Synopsis

The dimension stone polishing consists of eliminating the surface roughness of the slabs with the use of fickerts. The main tools used for this activity are composed of epoxy resin, derived from petroleum, which contains chemical elements with potential harmful to the environment and human health. To overcome this problem, it is necessary to develop new technologies with the lowest environmental impact in their life cycle, from the raw material acquisition, the use until the waste disposal. This study aims to contribute to the improvement of the ecological fickert, based on castor polyurethane resin, developed by the Centro de Tecnologia Mineral (CETEM). The fickerts presented here are composed of castor oil resin, silicon carbide and silica from rice hull ash. Two compositional formulas were used for the development of the pieces and they were submitted to an industrial polishing machine. The results showed that the formulas with higher percentage of extenders presented better performance, expressed by the relation between the loss of mass of the pieces and the gain of gloss on the surface of the slab. This fact allows to infer that this line of research presents great potential of applicability in the market of dimension stones.

Keywords
Polishing, Abrasive, SiC, RHA.

Introduction

The dimension stone polishing consists of eliminating the roughness of the slabs that come from the sawing process through an abrasive process that occurs in the contact between the diamond tools and the surface to be polished. The wear is performed by fickerts arranged in descending order on the polishing heads, from the coarse grain to the finest one. These polishing heads perform the rotational movement and are applied under pressure on the slab surface, which gradually decrease the roughness and increase the brightness intensity on it. The main fickerts used for the polishing of dimension stones can be divided into two types: the magnesia bond fickert and diamond bond fickert. The magnesia bond fickert is composed of a sorel cement (magnesium chloride and magnesium oxide) and Silicon Carbide (SiC). The diamond bond fickert is composed of an epoxy or synthetic metal matrix and the diamond as abrasive element. Epoxy fickerts are the most used by the polishing industry, and although they are more technologically advanced, they are composed of non-renewable materials and contain bisphenol A and epichlorohydrin, substances that may present a potential harmful to human health (BESERRA et al., 2012). From this observation, some studies were developed to test the potential of a polyurethane resin based on castor oil as a matrix of fickerts for stone polishing, as it can be seen at Dorigo & Silveira (2016), Almeida et al. (2017), among others. The present study proposes the preparation of a fickert composed of the polyurethane castor oil resin, extenders and green silicon carbide (Green SiC) for experimental tests in an industrial polishing machine. The tool is presented as a sustainable alternative for the dimension stone polishing process once it is a non-toxic product from renewable resources.
Objective

The objective of this study is to test the potential of a tool for the dimension stones polishing, which is consisted of a matrix composed of polyurethane castor resin, silicon carbide and rice hull ash, with the addition of green silicon carbide as cutting element. The research proposes to develop an ecological fickert that has a higher technical efficiency than the magnesia bond fickert and is cheaper than the diamond bond fickert, besides that, offer a sustainable alternative for the stone polishing process.

Methodology

Materials

The materials used to prepare the matrix of the fickerts were the bicomponent polyurethane resin composed of 1.2:1 ratio of polyol and prepolymer, respectively, and the silicon carbide (SiC) and the silica of the rice hull ash (RHA), both in grain size 1200 mesh. This matrix was used to formulate two sets of fickerts with different cutting elements. In the first set was incorporated the green SiC in the grain size 60 mesh and in the second the green SiC in the grain size 120 mesh. All the extenders used for making the fickerts are shown in Fig. 1A. The stone chosen for the polishing test was a porphyritic sienogranite composed by phenocrysts of potassium feldspar, quartz, biotite and little amount of plagioclase feldspar (Fig. 1B). A micro-tri-gloss glossmeter was utilized for the brightness measurements (Fig 1C).

Methods

First of all, two formulas (T1 and T2), presented in Table 1, were obtained from Taber Test assays generated in the study done by Dorigo and Silveira (2016). For the preparation of the samples, the resin components were first mixed for 2 minutes and subjected to a vacuum system for another 15 minutes to remove the CO₂ released during the polymerization reaction. After this step, the extenders of SiC and RHA and the abrasive element green SiC, previously submitted to oven drying, were homogenized with the resin and deposited in molds (Fig. 2A). The pieces were removed from the molds on the third day after molding and they went through a cure process for another 15 days before being subjected to the polishing process. The fickert samples and the polishing process itself are shown at Fig. 2B and C.
Table 1. Proportions of the compounds used in the experimental tests.

<table>
<thead>
<tr>
<th>Formulas</th>
<th>Polyol (g)</th>
<th>Prepolymer (g)</th>
<th>RHA (g)</th>
<th>SIC 1200 mesh (g)</th>
<th>SIC 60 and 120 mesh (g)</th>
<th>Total weight (g)</th>
<th>% extenders</th>
<th>% resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>58</td>
<td>48</td>
<td>53</td>
<td>32</td>
<td>30</td>
<td>221</td>
<td>52</td>
<td>48</td>
</tr>
<tr>
<td>T2</td>
<td>58</td>
<td>48</td>
<td>53</td>
<td>43</td>
<td>30</td>
<td>232</td>
<td>54,3</td>
<td>45,7</td>
</tr>
</tbody>
</table>

The polishing was performed in the semi-automatic polishing machine belonging to the Federal Institute of Espírito Santo. The first step was the uniformization of the slab surface using a 24 mesh magnesia bond fickert. After this, the plate was divided into two equal area strips to test the two sets of ecological fickerts. Each strip was polished by a 60 mesh fickert for 36 minutes and then by a 120 mesh fickert for 54 minutes. After the tests, 1000 measurements of brightness were made at the interior of each strip and the fickerts mass loss was measured.

**Results and Discussion**

The polishing tests showed a satisfactory performance of the ecological fickerts made with the castor polyurethane resin. From the analysis of the graphs (Fig. 3) it is possible to notice that the pieces formulated with a higher quantity of extenders (T2) presented a lower loss of mass in each piece, for both 60 mesh and 120 mesh granulometry, approximately 70% and 14% of difference, respectively.

Despite this fact, the measured values of gloss were 38.12 GU (Gloss Unit) for the two polished strips, which indicates that the formula T2 presented a better performance,
expressed by the relation between the mass loss of the pieces and the brightness gain on the slab surface. Some samples of the 120 mesh T2 fickert set showed a low mass loss, which was not possible to measure in the scale used to weight the samples.

**Conclusions**

The performance of the polishing experiments with the ecological fickerts allows to infer that the insertion of the silicon carbide in the vegetal matrix was efficient with great possibility of application in the polishing industry. Nevertheless, it is still necessary to study the relationship between the abrasion resistance of the matrix and the cutting element, by adopting different proportions of the components or even the addition of new elements.

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**References**


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