Optimization of Hammering Barrel for Life Enhancement by Wear Reduction

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Abstract–*This work deals with selection of different materials for lapping/hammering barrel which causes wear during the process of debarring of bearing needles. In debarring process the wear occurs inside the barrel by continuously rotating needles within the barrel. Therefore after some particular time interval the barrel gets damaged and cracks are initiated leading to cause failure of barrel. This causes dispersion of needles in environment. To overcoming this problem the barrel was modified with material having high wear resistance. The material selected was En-8,Abrex Lt 500, Hardox 500, Sumihard 340.The selected the material of barrel is ensured to fulfill the debarring process with less wear as compared to conventional barrel with more life of durability.Archard's wear model was used for determining the wear rate of this material to compute the wear depth over the sliding distance. The apparatus with pin on disc has been used to study the specification of the adhesion wear.*

***KeyWords*: *Archard's Wear Equation, Hammering Barrel, Wear Rate, Pin and Disk Tribometer* etc.**

1. INTRODUCTION

Wear is a complex phenomenon that is not well understood. Humans have been aware of wear for many millennia. It has been avoided by choosing harder materials for things that are more likely to wear. However, wear is not always something to be avoided, many times it is desired; for example a pencil writes because the lead wears, and metal is polished by wearing the surface smooth. Despite the fact that the occurrence of wear has been well documented throughout history, the scientific study of wear is relatively new Because wear is such a new field of study, there is not always agreement on theories or meanings of terms, the classifications and definitions presented in this report are by no means the only ones that have been proposed.
Wear occurs when objects are in contact; it is difficult to directly observe the process of wear as it happens. Therefore, experimenters generally rely on observations made after the test, and then infer what caused the wear. This is not the only difficulty; many of the causes and effects of wear only occur on a microscopic level.
A third reason that wear is not well understood is that it involves many deferent variables that make it difficult to generalize results. The adhesive wear occurs when two surfaces are moving relatively one over the other, and this relative movement is in one direction or a successive movement under the effect of the load so that the pressure on the adjacent projections is big enough to make a load plastic deformation and adhesion.
The needle manufacturing process after process of cutting wire the end face of needle is sharp and it not possible to finish it separately so hammering and lapping process are carried to mass quantity of needle. In this process the barrel is wear out continuously and after some time interval it get fracture. To avoid this we use alternative material to resist the wear and get more life. And to study the wear pattern with respective to the loading, sliding distance, temperature effect etc.

Hani Aziz Ameen1, Khairia Salman Hassan2 and Ethar Mohamed Mhdi Mubarak-The widely known methods in studying wear, depend on choosing the sliding surfaces, and then measuring, before testing the removal material, and after that, and any change taking place, will be attributed to the resulted wear (Rabinowicz,1965).There are several methods to specify wear rate such as:
1-Weighting method
2- Mechanical gauging method
3- Optical method
4- Methods for the measurement wear using radio tracers techniques (measurement of radioactive pick-up method.)Methods for the measurement wear using radio tracers techniques (measurement of non adherent debris method) In the current research the weighting method is used, that is considered from the easiest methods followed to fix and measure the wear. This method is summarized in weighting the sample before the test and after that, and then the rate of wear will be calculated from the lost weight.

Fermi National Accelerator Laboratory, -Fermilab has successfully demonstrated the ability to improve the performance of damaged 1.3 GHz single cell and 9-cell Tesla– type cavities by using a modified centrifugal barrel polishing (CBP) process that leaves a mirror finish on the inside of the cavity. Fermilab now is developing and constructing a new CBP machine which can handle both 650 MHz and 1.3 GHz cavities. The new machine will have a larger moment arm and therefore impart more force on the cavity and machine. Because of these increased forces the effects on cavity supports and machine design were examined. This paper will document the multistep mechanical analyses for the CBP barrel and cavity, calculations of the fatigue life and the requirements for the structural welds.

Centrifugal barrel polishing (CBP) is an alternative processing technique that polishes the inside of superconducting radio frequency cavities by rotating the cavities at high speeds while filled with an abrasive media [1]. CBP has received great interest at Fermilab because of its ability to produce mirror like finishes, reduce amount of chemistry needed, and repair defects that could not be repaired with standard processing techniques.

Wenyi Yan, Noel P. O'Dowd , Esteban P. Busso -A computational approach is proposed to predict the sliding wear caused by a loaded spherical pin contacting a rotating disc, a condition typical of the so-called pin-on-disc test widely used in tribological studies. The proposed framework relies on the understanding that, when the pin contacts and slides on the disc, a predominantly plane strain region exists at the centre of the disc wear track. The wear rate in this plane strain region can therefore be determined from a two dimensional idealization of the contact problem, reducing the need for computationally expensive three dimensional contact analyses. Periodic unit cell techniques are used in conjunction with a ratcheting-based failure criterion to predict the wear rate in the central plane strain region. The overall three dimensional wear rate of the disc is then determined by scaling the plane strain wear rate with a conversion factor related to the predicted shape of the wear track. The approach is used to predict pin-on-disc test data from an Al–Si coating using a tungsten carbide pin. The predicted results are found to be consistent with measured data.

Basavaraj Kanavalli, master thesis ,Royal Institute of Technology -Twin-disc rolling/sliding tribometer experiments try to mimic the rolling/sliding contact experienced by micro-machines, e.g., between the teeth of two mating micro-gears. In this work, a user defined subroutine UMESHMOTION, in the commercial finite element code, ABAQUS, has been applied to simulate wear in a twin-disc tribometer experiments, conducted for defined slips. ABAQUS invokes the adaptive meshing algorithm after the convergence of the equilibrium equations of the contact problem, which further, invokes the user defined sub-routine UMESHMOTION. UMESHMOTION is coded to compute the local wear using the generalized Archard's wear model and it integrates the wear depth over the sliding distance using Euler integration scheme. In the absence of wear coefficient data from such experiments, it is assumed to be the same as identified from pin on- disc experiments (Herz et al., 2004; J. Schneider & Herz, 2005). The computed wear is applied on each surface node as mesh-constraint by the adaptive meshing algorithm.

The resulting equilibrium loss is corrected by solving the last time increment. Thus the geometry and pressures are updated. Simulations were carried out with different applied loads (with constant slip) and different slips (with constant load) and the results obtained, are presented. The results obtained from UMESHMOTION are discussed by comparing them with the Global Incremental Wear Model (GIWM) and the Wear-Processor.

1.1 Problem Statement

To obtain a high wear resistance material with good mechanical properties and it easy to manufacture hammering barrel. The hammering barrel is wear too fast and whole is formed in weakest section and needle is spread out.

To find the contact area and maximum contact pressure at particular circumference of barrel and calculate the wear height with respective to the sliding distance and the load applying on it.

Another problem of testing is being generally associated with validation which includes design validation, performance validation, components validation, production process validation, tribology validation, mild steel vs Hardox 500 performance and Abrex 500 LT & Sumihard 340 , So for overcome these features we have to design a hammering barrel to max durability.

1.2 Objective

Minimize the wear of hammering barrel and calculating effect of temperature, rotating speed, load applied on it, design and develop a physically simpler, more reliable and less costly high wear resistance barrel and also to ensure and maintain proper testing functionality of the prior art.

1.3 Methodology

The importance of Methodology is there in proper and timely completion of any project, thus following points are to be included as strategy / scheme of implementation.

The literature review regarding the Design, Development and Testing of hammering/ lapping barrel and dry sliding wear.

The results and conclusion of the papers gives a brief idea of the gaps in the work up till now. Considering these gaps the work can be decided.

The size and complexity of Design of Barrel under which other parameters design are one of the major parameters which can be considered as main boundary conditions.

The designing of barrel is done by adopting a other conventional debarring or hammering barrel.

Fabrication of hammering barrel is done using test facilities project descriptions and conventional design parameters.

Documentation which will include the theory of Hammering barrel with wear behavior, Conventional hammering barrel, sketch and design of Hammering barrel, experimental results and validation results.

Concluding the thesis with future scope.

2. ARCHITECTURE AND WORKING OF HAMMERING/ LAPPING BARREL

A fig shows the hammering barrel which material is En-8 and the diameter of 1.9 m one side close. The circular window shows the material loading and rectangular window is material unloading. The rotating speed of barrel for hammering is 32 rpm and lapping 16 rpm.

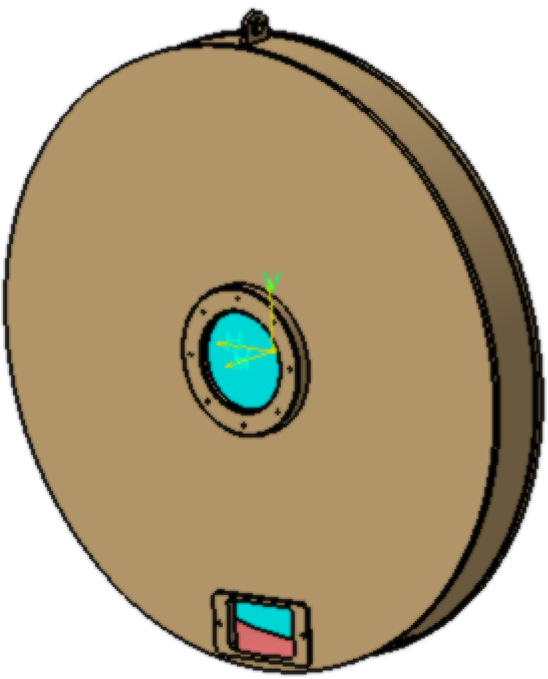


Fig - 1: Hammering barrel cad model

WORKING

By input the power through the prime mover as from Motor, the barrel which mount on shaft of motor should transfer the speed to gear box next situated on shaft and further on same shaft the other barrel is situated for converting the speed with required rpm.

When wire cut to needle size its corner are flat and to obtaining proper shape first insert the lot of needle in barrel and rotate it to 32 rpm .its effect is to corner are hammered and small bubble are occur in corner and get round shape.

This round shape is not proper so the excess material are removed by reducing the speed of barrel and insert the abrasive powder like as emery. this abrasive powder remove the excess material and needle are found good shape and sharp corner are reduced. In this process the water are used to cooling purpose.

These processes the needle are contact with barrel plate and plate is wear out. For this to calculate wear rate using damaged barrel wear height, speed of barrel, force applied, and duration of running process. After calculating the volume of wear and then using archard wear equation to find the coefficient of barrel plate.

3. PROPOSED MATERIAL CHEMICAL COMPOSITION AND THEIR PROPERTIES

Table 1: Chemical Compositions of Materials

Materia/ Content	En-8	Sumihard 500	Abrex 500 LT	Hardox 500
C	0.36	0.35	0.35	0.30
Si	0.4	0.7	0.7	0.7
Mn	0.6	1.6	2.0	1.6
P	0.050	0.025	0.025	0.020
S	0.05	0.01	0.01	0.01
B	-	0.003	0.005	0.005
Cr	-	1.0	1.2	1.5
Ni	-	0.25	1.0	1.5
Mo	-	0.25	0.6	0.6
T	-	0.3	-	-

Table 2: Mechanical Properties of Materials

Material /Content	En-8	Sumihard 500	Abrex 500 LT	Hardox 500
Yield Strength (N/mm^2)	465	1250	1250	1300
Tensile Strength (N/mm^2)	490	1500	1475	1550
Hardness (HBN)	201-255	450-550	450-550	470-530
Wear Rate(Impact angle 60°)	7 x 10-3	4.5x10-3	4.5x10-3	4.2x10-3
Weldability	Yes	Yes	Yes	Yes

3.1 Actual And CAD model of wear plate pattern

The actual and CAD model are as shown in following figures.

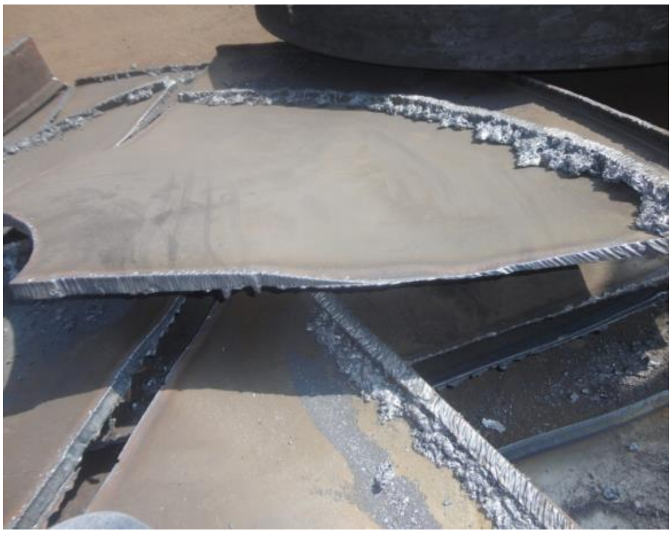


Fig - 2: Actual Wear Plate

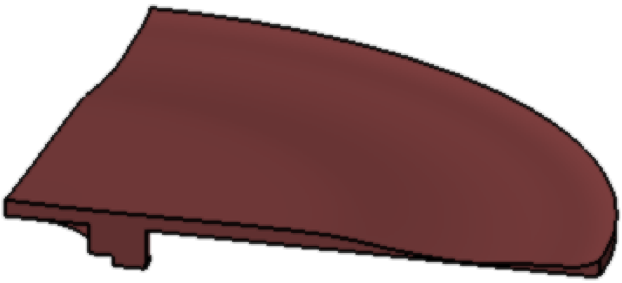


Fig - 3: CAD Model of Wear Plate

3.2 Calculations

Life Calculation –
Wear volume - 33 x 10^6 mm^3
Maximum wear height - 23 mm
Max wear occurred at a distance from barrel center radially - 0.75 m.
Sliding distance for one revolution = 2πR
= 2x3.14x0.75
= 4.71m.

Contact area of needle with barrel plate = 0.513 x 10_6 mm_2
Maximum needle weight putting in barrel = 500 kg
As per Archard's wear equation for wear calculation.
We know the formulae

$$K = \frac{VH}{SFn}$$

Where,
K= wear coefficient of material
V= Volume of wear
S= Sliding Distance
H= Hardness of Material
Fn = Normal Force Applied.
First taking current material of barrel which is En-8
For En-8 ,
Max hardness = 250 HBN
Wear coefficient = 7 x 10^{-3}.

So volume loss per revolution of barrel,

$$V = \frac{KSFn}{H}$$

$$V = \frac{7 X 10^{-3} X 4.7 X 500 X 9.81}{250}$$

= 0.64 mm^3

Height of Wear

$$h = \frac{volumeloss}{contactare a}$$

$$h = \frac{0.64}{0.153 X 10^{6}}$$

= 1.2475X10^{-6}mm

After 23 mm of wear height crack is formed so we calculate the revolution of barrel for these 23 mm height.

$$= \frac{23}{1.2475 X 10^{-6}}$$

= 18.435 X 10^{-6}

In an 1 hour barrel complete rotation = 32x60= 1920 revolution

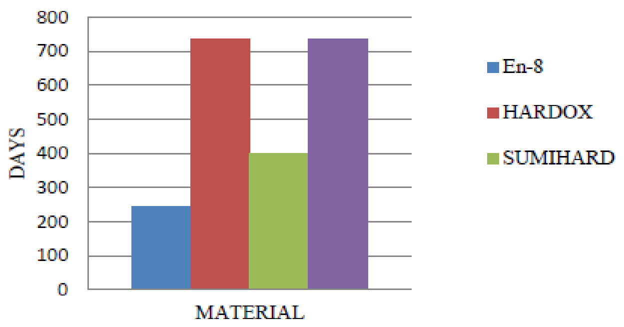
So barrel life in hour $= \frac{18.435 X 10^{6}}{1920}$ = 9602 hour

Total Working = 400 days.
For different material life cycle are given in below table.

Table 3: Theoretical Life of Material

Material	En-8	Sumihard 340	Abrex 500 LT	Hardox 500
Life in days	400	651	1200	1200

4. RESULTS AND DISCUSSION



Graph 1: Material Life

Table 4: Comparison between Analytical and Experimental Results

Material	Analytical	Experimental
En-8	400	245
Sumihard 340	651	400
Abrex 500 LT	1200	725
Hardox 500	1200	725

It has been observed that a large deviation has been seen in the results of analytical and experimental due to following reasons

1. Due to increase in the temperature the crystal gets expanded causing to increase the wear rate.
2. The wear caused by abrasive powder is assumed to be zero during analytical calculations.
3. Needle sizes are variable due to variable addition of load to the barrel.

CONCLUSION

As per the analytical results and experimental results it has been observed that the life of Abrex 500 LT & Hardox 500 is greater than En-8 & Sumihard 340. The cost of Abrex 500 LT is less as compared to Hardox 500.
Hence, Abrex 500 LT is selected as a final material for horizontal deployment.

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