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REDESIGN OF POLISHING CHAMBER IN RICE POLISHER

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Abstract: *As rice is most consumable crop in world there is huge need of optimization in the rice milling process. In rice polisher most of the rice grains are break due to extensive force applied to grain to remove bran. Optimization in polishing chamber leads to reduction in the rice breakage. Shape of polishing chamber is more important parameter. As the polishing rotor is prone to wearas milling progress, hence the consideration of easy replacement and minimum downtime is another important factor. Cylindrical polishing chamber is always preferred over conical chamber. Second parameter is the rotating speed of polishing wheel. Peripheral speed more than 600m/s is mostly preferred; however the broken percent of rice kernel nearly doubles when Rotating speed is increased from 600 to 1200 rpm.*

Keywords: *Degree of polishing; polishing chamber; rice; rice broken; rotation speed of polisher*

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I. INTRODUCTION

Rice is most staple food in world. And it is most consumable food grain in Asia pacific. India is in one of country having higher number of rice production per year and it is growing very fast. Rice processing involve the various steps. The paddy rice consist rice kernel surrounded by bran and husk layer. The husk is not eatable and bran layer is difficult to digest. Below the bran layer it enclosed endosperm and embryo. Refer fig 1. Hence it is need to be removed from rice kernel. Bran layer also contains the valuable nutrition hence there are some restriction on amount of bran to be removed from rice kernel. Government allows the 8% of bran to be removed from rice kernel. The marketability of the rice is also one of the important factors in the rice processing industry. A good surface finish of rice kernel is desired at customer end also it takes less time to cook the well polished rice. Hence all these parameters are need to consider while designing the polishing chamber. Also the rice polishing industry needs to optimize the rice polishing process to earn higher income by reducing the power requirement in rice polishing and by reducing the rice breakage.

Power consumption is highly related to rotating parts in machine. Where maximum power is needed to idle rotation of machine and very less power is utilized in actual polishing of rice kernel and rest is dissipated as increased temperature of rice. And this increase in temperature also leads to higher breakage of rice kernel. Also the factors which affect the rice breakage are shaped of rice polishing chamber, pressure inside rice polishing chamber, and the rotational speed of polishing wheel. The flow direction of rice inside the chamber also affects the rice breakage.

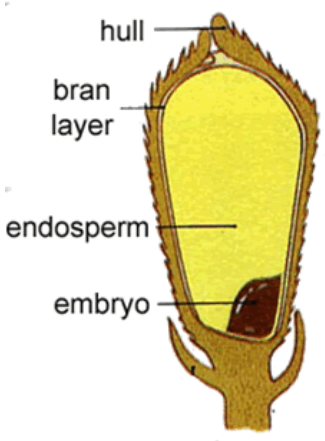

Figure 1. Rice kernel

II. LITERATURE SURVEY

Rice is most commonly used food crop in the world. About 90% of total rice production is produced as well as consumed in Asia [1]. In 2014 year 106 million metric ton is produced in the India. [2]. Hence rice polishing industry need to optimize the rice polishing process to earn higher income and keep the position in the highly growing and competitive market. Initially the rice is covered by husk and it is called as paddy and when the husk is removed the rice is called as brown rice. And the process of removal of husk is called dehulling process. After the dehulling process the brown rice is enters the polishing machine to remove the bran layer. After removal of bran layer rice is called as white rice [3].

In both dehulling and polishing process rice is prone to the breakage. Whereas more amount of rice breakage is observed in rice polishing process. Hence the rice polishing process is needed to be optimized. In a rice polisher polishing chamber is the heart of rice polisher and it is main parameter which affects the quality of polished rice. The breakage of polished rice depends on the wear rate hardness of material and shape of rice kernel. Shape of rice kernel depends on the length to diameter ratio. Long grains are more prone to breakage[4].

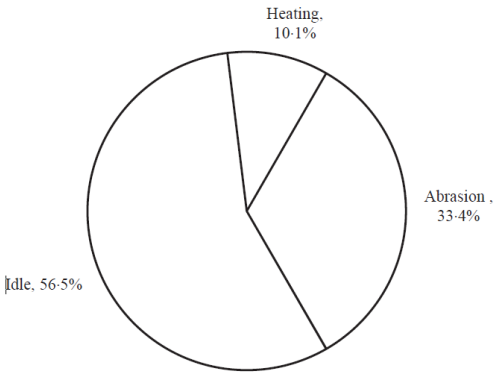

Figure 2. Pie chart shows distribution of energy in a rice milling operation [5]

Above figure shows the energy utilization of the rice polisher. Where as high as 56.5% energy is utilized in running the machine in no load condition. And only 33.4 % of total energy is actually utilized in abrasion process. And rest 10.1% energy get dissipated which lead to temperature increase of rice grain. It is undesirable as at higher temperature rice is prone to breakage.[5]

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III. DESIGN

The polisher available in market has conical shape of polishing chamber. It has very high weight and volume. It lead to higher power consumption for rotating such high mass. The polishing wheel is rotated at 220 rpm. To reduce the power consumption it is requires reducing the weight of the polishing wheel.

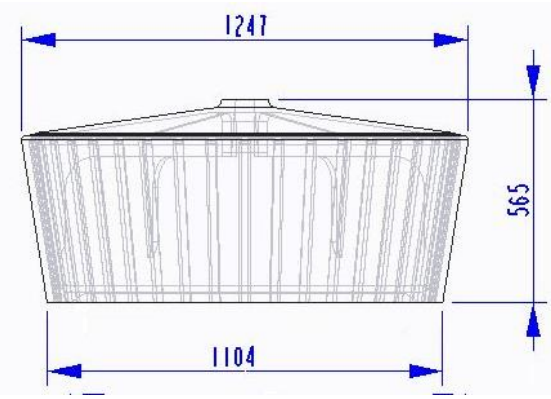

Figure 3. Initial design of polishing wheel

The weight of this polishing wheel is 751Kg and is been rotated at 220rpm. For abrasion type of rice polishing peripheral speed of 600m/min or higher is required.[6] Hence to redesign the volume and weight is reduced significantly and peripheral speed is also maintained at 600m/m. hence the new design is as shown in figure.

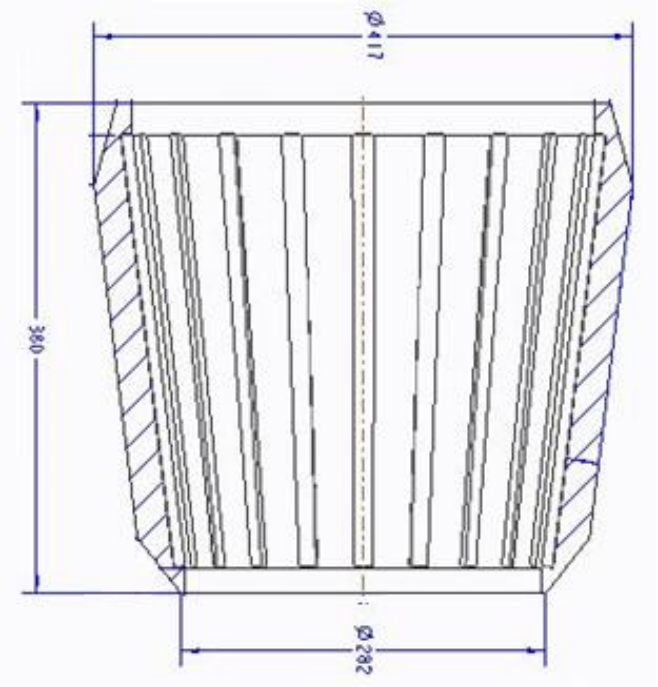

Figure 4. First alternative solution of polishing wheel

Weight has been reduced to 174kg and the speed is increased to 658rpm. This significantly reduces the power consumption of polisher. The side effect of increased speed results in higher breakage. Hence to reduce this the emery grain composition has been changed from rough to smooth. As in initial case it was 18 and it is been changed to 24.

Figure 5. Second alternative suggestion

The cylindrical shape of polishing wheel has various advantages over conical shape. Conical polishing wheel creates the uneven pressure in the polishing chamber. It is undesirable phenomenon. Variation of pressure in polishing chamber creates higher breakage of rice kernel.

The single long cylinder is prone to higher wear at the bottom of the polishing chamber. Due to this wear whole polishing wheel is need to be replaced. It increases the cost of maintenance. Also the downtime for replacement is longer as the new coating of emery grain needs to be implemented every time. Hence the polishing wheel is been replaced with several number of small length polishing wheel. The number of polishing wheel depend on the capacity for which polisher is to be designed. Also the modified design reduces downtime with easy replacement of parts.

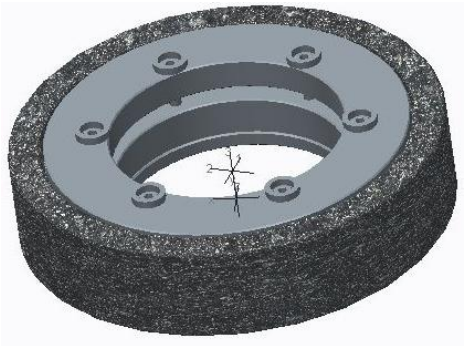

Figure 6. Final design of polishing wheel

Figure 7. Final design of polishing wheel

Six numbers of small wheels are arranged linearly along the metal shaft and act as a polishing rotor. The metal shaft is made such that it should sustain the all compressive and bending stresses. Taper shape is provided foe rice to enter in to the polishing chamber. The three strips are attached to the shaft to provide proper support to the polishing wheel. Also the another function is it helps in the bran aspiration system. It helps to throw air outside and create proper circulation of air.

Rice is enter from the feed screw into polishing chamber. For equal distribution of rice grain in polishing cylinder two start roller feeder is used. Also for proper distribution the top wheel of polishing chamber is made taper in shape. Broken rice percentage also depends on the quality of rice polishing cylinder. Normally, the rice polishing cylinder has two composite materials were abrasive material and binder material. The abrasive material has emery grain and silicon carbide. The binder material has magnesium oxide cement and magnesium chloride.

Table 1. Comparison of polishing rotor

Initial polishing chamber	**Final polishing chamber**
More weight (751Kg)	Less weight (243Kg – 28Kg/Wheel)
More power consumption	Less power consumption
Difficult in Maintenance	Easy Maintanance
Large Broken	Less Broken
Large in Volume	Compact Design
Grain size = 18	Grain size 24
Large downtime	Quick replacement

IV. CONCLUSIONS

Cylindrical shape of polishing wheel creates even pressure in polishing chamber. Hence cylindrical shaped is preferred over conical shape to reduce the breakage of rice kernel. Also the peripheral speed of 600m/min is preferable for abrasive milling and rice breakage increases with further increase in rotation speed of wheel. From this parameter the final designed polishing wheel has advantages of easy assembly, minimum downtime, easy replacement of parts, low cost of manufacturing, minimum breakage of rice kernel and optimized power consumption.

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