to 56 minutes which involves the consumption of productive hours, labour effort and hindrance to the production.

Observations: The above data calculations shows that the maximum time taken in changing the dies from 1/2 to 5/6. Similarly the same time taken for changing from 3/4 to 5/6 die and also the external work in tool transportation.

Problem Definition: Aims to reduce the change over time of the different dies in the quenching machine through setup reduction techniques in the process of case hardening of synchro rings.

Fig.4. TAL Press

3. PROPOSED METHODOLOGY

In our proposed method we are focusing on reducing the setup time of case hardening of synchro rings by incorporating the smaller die that is five by six onto the larger dies namely three by four and one by two with a lock mechanism from opposite sides. Here the one by two and three by four die is the parent and a new part or die with dimension of the five by six is made with a slot for the lock to fit in. A hole is made in respective positions on the parent dies for the insertion of lock, which can be tightened and loosened manually. The main advantage of this method is we can quench two type of ring without changing the dies .that is if we want to quench one by two ring we can do it using one by two die as usual and if want to quench five by six ring instead of replacing the die we can do just by inserting the new part with dimensions of five by six onto the larger die and locking with screw from both sides placing it in a tightly locked condition and quenching of five by six part can be done.simiarly the process be carried out with five by six die. Reducing labour effort and the setup time gets reduced increasing the productivity.

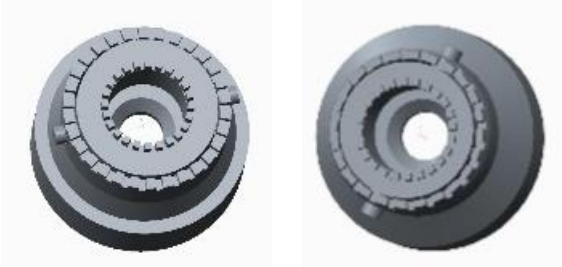

Figure.5.New 5/6 Die Onto 1/4 Die

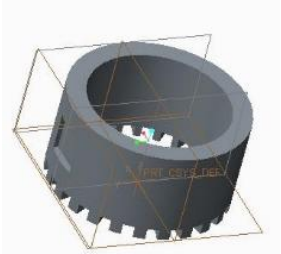

Figure.6.New 5/6 Die Onto 1/4 Die

4. PRODUCTION CALCULATION

Production calculation per shift 4 hours (240 minutes):

In quenching press 1 tray contains = 3 rings.
First the furnace is preheated to 850^{o}c = 90 minutes.

For ½ part (single tray):

Time taken in furnace = 100 seconds.
Time taken in quench press = 68 seconds.
Total time = 168 seconds.
Net Time taken for 17 trays quenched = 47 minutes
Time taken to replace the ½ part to ¾ part = 56 minutes

For 5/6 part (single tray):

Time taken in furnace = 100 seconds.
Time taken in quench press = 68 seconds.
Total time = 168 seconds.
Net Time taken for 17 trays quenched = 47 minutes

Before implementation:

Total trays produced per shift = 34 trays
Total amount of rings manufactured = 102 rings

After implementation:

The setup time reduced to = 20 minutes
Total time saving = 36 minutes
Total production in the saved time = 6 trays of each part
Per shift we can produce extra = 36 rings
Total rings produced after implementation of new die = 138 rings

Extra synchro rings manufactured per day =144 rings
Overall production is increased by =23%

5. CONCLUSION

Thus the objective of our project is achived by implementation of die with improvised design onto the existing quenching process, thereby reducing the setup time involved in the installation of top die to 20 minutes from 56 minutes. Significantly increasing the production margin by 23% per day which inturn leads to manufacturing an additional 144 rings in the saved time and also reducing the labour effort in setting of dies in quenching machine.

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