Study on Wearing of Screw of Biomass Briquetting Extruder

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Abstract

Production of rice husk briquettes, which could be used as substitute for fuelwood, was initiated in 1982 in Nepal. One technical problem of this industry is the fast wearing of the screw of the briquette extruder. Different types of welding rods were used in the welding and hardfacing of the screw and tested in the briquetting of rice husk. Results showed that the wearing of the screw takes place mainly at the first three flights of the screw from the guiding rod, where the pressure is the highest. The tests showed that tungsten carbide and austenitic electrodes can double working hours of the screw compared to the life of the screw prepared from ordinary electrodes. The use of a new welding technology - thermal powder spray technology - to uniformly coat the surface with Eutalloy also increases the working hours remarkably to more than 15 hours.

Keywords: biomass briquetting, extruder, handfacing, screw

Introduction

Briquetting of rice husk in Nepal was initiated in 1982 with the establishment of a pyrolyzing type of briquetting industry in Butwal (Pokharel 1988). However, the demonstration of non-pyrolyzing rice husk briquetting using the extrusion method took place only in 1984 in Khumaltar. The demonstration was conducted with a machine from Fuzi Conveyor of Japan with the initiative from the Japanese embassy. This event led to further promotion of rice husk briquetting technology and in 1988 private entrepreneurs imported four briquetting plants from Taiwan. These plants were established in Chitwon, Hetauda, Simara and Nawalparasi. During those years, rice husk was abundantly available and almost free of cost and hence there was a great potential for the use of rice husk in briquetting (Pokharel 1988, Oosterveen 1990). This caused the upsurge in the registration of briquetting industries for establishment within the Department of Industries to more than two dozens. However, due to increasing use of rice husk for animal feed, animal bedding, industrial boiler, etc., the price of rice husk increased, making rice husk briquettes economically non-competitive and unsuitable in comparison with other energy resources.

Another reason for the decline in production of briquettes was the wearing of the screw of the briquette extruder due to high compression and friction of the biomass with the screw. Due to the high abrasive characteristics of rice husk, the screw of the extruder used to wear quickly (Aims Consulting Group. Pvt. Ltd. 1990, Grover et al.1996). The wearing of the screw of the extruder usually takes place mainly in the first three flights of the screw near the guiding rod. One method to increase the life of the screw is to use a less abrasive raw material such as sawdust and sugarcane bagasse. Another method is hardfacing of the screw using specialized welding rods to coat the surface of the screw of the extruder (Grover et al.1995 & 1996). Besides these factors, one important point that affects the screw life is the skill with which welding is done and the screw is prepared.

The Joint Study Research Project on National research and Development Center for Alternate Energy (NRDC for AE) looked into both these aspects to give some technical support and assistance to the existing local briquetting industries. The hardfacing of the screw of the briquette extruder and briquetting tests were carried out in the Chitwon Briquette and Koila Udyog Pvt. Ltd. in Chitwon. This study has tried to quantify the wear in terms of mass and change in the cross-sectional distance (diameter) of the first three flights of the screw.

Methodology

The screw of the extruder was prepared using the conventional electric arc welding method. The surfaces of the screws were then prepared with the help of a grinder and lathe machine. Three to four sets of screws were prepared using the welding rods given in Table 1. Two screws were sent to Japan for hard-facing using thermal powder spray technology for
Table 1. Welding rods used for testing

<table>
<thead>
<tr>
<th>No</th>
<th>Brand</th>
<th>Country of origin</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>W</th>
<th>Type of welding Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>HF-450</td>
<td>Japan</td>
<td>0.20</td>
<td>1.21</td>
<td>0.39</td>
<td>2.54</td>
<td>0.57</td>
<td>-</td>
<td>JIS DF2A-450B Martensitic</td>
</tr>
<tr>
<td>2.</td>
<td>HF-600</td>
<td>Japan</td>
<td>0.48</td>
<td>0.88</td>
<td>2.58</td>
<td>2.50</td>
<td>-</td>
<td>-</td>
<td>JIS DF2B-600B Martensitic</td>
</tr>
<tr>
<td>3.</td>
<td>H-600</td>
<td>India</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>NA Tungsten carbide</td>
</tr>
<tr>
<td>4.</td>
<td>HF-1000</td>
<td>Japan</td>
<td>2.8</td>
<td>0.5</td>
<td>1.7</td>
<td>-</td>
<td>-</td>
<td>56</td>
<td>NA/Austenitic</td>
</tr>
<tr>
<td>5.</td>
<td>CXA-41</td>
<td>Japan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Screw repaired with Eutectic alloy by micro flow welding technique</td>
</tr>
<tr>
<td>6.</td>
<td>HF-1000 + Eutalloy 10000</td>
<td>Japan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Uniform coating of the screw surface in Tanimech Welding Company.</td>
</tr>
</tbody>
</table>

Table 2. Wearing of the screw of the extrusion briquettor

<table>
<thead>
<tr>
<th>No</th>
<th>Type of Welding rods</th>
<th>Rate of wear (gm/hr)</th>
<th>Working hours/Life of screw (hrs)</th>
<th>Wearing of the flights of the screw (AD %)</th>
<th>Country of origin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>1.</td>
<td>HF-450</td>
<td>44.3</td>
<td>1.58</td>
<td>27.5</td>
<td>20.0</td>
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<tr>
<td>2.</td>
<td>HF-600</td>
<td>19.0</td>
<td>2.42</td>
<td>15</td>
<td>10</td>
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<tr>
<td>3.</td>
<td>H-600</td>
<td>37.1</td>
<td>2.72</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>4.</td>
<td>HF-1000</td>
<td>4.3</td>
<td>7.50</td>
<td>12.5</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>CXA-41</td>
<td>8.5</td>
<td>8.50</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>HF-1000 + Eutalloy 10000</td>
<td>1.3</td>
<td>15.50</td>
<td>19</td>
<td>12</td>
</tr>
</tbody>
</table>

uniform coating of the screw surface in Tanimech Welding Company. The thermal powder spraying method consists of 3 stages:

1. Build up stage - this stage consists of welding the screw with the use of superior quality welding rods (HF-1000) to fill the cavities and holes of the screw to prepare a uniform surface.
2. Thermal powder (Eutalloy 10000) spray welding to apply a thin coat of superior material on the working surface.
3. Thermal powder (Eutalloy 10000) spraying of the total surface of the screw.

Among the 4 briquetting machines in the factory, the wearing of the screw of the briquette extruder was studied by using machine No 4. A simple methodology was used to measure the wear of the screw in terms of mass and change in the cross-sectional distance (diameter) of the screw. The change in weight of the screw of the extruder was registered before and after briquetting.

Loss of weight or wearing of the screw (DW) = \( W_1 - W_2 \),

Where \( W_1 \) - weight of the screw before briquetting and \( W_2 \) - weight of the screw after briquetting.

The amount of wear in terms of change in cross-sectional measurement (diameter) of the first three
flights of the screw were measured with the help of a lathe machine and calipers measuring at exactly the same places before and after briquetting.

In all the cases of briquetting the working hours of the screw was noted (the life of the screw) for the evaluation of the performance of the rods. To keep the physical parameters of the raw material the same, only rice husk from the neighbouring Kailash Rice Mill and husk from the same rice brand was used. The temperature of the briquetting die (muff) was regulated and noted so as to maintain 300 ±50°C. Other parameters (temperature, pressure, speed, etc) of briquetting were assumed constant since the same briquetting machine (No 4) was used throughout the tests.

Results and Discussion

The different types of welding rods used in hardening the surface of the screw are given below in Table 1. The composition of some of the rods is also shown in the Table 1.

The loss of weight due to wearing of the screw is given in Figure 2 and the change in cross-sectional distance (diameter) of the first 3 flights of the screws are given in Table 2.

As reported in earlier (Grover et al. 1995 & 1996), we can clearly see that the wearing of the screw takes place mainly in the first three flights of the screw briquetor. The maximum wear is noticed on the first and the second flights from the guiding rod of the screw briquetor, where the pressure and friction is the greatest in the process of briquetting.

Observation of the nature of wear of screws showed that the wearing of the screw is mainly in the form of scratches and abrasions. Sometimes the guiding rod was found to be broken with chunks of metal torn out from the surface leaving cavities and holes. In cases of poor welding and build up process the flights of the screw are found broken. In some cases the screw itself was found to be broken. On the whole the worn out surface is left shining as if the surface has been worked with sandpaper or a grinder.

Conclusions and recommendations

The study on the wearing of the screw of the extruder leads to the conclusion that
1. The life of the screw very much depends on the welding skill and the uniform deposition of the welding material on the screw.
2. Tungsten carbide (HF-1000) and austenite (CXA-41) electrodes substantially increases the working hours of the briquette extruder to work one eight hour shift.
3. The thermal powder spraying method for coating the surface of the screw with Eutectic alloys drastically increases the performance of the briquetting machine to operate two eight hour shifts.

Acknowledgements

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References