INSPECTION OF THE WEAR OF AN IMPELLER OF A CENTRIFUGAL PUMP COATED BY HARD METAL FOR PUMPING OF VINASSE UNDER CAVITATION

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ABSTRACT

Brazilian world leadership in getting ethanol derived from sugar cane can be associated with the production of vinasse, according with a proportion until 18 liters of vinasse per liter of ethanol produced during the distillation process. In the agricultural production of sugar cane, the vinasse has been used as organic fertilizer. Its pumping is a critical element of this system. Cavitation in the suction zone of the pump is frequent, figure 1. It is well reported in the ASM Handbook, v.11, 2002, which morphology is similar to that of figure 1.

The aim of this experimental study was to investigate the main wear mechanisms of a impeller and parts of a centrifugal pump (1 HP) after pump during 1,000 h vinasse treated for attenuate pH (8.3±0.7).

Keywords: wear, pump, cavitation, erosion, corrosion

MATERIALS AND METHOD

Considering the experience of the author during thirty years designing pumping systems and its maintenance, a test rig was developed in the Laboratory for pumping the vinasse at 27±2 °C with recirculation for promote vortex and cavitation was composed by (1) a centrifugal pump of 1 HP, size 32-125, (2) closed impeller 32-125, type radial (3) mechanical seal with seat of tungsten carbide and EPDM sealing and (4) a hydraulic circuit composed by PVC #2” tube since a (5) tank of 500 l. (6) A butterfly valve wafer type with internal part in inoxidable steel was utilized to manually regulate the flow rate. Additionally, two coupons of grey cast iron ASTM A48 CL30 with dimensions of 15x15x15 mm³ were manufactured for investigate features of the HVOF coating: the hard metal coating based on tungsten-cobalt carbide (WC10% CO4% Cr) was measured as 360 ± 35 μm. These coupons were adopted for reproduce the same conditions of the hard coating of the impeller.
RESULTS

After the tests, the hard metal coated impeller and some uncoated pump parts in the suction zone showed severe wear by cavitation erosion. By the other hand, where the effects of cavitation are smaller, some coated surfaces of impeller areas showed a moderate wear.

![Image](a)
![Image](b)

![Image](c)
![Image](d)

Fig. 2 - (a) SEM(SE) Image with a measurement of the hard metal coating. (b) SEM(BSE) Image of the grey cast iron substrate denoting vestiges of lamellar graphite and the hard metal coating. (c) EDS Spectrogram confirming the presence of W, Co, C, Si in the hard metal coating. (d) Discharge zone aspect of worn impeller after pumping vinasse during 1,000h.

Figure 2 (a), (b) and (c) present the morphology of hard metal coating on the substrate of grey cast iron and the analysis obtained by EDS relative to elements W, Co, C, Si detected in the material which image is sketched in Figure 2(b). Results of the HV microhardness are tabulated in Table 1. A discharge zone of vinasse where there is a region of high pressure in the impeller is shown in Figure 2(d). After 1,000 hours of pumping, the cavitation erosion wear mechanism was evident.

<table>
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<tr>
<th>Coupon</th>
<th>Locus</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>Mean</th>
<th>Result</th>
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<td>1449</td>
<td>1449</td>
<td>1515</td>
<td>1515</td>
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<tr>
<td>HV0,3</td>
<td>Surface</td>
<td>1391</td>
<td>1541</td>
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</tr>
</tbody>
</table>

CONCLUSION

A hard metal coating based on Tungsten-Cobalt was deposited on a substrate of grey cast iron of a pump impeller was effective because 1,000 hours after pumping vinasse its structural integrity was preserved. The moderate wear regime of the coated impeller was the opposite of the respective non-coated casing, which wear was severe.