THE EFFECT OF NOZZLE GEOMETRY ON EROSION WEAR BEHAVIOR OF POLYMETHYL METHACRYLATE

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ABSTRACT

The aim of this study is to evaluate the effect of nozzle geometry on erosive wear behavior of polymethyl methacrylate (PMMA). One of the most important factors that effects the abrasive particles velocity and diameter is the internal geometry of the blasting nozzle. Various types of nozzle geometries are used in industry such as jet blast machining and sandblasting. Abrasive blasting is a traditional method for micro machining process and has a widespread usage area such as micro-machining, surface treatment, surface cleaning. Various types of engineering materials such as metals, polymers can be processed by this method. The main purpose of this method is to accelerate the abrasive particles by using a high pressure carrier gas through the nozzle and impacting them to the surface and removing material. Repeated impact of abrasive particles to the surface of the samples erodes the target material.

Keywords: Nozzle geometry, Erosion wear, Polymethyl methacrylate

Introduction

Polymethyl methacrylate (PMMA) is a transparent thermoplastic, often used in a window or other pressure-resistant alternative to glass. High-frequency characteristics of PMMA make it a viable engineering material and is used in the forms of electric lights of automobiles, viewing ports of submarines and in aircraft passenger windows or windshields. Abrasively eroded surface such as as-cast available is exposed to high speed solid particles, they may lose their mechanical and optical transparency properties. The loss of transparency of as-cast available is caused by an internal effect on surface structure and optical reflection,[1] In order to assess the effect of nozzle geometry on the erosion wear behavior of PMMA material, tests were carried out using different nozzle geometries and PMMA samples were evaluated. The nozzle designs were chosen according to usage potential in industrial applications such as micro-machining, sand blasting, surface preparation, cold cutting, etc. Hence, by using the experimental results, it is aimed to perform the proper nozzle geometry for each industrial application. The surface damage due to the energy loss by the impact of abrasive particles on the target material is evaluated. The results of the experiments were calculated according to the erosion rate and crater volume. The principles of the particle erosion behavior of any material is not easy, because the erosion resistance of the material can be evaluated after removing the surface damage. The main purpose of this study is to evaluate the effects of nozzle geometry on erosive wear behavior of PMMA material using different nozzle designs.

The erosion rate is also a tool for damage dimension calculation and can be obtained by using different impact force per area. Measurements of the nozzle radius and crater depth of tested PMMA samples were obtained by using non-contact 3D laser scanner. As an important parameter to evaluate the surface damages in solid particle erosion tests, the crater depth was evaluated. The erosion rate was calculated with the experimental results. The erosion rate was calculated using the experimental results. The erosion rate was calculated using the experimental results.

Non-contact Laser Profilometer/roughness Measurements

After solid particle erosion tests, PMMA samples surfaces were scanned with Renishaw P500 non-contact 3D profilometer. A profile with 25 mm length at the center of the erosion crater scanned with a 0.1 μm gap (Figure 3).

Surface Visualization with Image Processing

In the next part, the examined flat básico samples is showing an attractive option for dimensional measurement due to the more objective measurement results, reduced variability, high resolution, low cost and ease of implementation.[2] The data obtained from the erosion surface was tested to a pronounced crater, found to have a pronounced crater, used to confirm the results. The influence of nozzle geometry on erosion rate of PMMA material was obtained. To capture the edge of PMMA test specimens, an HP CarlZeiss Stemi 2000 C microscope was used. The erosion crater edges were scanned with a contact profilometer Renishaw P1000. These were scanned with a flatbed scanner system and image processing was achieved by using an open-source program ImageJ. The erosion surface images were scanned using the software ImageJ. The erosion surface images were scanned using the software ImageJ. The erosion surface images were scanned using the software ImageJ.

Surface Roughness Profilometry

The surface roughness and crater depth of tested PMMA samples were obtained by using non-contact 3D laser scanner. As an important parameter for evaluating the surface damages in solid particle erosion tests, the crater depth was evaluated. The erosion rate was calculated using the experimental results. The erosion rate was calculated using the experimental results.

Table 1: Non-dimensional group of solid particle erosion test

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Gravitational field</td>
<td>9.81</td>
</tr>
<tr>
<td>V</td>
<td>Velocity of particle</td>
<td>300 m/s</td>
</tr>
<tr>
<td>D</td>
<td>Diameter of particle</td>
<td>0.5 mm</td>
</tr>
<tr>
<td>E</td>
<td>Erosive energy</td>
<td>100 mJ</td>
</tr>
<tr>
<td>R</td>
<td>Radius of nozzle</td>
<td>5 mm</td>
</tr>
<tr>
<td>H</td>
<td>Height of nozzle</td>
<td>5 mm</td>
</tr>
<tr>
<td>T</td>
<td>Time of impact</td>
<td>0.1 s</td>
</tr>
<tr>
<td>N</td>
<td>Nozzle geometry</td>
<td>A, B, C, D</td>
</tr>
</tbody>
</table>

Figure 1: Solid particle erosion test rig

Figure 2: Surface roughness measurement profilometer schematic representation

Figure 3: Erosion crater spreading area visualization steps by image processing

Figure 4: Surface visualization with image processing

Non-contact 3D laser profilometer/roughness measurements

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