Optimization of Turret Components of Tablet Press Machine

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Abstract - A tablet press is a mechanical device that compresses powder into tablets of uniform size and weight. To form a tablet, the granulated material must be metered into a cavity formed by two punches and a die, and then the punches must be pressed together with great force to fuse the material together. A method of structure optimization for tablet press is proposed in order to reduce mass while assuring adequate stiffness. Pre compressor assembly, main compressor assembly, turret, plates are determined as optimal objects by mass analysis. Key geometric parameters of plates which have relatively larger impacts on mass and stiffness are extracted as design variables. In order to research relationship between stiffness, mass and design variables, command batch file is built by CREO and analysis is done in ANSYS and topology optimization is done in HYPERMESH.

Index Terms - Optimization, Tablet press machine

I. INTRODUCTION

A tablet press is a mechanical device that compresses powder into tablets of uniform size and weight. A press can be used to manufacture tablets of a wide variety of materials, including pharmaceuticals, illicit drugs, cleaning products, and cosmetics. To form a tablet, the granulated material must be metered into a cavity formed by two punches and a die, and then the punches must be pressed together with great force to fuse the material together.

A tablet is formed by the combined pressing action of two punches and a die. In the first step of a typical operation, the bottom punch is lowered in the die creating a cavity into which the granulated feedstock is fed. The exact depth of the lower punch can be precisely controlled to meter the amount of powder that fills the cavity. The excess is scraped from the top of the die, and the lower punch is drawn down and temporarily covered to prevent spillage. Then, the upper punch is brought down into contact with the powder as the cover is removed. The force of compression is delivered by high pressure compression rolls which fuse the granulated material together into a hard tablet. After compression, the lower punch is raised to eject the tablet.


II. TURRET

The central part of the rotary press is the turret which is equipped with a number of tool station consisting set of Upper punch-Die-Lower punch. Figure 1,2,3,4,5 shows the constraints and loads, von-Mises stress contour, maximum stress position, maximum principle stress contour, Total deformation contour respectively. Table 4.1 shows the material property.

Figure 1 Mechanism of tablet press machine
<table>
<thead>
<tr>
<th>Material</th>
<th>SGI GGG(40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young's modulus</td>
<td>1.7 × 10^5 MPa</td>
</tr>
<tr>
<td>Poisson's ratio</td>
<td>0.25</td>
</tr>
<tr>
<td>Density</td>
<td>7.2 × 10^6 kg/mm^3</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>390A</td>
</tr>
</tbody>
</table>

Table 1 Material Property

**FEA of turret**

Pressure acting on die port face in die during tableting operation which is very higher. Centrifugal force due to rotational speed (50 RPM)

![FEA of turret](image1)

**Figure 1** Constrain and Loads of Turret

**Figure 2** von-Mises Stress Contours for Turret (Mpa)

Figure 2 shows the equivalent stress is around 100 Mpa and figure 4 shows maximum principal stress is around 88 Mpa. The capacity of material is up to 390 Mpa so it is very safe stress.

![FEA of turret](image2)

**Figure 3** Showing Stress Position

![FEA of turret](image3)

**Figure 4** Maximum Principle Stress Contour
Optimization of turret

Topology optimization is carried out in the HYPERMESH.09. Shows in figure 6 shows the constrain and Loads for turret. Here white area shows load and fixed support acting on turret.

After applying boundary condition and forces to the component do the optimization in the HYPERMESH. To solve this problem 19 iteration took place and at different iteration the density distribution is shown in Figure 7. It can be seen at final iteration of optimization, some of the design area is fall in blue zone which shows the state of void but its not possible to remove all the material from the blue zone of the component, some density threshold is defined to keep the material in optimized result.

Iteration of Turret

After complete topology optimization, remove the material approximately from the top surface and do analysis again in ANSYS Figure 8 shows the model after removing excessive material.
Figure 8 Optimized Turret

Shows in figure 9 shows the constrain and Loads for Turret in which A indicate Fixed Position and B indicates 0.833 r/s rotation velocity and c indicate pressure acting in hole.

Figure 9  Constrain and Pressure applied on Turret

Figure 10  Equivalent Stress of Turret

Figure 10 and Figure 11 shows von-Mises Stress contour and Maximum Principle Stress Contour for Turret showing values around 95 MPa and 77.3 MPa and it is well below 390 MPa. So it is safe.

Figure 11  Maximum Principal Stress of Turret
Figure 12 shows the total deflection of component is 0.006 which is safe deflection. Here maximum material is removed from the turret as consider of the components assembly. So iteration 1 is final selected optimized component.

### III. RESULT AND COMPARISON

Table 2 shows the displacement and stresses of turret which are analyzed under the maximum loading condition.

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Existing Component</th>
<th>Modified Component</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Principal Stress</td>
<td>87 Mpa</td>
<td>77.3 Mpa</td>
<td>11.1 %</td>
</tr>
<tr>
<td>Equivalent Stress</td>
<td>100 Mpa</td>
<td>95 Mpa</td>
<td>5.26 %</td>
</tr>
<tr>
<td>Total Deflection</td>
<td>0.007 mm</td>
<td>0.006 mm</td>
<td>16.66 %</td>
</tr>
<tr>
<td>Weight</td>
<td>1346 kg</td>
<td>1320 kg</td>
<td>2 %</td>
</tr>
</tbody>
</table>

Table 2 Comparison of turret

### IV. CONCLUSION

In rotary tablet press machine UNIC I FC, turret and upper plate are the major components and static analysis of some of the component has been carried out with FEA tools, which shows the stresses and deflection on these component are less than the permissible values.

After analysis, shape optimization is carried out by using ANSYS and topology optimization is carried out by using HYPERMESH.

### REFERENCES


