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Wear in Screw Presses: A Major Problem in Oil Palm Mills

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Abstract: Metal wear has been identified as the major study of machine breakdown in oil palm mills. This results to serious economic loss owing to such mills operating at a greatly reduced installed capacity. This was the findings from a research visit made to one of the major oil palm mills in Nigeria, Rison Palm Oil Mill, Ubima, located in the eastern part of the country. It was found that the greatest wear and breakdown in the mill occurs in the press screw unit. Measurements on the flight thickness were taken at one week intervals covering a period of six months and the resultant wear curves are discussed. A general review of press screws and the Twin Press Screws in particular-commonly employed in Oil Palm Mills, their operational principles as well as descriptions are highlighted. The wear curves show that the first and the second flights wear most, with initial rapid wear within the first week of operation. Flight 1 witnessed the most wear, followed by flight 2. Flights 4 and 5 suffered minimal wear. Smooth operation with minimal wear was recorded for the next five months after the initial rapid wear of flights 1 and 2, followed by a final stage of rapid wear. For continuous operation, the screw was found to give an average service life of twenty-two weeks. Cast manganese steel is suggested for the screw materials.

Key words: Wear, breakdown, screws, mills, press, flights

INTRODUCTION

Generally, metals naturally undergo deterioration in value through a process of oxidation and/or corrosion as they react with unfavourable environmental conditions. In modern industries, these metals are often subjected to rubbing processes against each other. This studies resistance to motion which in turn generates heat that ultimately affects the structure of the rubbing parts. During the sliding process, the mating surfaces may become smoother or even rougher and their physical properties altered, thereby losing some materials in the process[1]. Such surface changes may sometimes be beneficial, especially when it produces a near ideal operation, or disastrous, causing surface failure and hence may necessitate replacement of the components.

The wear life of a power screw is difficult to predict theoretically owing to too many variables involved. Such attempt would however involve a general understanding of the wear mechanisms, simple design and operational guidelines; the best result being that deduced from a life test performance. The screw press is generally a slow moving mechanical device. Dewatering is continuous and is accomplished by gravity drainage at the inlet end of the screw and also by reducing the volume as the material being dewatered is conveyed from the inlet to the discharge end of the screw press. Proper screw design is critical (FKC screw press; Cache: jeVm84c),as different materials require different screw speeds, screw configurations and screens in order to dewater to a high outlet consistency whilst maintaining an excellent capture rate. The Twin Screw Press found in modern Oil Mills is a continuous dewatering press that has proven successful in both virgin fiber and recycle mills. Unfortunately, the twin problems of metal wear and breakdown has become a major concern.

THE TWIN SCREW PRESS

This has been found to give excellent dewatering characteristics. In all moisture tests (vincentcorp. Com), it was found that the twin screw press removed as much or a little more, water than the other presses commonly used in feedmills.

Operational principle/description: Figure 1 illustrates the operational principle of the twin press. Two screws of progressively reducing pitch are caused to rotate oppositively inside a screen surface. Material entering the hopper is subjected to gradually increasing pressure as it moves toward the exit end of the press, thereby forcing the liquid phase to extrude through the screen. Final

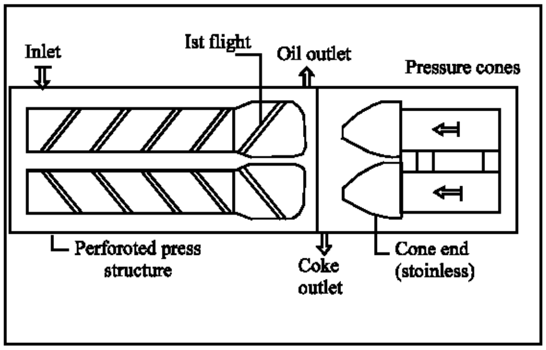

Fig. 1: Operational principle of the press

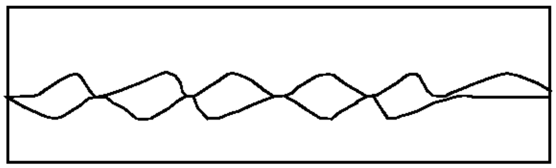

Fig. 2: Contacting asperities before break-in wear

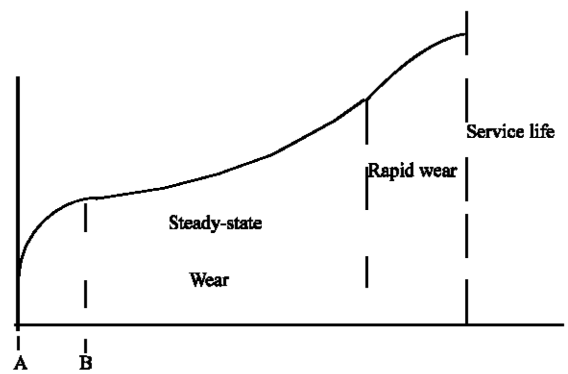

Fig. 3: Typical wear curve of power screws

pressing is controlled by hydraulically actuated cones that provide easy adjustment of moisture content. Wedge wire screens and hard surfaced wear areas are standardized. Outstanding characteristics of the Twin Screw Press include tight squeezing automatic control, positive feeding and low horsepower. Two hydraulically actuated discharge cones allow consistent performance over a wide range of flow rates and consistencies.

Wear mechanism: Much research work is documented on tribology (the science of wear, lubrication and friction), but little definitive work that can be useful in determining the wear rate of two surfaces in any specific application. Generally, two rubbing surfaces can only make contact at their highest microscopic asperities, Fig. 2[2]. Under high contact stress upon relative motion, the contacting asperities shear off and become debris. Lower asperities

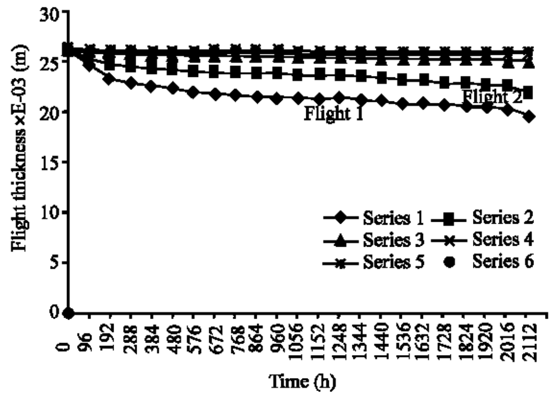

Fig. 4: Functional wear rate of the five flights

then come into contact thereby increasing the contact area until the unit pressure balances with that of the underlying materials. At this point, break-in wear has occurred on the mating surfaces represented by the curve between A and B in Fig. 3. In palm oil screw presses however, the wear problem is a peculiar case involving mixed contacting surfaces between the flights and the matrix[3].

MATERIALS AND METHODS

In order to examine or predict the wear trend or behaviour in the twin screw press, measurements on the flight thickness were taken at one week intervals on each of the five flights of the press screws covering a period of six months. Three different readings were taken on each flight at different points and the average value used to examine the wear trend in the press when operated at the designed throughput capacity and operational speed.

Initial flight thickness = 26 mm

Wear life of screw (as recorded by maintenance crew) = 5 ½ months

Wear curves of the five flights is shown in Fig. 4. Figure 5 shows the wear trends for the first and the second flights.

RESULTS AND DISCUSSION

Flights 1 and 2 experience severe wear, whereas flights 4 and 5 witnessed minimal wear. This is quite understandable since the actual pressing out of the entrapped oil is concentrated near the outlet of the press owing to high pressure occasioned by the action of the

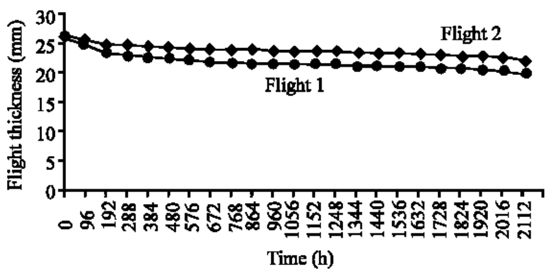

Fig. 5: Functional wear rate for flights 1 and 2

hydraulic cones. Flight 1 wears out most since it is nearest to the cone pressure, followed closely by flight 2. Initial rapid wear was recorded in flights 1 and 2 within the first week of operation. The press thereafter operated smoothly for the next five months. Final rapid wear sets in after about five months of smooth operation.

CONCLUSION

The twin problems of wear and breakdown in oil palm mills is obviously a serious one, especially in the screw press unit. Unfortunately the cost of importing new screws as hitherto experienced in a developing country like Nigeria is very high. In most cases the worn out screws are electrode-filled. This however gives a very short service life. Since the problem is found to contribute to about 70% of the recorded high maintenance cost in the oil mill, it thus opens a challenge for indegineous design approach in relevance to locally sourced engineering materials.

A microstructure of the screw material should be examined. Also a chemical composition test must be taken on the existing materials to aid in deciding on the best wear resistance material for the screws. Generally, cast manganese steel is highly recommended under severe abrasive wear conditions[4].

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