Optimization of Edge Trimming and Rolling Operations in Steel Lid

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***Abstract*- The steel lid containing the manufacturing processes which begins with circle cutting, circle edge smoothening, forging, washing, and later for the edge trimming rolling and fine trimming operations. After these processes it also undergoes for polishing. In these processes the edge trimming which is similar to the facing operation, here the length of the lid which will be not uniform so it is trimmed to the required length and while trimming the steel lid which is of 1.20mm to 1.25mm thickness it undergoes some inner and outer bending due to the perpendicular cutting force. To straighten this from bending the rolling operations are performed on the steel lid and while rolling is performed the steel lid undergoes elongation to certain millimetres(~2mm) and to trim this elongated length it is again undergoes to final trimming operations. These edge trimming, rolling and fine trimming operations are performed on separate machines and it consumes more time for manufacturing, thus by optimizing the operations in a single setup the machine usage and operation time can be reduced.**

INTRODUCTION

Lid is also known as cover, is a part of a container used for closing or sealing, usually one that completely closes the object. It is used to cover tubs, vessels, open head pails and drums. In other words lid is a removable cover at the top of a container that can be lifted up or removed. These lids are made up of plastics, fibres and metals such as steel, aluminium etc,. The lids are forged and machined on the basis of the container it is to be sealed. On the machining process the lids undergo edge trimming and rolling operations. After forging is completed the edge trimming operation is performed to trim the irregularity in the length of the lid. While trimming the lid, the cutting force of the tool makes the edge of the lid to deviate. To retain the deviation rolling is performed. The trimming and rolling operations are performed on the lathe machines. The trimming tool is a normal lathe turning tool and the rolling tool is bearing like tool that is fixed on the holder. The steel lid is initially punched in circular shapes and it is forged to the required shape. The thickness of the lid is about 1.20-1.25 mm.

*Components:*The components required are lathe machine of normal specification, edge trimming tool, rolling tool, mandrels and pneumatic piston cylinder setup for locking the lid on the chuck. These components are explained in the following,

Lathe: A lathe is a machine in which the work piece is fixed on the chuck and is rotated against a suitable cutting tool. The work piece should be in the cylindrical form of metal, wood or glass. The lathe machine have different parts in it, they are headstock, which supports the spindle in the bearings and aligns it correctly. It also houses the transmission mechanism system of the lathe machine. Two types of chuck such as 3 jaw chuck or 4 jaw chuck can be used for mounting the work piece. The following are the some of the work holding devices on the lathe they are lathe center, and lathe dog, collect chuck, face plate, and magnetic chuck. Spill nut when closed around the lead screw, the carriage is driven along by direct drive without using the clutch. Carriage moves on the outer ways and it is used for mounting and moving most of the cutting tools. The compound rest is mounted to the cross slide, it pivots around the tool post. The tailstock fits on the inner ways of the bed and can slide towards any position the headstock to fit the length of the work piece. It also contains Apron, Main spindle, Tool post, Cross slide, Dead center, Hand wheel, Bed, Lead screw, Feed rod, Clutch, Longitudinal and transverse feed control, Chip pan, Feed selector. The operations that can be

performed are turning, profiling, threading, grooving, drilling, knurling, boring, etc.,

Mandrel: A mandrel is a work holding device or a spindle on which a work piece is supported during machining operations. It is a shaft on which a machining tool is mounted. There are several types of mandrel for lathes. Expanding mandrels are slightly tapered and have a expandable wedge for holding the work piece. There are many different types of mandrels for specialized applications. Examples include live chuck mandrels, live bull ring mandrels and dead bull ring mandrels. The product specification for mandrels include diameter hole size, tool type and series, drill-collar size, length, body diameter, blade length, finishing neck, weight. The mandrel is fixed on the chuck of the lathe and the work piece is placed on the mandrel, the mandrel on the chuck is made of mild steel. An another mandrel in the form of aluminium disc is fastened on the pneumatic cylinder which moves back and front while the solenoid valve is actuated.

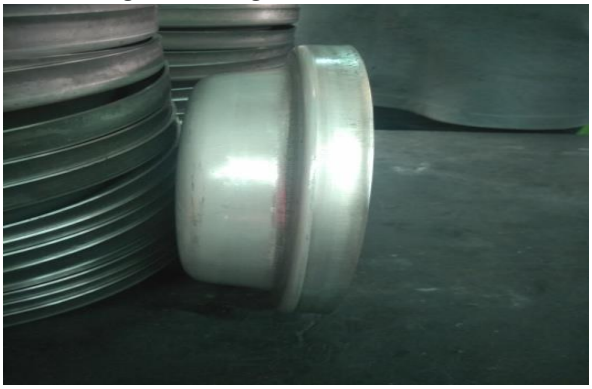
Single acting pneumatic cylinder: It is a mechanical device which uses the power of compressed gas to produce a force in a reciprocating linear motion. The piston is a disc or cylinder, and piston rod transfers the force it develops to the object to be moved. The purpose of pneumatic cylinder is to hold the lid in the mandrel while machining. The aluminium disc is attached to the one end of the piston.

Solenoid valve: Solenoid valve is an electromechanically operated valve. Electric current is used to control the solenoid valve. The solenoid valves are most frequently used to control the elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. Solenoid offers fast and safe switching, high reliability, long service time, good medium compatibility of the material used. Here 3/2 solenoid valve is used to control the pneumatic cylinder.

Tools: The tools used in this operations are normal lathe machine tools such as trimming and rolling tools. The trimming tool is made of High Speed Steel (HSS) material whereas the rolling tool is special tools which is a bearing that is fixed on the holder.

Construction: The mandrel is mounted on the chuck of the lathe machine, and the centres of the head stock and tailstock is matched. Then the lid which to be machined is fixed on the mandrel. The pneumatic single acting cylinder setup is activated by the 3/2 solenoid valve. The another mandrel which is attached to the single acting pneumatic cylinder is operated and it matches to the internal diameter of the lid. The mandrel moves until it completely mates with the lid, In other words, here the lid is the female part that is fixed on the mandrel in chuck and the another mandrel which is attached on the pneumatic cylinder acts as a male part. The tool post is designed in such a way that it houses the both trimming and rolling tools. Initially the rolling tool is fixed by facing the roller parallel to the lid that it is contact with the surface of the lid, then followed by the trimming tool which is placed perpendicular to the both rolling tool and the lid on the chuck. The tool is operated manually and its movement is arrested for the required dimensions (based on the length of the lid). The loading and unloading of the lid can be done on both the mandrels.

Working: After loading the lid in the mandrel and the pneumatic single acting cylinder is actuated, the tool post is moved perpendicular to the lid. At initially the rolling tool is made to roll on the outer surface of the lid and then the tool post is moved transversely that it the trimming tool makes a contact with the lid. When the feed is given on the tool post the required material is removed at the same time the rolling tool also comes in action, since it is in contact with the lid. Hence the elongation of lid which occurs while rolling is trimmed by the trimming tool since both the tool are integrated. The clearance provided between the trimming and rolling tools are 3mm.



LID BEFORE TRIMMING

LID AFTER TRIMMINHG

Dimension calculations:

CURRENT SETUP:

Actual length required = 14.4 mm

Length obtained after Forging of lid = 15.2 mm

Length after trimming = 14.7 mm

Length after rolling = 14.9 mm

Length after fine Trimming = 14.5 mm

INTEGRARTED SETUP:

Actual length required = 14.4 mm

After forging = 15.2 mm

Using integrated Machining setup = 14.5 mm (Trimming & rolling)

Design:

DESIGN OF INTEGRATED TOOLPOST:

SQUARE PLATE 1 & 2:

Side = 120 mm

Thickness = 22 mm

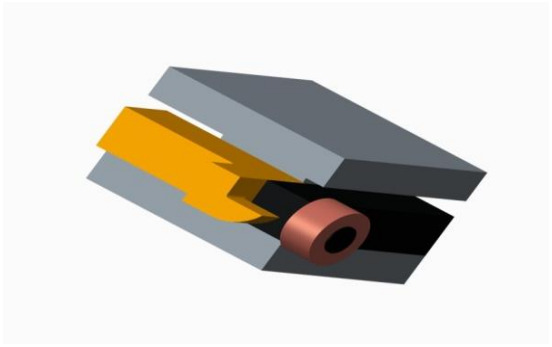
CUBE BLOCK:

Side= 46mm

ROLLING TOOL:

Outer diameter of Roller = 62 mm

Inner diameter of Roller = 25 mm

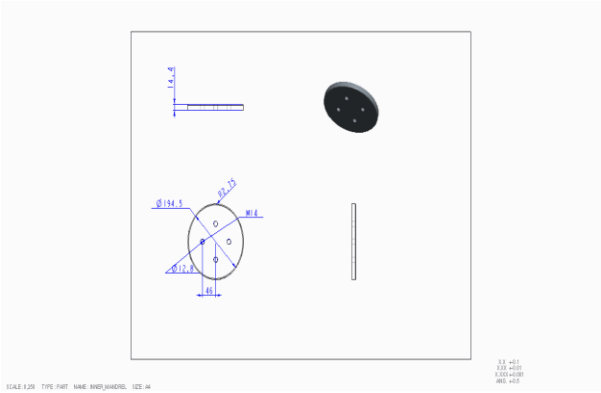


INTEGRATED SETUP OF TOOL POST

MANDREL: Diameter = 194.5 mm

Thickness = 14.4 mm

Bolts = M14 X 1.25



Time calculation:

CURRENT SETUP:

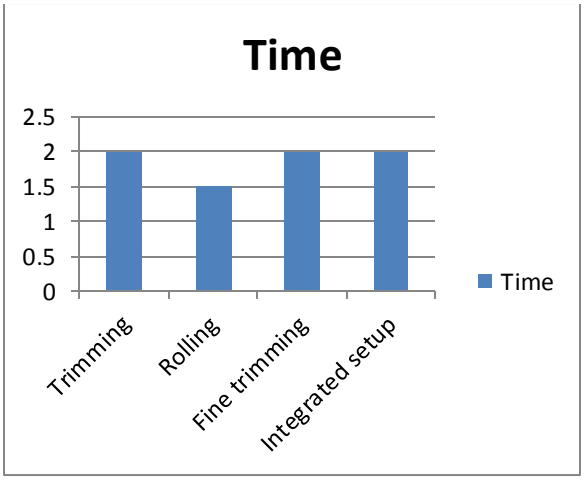
Setup time = 8mins

Process time of trimming, rolling & fine trimming =5mins30secs

INTEGRATED SETUP

Setup time = 8mins

Process time = 2mins



RESULTS AND DISCUSSIONS

By installing the setup the production rate is increased, manpower is reduced and number of machines also reduced. The return of investment for this setup is quick when compared to the other new process. On the current setup 1200 number of units manufactured for a day. On installing the integrated setup the 1600 number of units can be manufactured per day.

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