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WEAR IN CENTRIFUGAL SLURRY PUMP CASING

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ABSTRACT

Slurry pumps are widely used in transportation of coal, copper, iron ore,phosphate, slurry of ash and other mining operations. In this paper wear alongside volute casing has been measured for the dense flow of ash slurry. In the study 3 different volute casing has been used to compare wear in the same type of ash slurry flow. The result shows that wear in the particular areas such as throat and near throat are more compared to other areas of the casing. It is observed that wear rate alongside volute casing is increased with increase in pump running hours.

Keywords: Slurry Pump, Erosion Wear, Centrifugal Slurry Pump, Casing

I INTRODUCTION

Wear is a phenomenon related to material removal from a surface due to interaction with a mating surface. Because of wear the machine and its components leads to frequent maintenance and replacement which causes loss in production and availability which carries economical loss. Wear may also decrease the operating efficiencies. It is observed that over period of time almost all machines lose their durability and reliability due to wear. The material's surface properties such as strength, ductility, hardness, work hardening and, etc. are very important factors for wear resistance, but other factors like surface finish, speed, corrosion, temperature, , lubrication, load and properties of the opposing surface are equally important. Therefore, wear control has become a strong need for the advanced and reliable technology of the future.

Centrifugal slurry pumps are widely used to transport solid liquid slurries which have applications in chemical, coal, mining and power industries. Normally in slurries the range of diameters and concentration of the solid particles varies with the requirement of the particular application. The hydrodynamic and erosion performance is affected by solid particles contained in the slurry. Because of abrasive nature of the slurries wet components like suction liner, impeller and casing have to be replace at frequent intervals. As erosion wear happens thickness of the each component is reduced which affects the performance of the pump. As very high erosion wear happens in the slurry it is very important to know that at which rate erosion wear is happening and at which time the component of the pump will fail. As the centrifugal slurry pump is the most important part of the slurry disposal system. It is crucial at which rate it is going to fail. So before the failure occurs we replace the component or the whole pump.

1.1 Slurry Pump Selection Parameters

The selection of any transportation is mostly govern by the economical consideration of maximum efficiency. But in the slurry transport system discharge pressure and the abrasivity of the solids are key factors for the selection of the pump. Fir in plant pipe line slurry transport system centrifugal slurry pump are best suited. Centrifugal slurry pump normally have very low discharge pressure. When used in series they can be used for moderate discharge pressure. The efficiency of the centrifugal slurry pump is lower as compared to conventional centrifugal pump. as the There are certain parameters which are to be taken into account for the correct and proper selection of a slurry pump in any slurry transport system, which are particle maximum size, particle size distribution, solids abrasivitysolids friability, particle shape, particle hardness, solids content, flow properties, slurry density, corrosivity, temperature, volume flow rate and reliabilityCost.

1.2 Wears in Slurry Pumps

The useful life of slurry transport equipment is limited by wear. Because of that wear of the wetted parts must be evaluated considering the design or operation of slurry systems. Wear is among the most common problem faced in industry which leads to often maintenance and replacement of machinery or its component.it also reduces the operating efficiencies.The conventional pumps handling clear liquids and the pumps handling solid-liquid mixture has difference in various aspects of design.The performance of the centrifugal slurry pumps plays a key role in the successful operation of the hydraulic transportation system. The pump is designed on requirement of the operation because that their performance characteristic are matched with operating parameters. There are mainly three parts of the centrifugal slurry pump where wear happened which are impeller, casing and side liner. Al these three parts are wetted components of the centrifugal slurry pump.

M. C. ROCO et al. [1] suggested the computation approach to study and predict the wear in centrifugal slurry pump. He suggested to use the energy approach to compute the mixture velocity and solid particle dynamics in the casing, and on this basis the erosion wear distribution inside the pump casing. The suggested techniques are useful for estimating casing wear rates and for the optimal design and selection of slurry pumps. **Bunn *et al*.** **[2]**found that the ash slurries may shows a non-Newtonian nature with rheological equation showing either Bingham or yield pseudo-plastic behaviour. If the concentration of is increased in the ash slurry mixture behave like non-Newtonian fluid. Different samples of fly ash collected from different power plants showed a difference in the rheological parameters like yield stress and Bingham plastic viscosity over a wide range. Thus, it is very vital to measure these factors before the ash disposal pipeline is planned. Once the rheological behaviour of the slurry is established the head requirements for operating fly ash disposal pipelines at higher concentrations can be easily calculated. He suggested to use additives in slurry to reduce the head requirement which have shear thinning properties and diserding/wetting.**Hector mci. Clark[2]** at al.,measured the erosion and calculation of specific energy for material removal by Coriolis slurry erosion tester. The Coriolis erosion tester gives a simple and rapid way of assessing the erosion resistance of materials under sliding bed conditions, provides more information than wear measurement by mass, Calculation of specific energy provides a method of checking the consistency and reliability of the experimental data. Comparison of different materials can easily be made, by testing under standard conditions and the test lends itself to measuring wear rates on very erosion-resistant materials simply by passing a greater volume of slurry through the machine. **Craig I. Walker**[3] compares some slurry pump lab wear results with the wear found across different field applications with *d*85 particle size ranging from 100 to 4000 m. Side-liner wear life data has been collected for two different impeller geometries and two different material classes (cast iron and natural rubber). Overall trend of wear with particle size for the white iron parts was similar to the grey iron lab tests albeit at significantly lower wear rates. In this work it was found that the inlet side-liner wear did not change much regardless of particle size over the range *d*85 = 100–1000 m. Most of the wear on the side-liner occurred on the face and around the periphery. The front expelling vanes on the impeller were presumed to be responsible for keeping particles away from the eye (centre) region. **Seshadri *et al*.**[4]have mentioned that in India, slender phase fly ash slurry disposal system is by far the most extensively used method of ash transportation in the prevailing thermal power plants. The normal range of the ash concentration is around 10-15% (by weight). The design is extremely conservative and accordingly the system is very inefficient from the point of energy consumption. He suggested that the fly ash dumping system where ash is mixture with water should have ash concentration above Cw > 60% by weight. At these higher concentrations distinct types of slurry pumps are essential to pump the slurry. **Bhupendra K. Gandhi**[5], described methodology to determine the nominal particle size of multi-sized particulate slurry for estimation of mass loss due to the erosion wear. It is observed that a reduction of approximately 40–50% in the wear is possible by addition of finer particles 25% (w/w) of bigger particles. In this work has been carried out to determine the nominal particle size of the multi-sized slurry representing the erosion wear and the effect of presence of the fine particles (<75 m) on erosion wear has been analysed separately.It has been observed that the erosion reduces with the addition of fine particles for constant mass of bigger particles. This phenomenon could be attributed to partly increase in carrier fluid viscosity, partly decrease in turbulence and to partly decrease in impact velocity due to particle-particle collision and formation of thin layer of fine particles on the eroding surface.The reductions in erosion wear due to addition of fine particles decreases with increase in the concentration of coarse size particles.

II EXPERIMENTAL PROCEDURE

In this experiment 3 different casing is used to study the wear in centrifugal slurry pump casing. All 3 casing are completely different in terms of flow rate and head. As these casing are different in terms of design but they all are equipped with the same impeller. Here 3 different slurry pump has been undergone through 400 hours of running in slurry. As the wear of any wetted part of the centrifugal slurry pump heavily depends on the type of slurry and its property which they have subjected to for example if the slurry pump is used in mining or mineral operation due to its volatile, hardness of the material and shape of the particles wear is increased hear in this experiment the ash came out from the thermal power plant is mixed with water. Which made the mixture as ash slurry. The general information about the slurry and composition ash in which the experiment is undergone is described below in TABLE 1 and TABLE 2.As described in the introduction the wear in the centrifugal slurry pump depend upon the design of the pump and operating conditions.

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TABLE 1

Ash content in slurry by volume	30%
Ash density	1.6 t/cum
PH value	9.50
Specific gravity of ash	2.60
Bulk density	1.007

TABLE 2-Composition of ash

Si_2O_3	61.26%
Al_2O_3	25.84%
Fe_2O_3	5.41%
CaO	1.15%
MgO	2.24

TABLE 3

Casing No.	Impeller Diameter	H(m)	Q (m^3/hr)	RPM
1	65	23	613	994
2	65	37	1255	695
3	65	18.5	613	994

TABLE 4-Impeller Details

Type	Closed
Material	Ni-Hard
No. of vanes	5

TABLE 5-Casing Details

Type	Volute
Material	Ni-Hard

To measure the wear alongside slurry pump casing thickness of the casing has been measured by the ultrasonic thickness gauge.The equipment is Modsonic Ultrasonic Thickness Gauge (Edison-1bl). Machine used to measure the thickness of the casing at each point can measure 1 mm to 50 mm of the thickness with 1 mm accuracy.

FIGURE 1 – Experimental Setup

FIGURE 2- New Casing (Unused)

FIGURE 3

FIGURE 4- Wear In Casing

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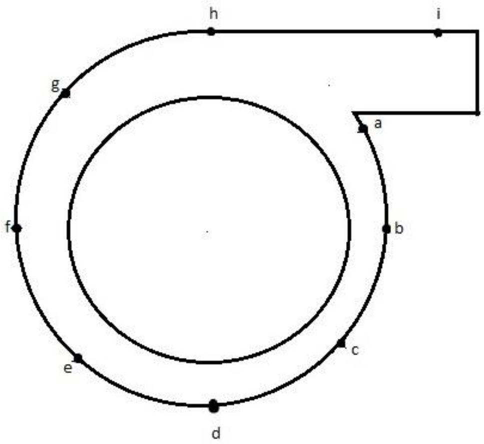

TABLE 6

	Casing 1			Casing 2			Casing 3		
	0 hours	200 hours	400 hours	0 Hours	200 hours	400 hours	0 hours	200 hours	400 hours
Points along casing	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)
a	27	24.1	20.5	33	28.3	23.7	35	31.2	26.6
b	27	21.6	15.9	33	27.8	22.2	35	29.5	23.8
c	27	19.8	11.6	33	25.4	17.1	35	28.2	21.4
d	27	20.5	14.2	33	26.1	18.8	35	28.8	22.4
e	27	24.1	20.7	33	26.8	20.2	35	31.5	27.8
f	27	24.3	21.4	33	27.6	22.7	35	31.8	28.2
g	27	23.9	21.2	33	27.9	22.4	35	31.2	26.6
h	27	23.7	20.3	33	28.2	23	35	31.4	27.6
i	27	23.4	19.9	33	28.8	24.1	35	31.1	27

III RESULT AND DISCUSSION

After the 400 hours running the centrifugal pump casing is observed and the wear along the casing has been measured. The wear in the casing has been measured by the varying thickness of the casing over period of 200 hours and 400 hours. In fig 3 2D diagram of casing is shown and points are marked at which thickness measurement is taken. In the fig6 graph of the wear in casing with over period alongside casing is shown. The maximum wear is found at the c point of the casing. As shown in the fig 5 wear rate is also slightly increased with period of time. Casing 2 and casing 3 follows the same characteristic where wear is increased with period of time. Here at 200 hours wear is already happened in the casing because of that inside wall of the casing is already rough and because of that slurry require lower energy to remove the material from the surface. By comparing the average wear rate of the every casing at each point it is found that wear in casing is maximum at

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the area under b to d in which c point have the maximum wear rate of them all. For casing 1 maximum average wear is 0.0.03725 mm/hr where casing 2 and casing 3 have the maximum average wear of 0.0388 mm/hr and 0.035 respectively. As in the casing 2 average wear is more because of the flow rate of this casing is more than casing 1 and casing 3. As it is obvious that because of the same reason wear at e, f , g and h point is higher than casing 1 and casing 3. In every casing throat area have the maximum wear along the casing because in erosion wear impact wear play the major part as in the throat area distance of the impeller is near with respect to other area velocity of the particles also more compared to the other areas. As other area mostly undergo through sliding wear at which particles go sliding along the wall of the casing and remove the material. At point f, g and h wear is then increases because at that point pressure and velocity of the slurry increased so the wear is also increased.

FIGURE 5

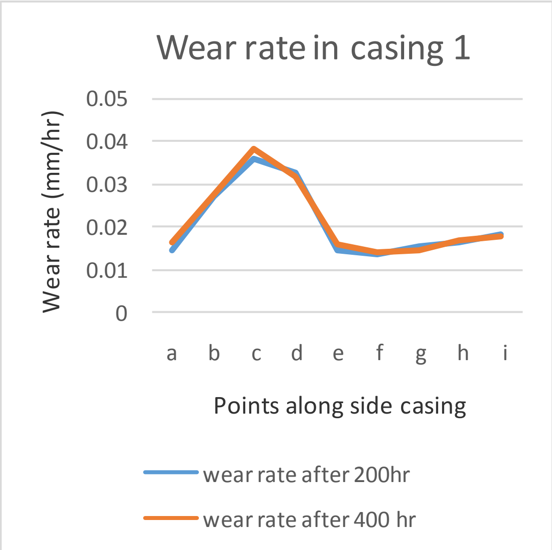
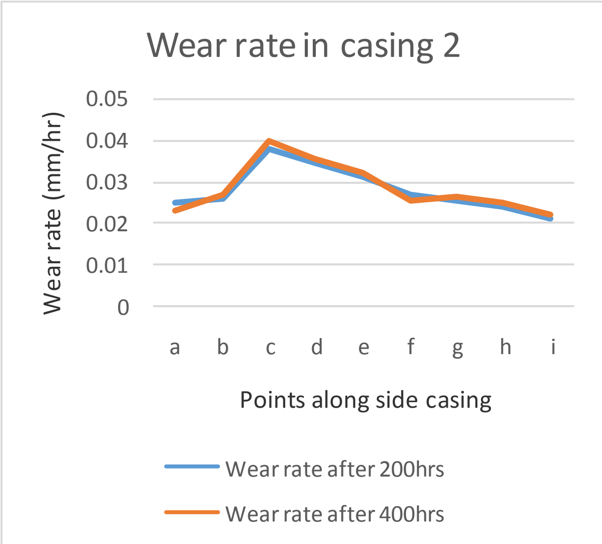


FIGURE 6



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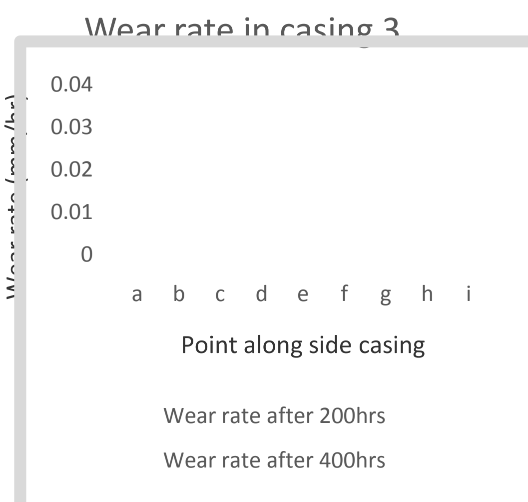
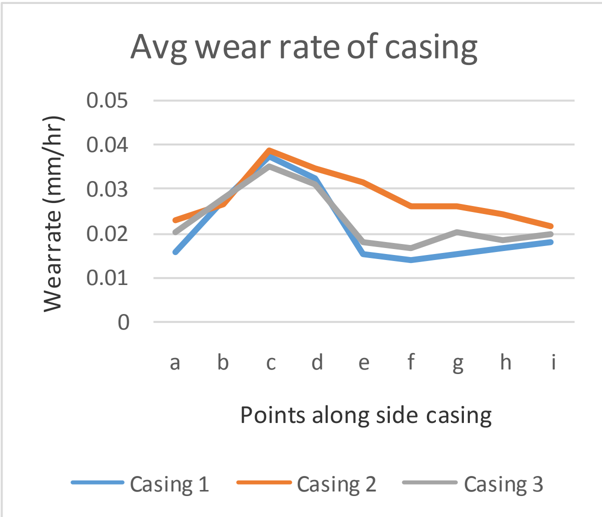


FIGURE 8



VI CONCLUSION

Based on the present investigation it is concluded that wear alongside casing is the function of the design of the casing and material of the slurry. It is also seen that wear is maximum at the throat area of the casing. It is also seen that wear rate of the casing is increased as the period of time.By this investigation actual wear happened in the casing was identified and according that data which time maintenance is required can be determined. Also at which point casing will not be usable and have to replace with new casing can be predicted so productivity of the system does not get affected by casing wear. As the design of the casing play big part on wear profile of the casing there is some research required to optimize the wear.

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