PROBLEMS IN SPINNING IN KOLFE HOUSE-HOLD UTENCIL FACTORY

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ABSTRACT

Kolfe House-Hold Utensil Factory in Addis Ababa, is producing different types of utensils for house-hold use from commercial aluminium. Deep drawing or/and spinning are the methods used for shaping this metal to desired shape and size, though some small parts are cast too. One of their products is kettle, which is produced by deep drawing the aluminium discfollowed by spinning. The spinning chuck is made of wood. The problem put forward to the investigator was the short span of life of this chuck, though the rough surface finish of the kettles was also observed and taken as another problem. Investigations were carried out at each stage of processing. The suggestions made, after experimental results, not only solve the problems, if incorporated, but also increase the production few fold times with increased financial gains.

INTRODUCTION

Metal spinning is one of the oldest of the metal working arts. It consists of forcing a circular metal disc to fit around a form or chuck, which is revolving in a lathe. A tool is pressed into the disc and when the pressure is applied, the metal is gradually worked around the chuck until it assumes its size and shape. Spinning is normally a cold-working process, which strain-hardens the metal.

The kettles are made in two different sizes in this factory, using commercial aluminium (1100) discs (called circles in the factory) imported from 'The Excelsior Metallurgical Works Co., Ltd., Hong Kong. Table 1 illustrates the other specifications of these discs. Each disc is first deep drawn in a press. The time of deep drawing is 5 seconds per piece. The deep drawn part is then spun on a spinning lathe, which are two in number. The actual time of spinning is 3 minutes per piece. Each spinning lathe spins 120 pieces in a 8-hour shift.

Table 1. Specifications of Imported Aluminium Discs

Type of Kettle	Dia. of Disc (cm/inch)	Gauge	Weight (gms)	Cost per Disc (Birr)
Big	40.64/16	20	323.15	2.28
Small	35.56/14	20	247.41	1.74

REASONS OF THE SHORT SPAN OF LIFE OF CHUCKS

Spinning chucks are of two types of construction, solid and collapsible. Solid chucks are easy to produce, but use of collapsible chuck becomes essential when the spun-objects with undercuts cannot be withdrawn from solid chucks. Collapsible chucks involve many construction problems and require skilled labour to produce them.

Chucks are commonly made of hardwood, cast iron, steel, or plastics. For the spinning of aluminium, wooden chucks are very commonly used. These are normally made of maple, birch, cherry or walnut. A close-grained wood such as maple is desirable for good service for a long period of time. In Kolfe Factory, only the collapsible type of chucks are being used, and are made of 'Girar' or 'Dare' wood obtained from Langano. 'Kararo' is a very hard and close-grained wood found in Ethiopia. If this wood is used for making wooden chucks, it is bound to provide a longer useful life than being given now. Sheet metal covering of a collapsible chuck creats many problems during its construction, and is not recommended. Metal chucks, though have greater accuracy and longer life, but cannot be recommended for the following reasons:

1. Spinning lathes in this factory are less powerful.
2. Stripping of a spun part from the metal chuck creates problems.
3. The assembling and dissembling of a collapsible metal-chuck is much more time consuming, and tiresome to the spinner, resulting in the fall of production of the kettles.

Commercial aluminium is one of the easiest metals to spin because of its low rate of strain-hardening, and wooden chucks are perhaps the most satisfactory [1]. The main reason of the short span of life of the wooden chuck lies else where. Deep drawing, the first step in shaping the metal, strain-hardens it to a very large extent, decreasing its ductility. Spinning, which itself is a strain-hardening process, at this state of the metal, requires high and higher pressures to be applied by the spinner. A metal becomes harder and less ductile with additional mechanical working, necessitating the use of more and more power [2], that is, the spinning pressure in our case. The use of high pressures during spinning is the main cause of the short span of life of the chuck. This is also partly responsible for the rough surface finish of the kettles.

When a metal is cold-worked, about ninety per cent of the energy used in cold working, is released in the form of heat [3]. The strain-hardening of a metal increases with a decreasing rate resulting in further evolution of more heat. Thus, a large amount of heat is bound to be evolved, when a deep drawn object is spun, particularly when spinning is a very quick process. Aluminium has a good thermal conductivity to transfer this large amount of heat quickly to the wooden chuck. This continuous supply of heat for almost 8 hours in a shift under high spinning pressures lead to the deterioration of the wood of chuck, resulting in its short span of life.

The high friction resulting from the high spinning pressures on the tool against the aluminium produces a large amount of heat. This heat is unevenly present, making the spinning surface to be more soft and ductile, resulting in roughened surface finish. These marks, once produced, are almost impossible to be removed [4]. The most effective method of decreasing or avoiding the production of these marks, is to reduce the friction by applying good amount of a lubricant to the surface of the metal being spun, and even the tool. Grease No. 40 (Shell) is being used as a lubricant in this factory. The consumption of this is 12 Kilogram per lathe per year, and is bought locally at a price of Birr 3.00 per Kilogram. Inadequate use of this lubricant by the spinner under the existing practice (when the spinning pressure is high) is the basic cause of the development of rough surface of kettles, which can be easily taken care of.

The solution of the main problem, as now visualised is to decrease the pressure used by the spinner and the heat generated during spinning. Both these factors could be decreased if the extent of strain-hardening of the metal could be made to decrease [5]. A series of tests were made at each stage of the processing to know the extent of strain-hardening and the method to decrease or remove it.

EXPERIMENTAL WORK

The first step was to find out the state of the aluminium discs in the as-received condition from Hong Kong. Hardness has been commonly used as a criterion to measure the extent of strain-hardening. Thus, hardness testing was carried out of the discs in the as-received condition and after annealing. The annealing was carried out at 400°C for half-an-hour in a furnace in the Faculty of Technology, Addis Ababa University. The results are illustrated in Table 2. It is evident that the discs are in the annealed (soft) state in the as-received condition. The rest experimental work refers to the processing of big size kettle. The conclusions stand true for small size as well with little modifications.

Table 2. Hardness of Aluminium Discs

As-received condition	20 VPN ≏ 19.4 BHN
Annealed at 400°C, ½hr.	20 VPN ≏ 19.4 BHN

Having seen that the incoming discs have no strain-hardening, tests were then carried out to know the extent of strain-hardening during deep drawing by measuring the hardeness of the bottom and the wall of the part, which is illustrated in Table 3. The bottom of the part gets some strain-hardening during deep drawing to increase its hardness value from 20 VPN to

Table 3. Hardness of the Deep Drawn Part

Hardness of the bottom	:	25 VPN
Maximum value of the hardness on the wall of the part	:	400 VPN

25 VPN. The maximum value of the hardness on the wall is 40 VPN, which is twice the annealed-state value, and is also the hardness of commercial aluminium in more than 3/4 hard state [6]. Spinning now shapes this wall of the deep drawn part to the final shape of the kettle. An already 3/4 strain-hardened metal is further strain-hardened. The presence of strain-hardening to such high values due to deep drawing is the main canse of evolution of large amount of heat, and necessitates the use of high tool pressures during spinning. Annealing is the only solution to remove this strain-hardening produced during deep drawing. A deep drawn part was annealed at 400°C for ½ hour in a furnance, and then given to the spinner for spinning. As manual spinning is being used in this factory, there are no means to find out the pressure required and actually used during spinning, except to find out from the spinner the difference in the pressures required and used by him during spinning the two pieces – one nnannealed, and the other annealed. The spinner found that the spinning of annealed piece required the use of less pressure, and was mnch easier and less tiresome. The time of spinning in both cases was determined and is illustrated in Table 4. The actual spinning time decreased from 3 minutes to one minute. As the spinning pressure and the spinning time had decreased, the heat evolved was very less.

Table 4. Comparison of Spinning Time and Annual Production

Condition of Part	Actual Spinning Time (minutes)	Annual Prodnction (No. of Kettles)
Un-annealed deep drawn	3	87,600
Annealed deep drawn	1	262,800*

*estimated production if annealing is used.

The life span of the wooden chnck is visualised to increase many times under the new conditions as both the factors effecting the life span have been made to decrease by annealing in-between deep drawing and spinning with additional advantages enumerated in suggestion one.

As this factory does not have an annealing furnace, a low temperature (air-circulation type) electric resistance furnace, using nichrome as heating element, can easily be designed and fabricated. As, such a furnace has better control over the temperature, the use shall result in reliable and quality product. A little less reliable substitute was found in the same factory and used. The aluminium melting furance (oil-fired) in the factory, has a space of 30 cms X 40 cms X 28 cms, for letting off the flue gases, where the temperature is around 500°C. Annealing could be done in this space. Eight deep drawn parts (four of each size), stacked over each other, can easily be accommodated. As a test, one deep drawn part was put in this space for 10 minutes and then air-cooled. The time of spinning this part was one minute, and required low spinning pressure. Thus, this space of the furnace could be used for annealing purposes, when this furnace is being used for casting purposes, as an alternative to an annealing furnace. The correct annealing temperature (when the parts are getting heated up in this space) can be found out by rubbing a soft pine stick across the face of the part at regular intervals. When the brown chart mark is left upon the part, a satisfactory annealing temperature has been reached.

SUGGESTIONS

1. Based on the step by step investigations, and with the practice at present being followed, that is, deep drawing followed by spinning, annealing in between is a must. The space in the aluminium-melting furnace may be utilised for this purpose at no extra cost with additional advantages as given below. An electric-resistance furnace may be fabricated and used for quality product. Though it shall increase the cost a little, but this extra cost shall be outbalanced by following advantages:

   (a) The production of the kettles shall increase by 200 per cent with almost the same set-up, increasing thereby the profits of the factory.

   (b) The life of the chuck shall increase at least 4-5 times with additional gains.

   (c) The spinner shall hardly require in-between rest in a shift, because the spinning becomes less tiring, increasing the production of the kettles further.

2. A better solution of the problems in producing the kettles, is to little change the practice of producing them. When the draw is very deep in an article to be made snch as the kettle, it is more practical to use spinning as the sole method of shaping than to try to form it on a press and spin [1]. The deep drawing may be avoided completely. The shaping of the kettle from the aluminium disc may be done by spinning in two stages. The first stage spinning may be done by using a solid wooden chuck, called the breakdown chuck as illustrated in Fig. 1. No interemediate annealing is required for commercial aluminium [7]. The second stage spinning may be done by using a collapsible chuck (wooden) of the dimensions beiug used at present in this factory.

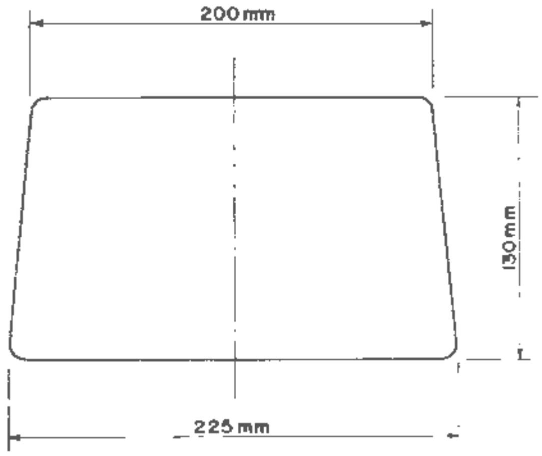

Fig. 1 Solid Wooden Chuck for Big Sized Kettle

This shall shift the point of strain to a new position and shorten the leverage to reduce the stress on the metal. The total spinning time of both stages shall come out to be less than 2 minutes. The advantages of the two stage spinning are as follows:

(a) The production shall increase by 50 per cent directly.

(b) As no annealing is required, there shall be savings in initial cost of furnace, running and maintenance cost, labour, etc.

(c) As deep drawing is not required, this spared capacity can be utilised in producing the other deep drawn utensils at no extra cost. The cost of deep drawing the kettle being saved further reduces the cost of the kettle.

(d) The life of the chucks shall be few times more than now with additional savings

(e) The spinner shall be less tired, and can spin more parts per shift to increase the production further.

3. As suggested earlier, the rough surface finish of the kettles may be avoided or decreased by more use of the lubricant. A good lubricant can be prepared by melting the yellow laundry soap in water by heating it and then mixing it with engine oil (no. 30). The spinner can also apply the lubricant to the spinning tool.

4. 'Kararo' wood may be used for producing the wooden chucks.

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