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DESIGN AND FABRICATION OF ROTOR BLADE FOR MOLDING SAND RECYCLING MACHINE

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ABSTRACT

Molding sand waste is one of the major problem for casting industries. It is serious issue to dispose this waste molding sand. Also this molding sand is very costly imported by foundries and it is destroying at very fast rate. So reuse of sand is the need of the future, and so many of the foundries are started the reuse of molding sand. To convert waste molding sand in to usable form foundries develops their own molding sand recycling machine. In this machine the waste sand mould are crushed in the machine and very fine powdered form sand is obtained, which can be again used for making moulds for casting. The molding sand recycling machine consists of a motor which provides propulsive power to drive the shaft of the machine. Shaft is coupled with motor by means of belt. The shaft of the machine consist of number of blades generally fourteen mounted on shaft by means of fastening devices such as nut and bolt. The blades are free to rotate on the shaft so by striking on the sand moulds they crush the sand and make them applicable for reuse.

After continuous use the blades of the molding sand recycling machine gets weared and have to be replaced after particular interval of time so industries faces this another problem of frequent replacement of blades. It consumes valuable time, also interruption in the work so we decide to design and fabricate a blade for this molding sand recycling machine which has more life than the existing one. For solving the problem various alternative solutions are considered such as providing bush to existing blade, heat treatment of the blade, providing hardened blade with bush, alternate material for the blade. Trials with these alternatives have done and best alternative is suggested to the industry.

Keywords : Molding sand, molding sand recycling machine, blades, Defects in pipe, heat treatment, alternate material etc.

I.INTRODUCTION

Molding sand waste is one of the major problem for casting industries in Kolhapur area. As per journalist report about 500 ton waste sand is thrown out from about 70 foundries. So it is serious issue to dispose this waste molding sand. Also this molding sand is very costly imported by foundries and it is destroying at very fast rate and within few years it may destroys completely. So reuse of sand is the need of the future and so many of the foundries are started the reuse of molding sand.

The growing awareness of ecology has been increasing the production costs in items such as disposals according to the laws, treatments of residues, monitoring, transportation and occasional fines. On the other hand, the recycling reduces the purchasing costs of raw materials Foundry sands are generated by the metal casting industry. Foundries purchase new, virgin sand to make casting molds, and the sand is reused numerous times within the foundry. However, heat and mechanical abrasion eventually render the sand unsuitable for use in casting molds, and a portion of the sand is continuously removed and replaced with virgin sand. The foundry sand, that is, the sand that is removed, is either recycled in a non-foundry application or land filled. Estimates are that less than 15 percent of the 6-10 million tons of foundry sands generated annually are recycled. The Agency believes a greater percentage of foundry sand can be safely and economically recycled.

Fig.1 waste molding sand photo

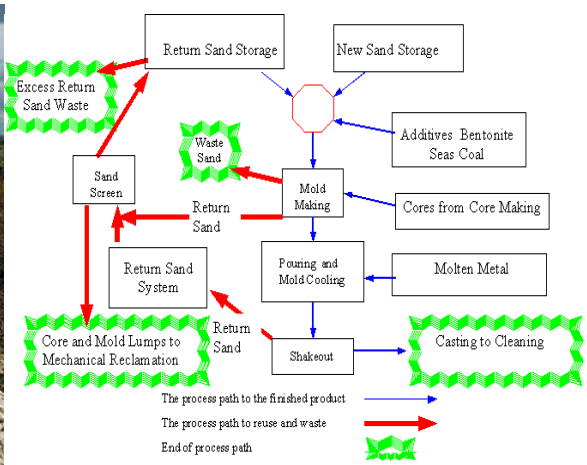

Fig.2 recycling process of molding sand

1.1 Molding sand recycling machine -

To convert waste molding sand in to usable form foundries develop their own molding sand recycling machine. In this machine the waste sand mould are crushed in the machine and very fine powered form sand is obtained, which can be again used for making moulds for casting.

Construction

The Molding sand recycling machine consist of

a) Motor

b) Rotor Shaft

c) Blades

d) Fastning devices such as nut and bolt.

e) Belt

f) sieve shaker

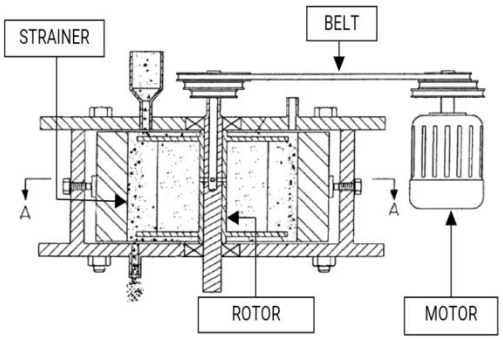

Fig. 3 molding sand recycling machine

1.2 Working of Machine

In molding sand recycling machine there is motor which provides propulsive power to drive the shaft of the machine. The capacity of motor is 3hp. Shaft is coupled with motor by means of belt. The shaft of the machine consist of number of blades generally fourteen mounted on shaft by means of fastening devices such as nut and bolt. The blades are free to rotate on the shaft so by striking on the sand mounds they crush the sand moulds and from sieve shaker it is collected to make them applicable for reuse

II. PROBLEM IDENTIFICATION

a) Deformation of blade due to abrasive wear:

During recycling of sand the blades continuously impacted on waste sand molds so due to the friction between sand & blades wear of blade takes place. When around 50 ton of sand recycled or around 15 days (depends upon how much quantity of sand, the machine crush daily)

b) Adhesive wear of blade:

The construction of machine is such a that the blades are not fixed on rotor shaft they are free to rotate around bolt due to this during recycling of sand there is adhesive wear occurs between blades & bolts. So failure of blade takes place.

c) Failure of bolt:

Due to relative motion between blades and bolts, neck formation of bolt occurs

d) Welding, time & cost:

During mounting of blades on the rotor shaft, every time nut is required to be weld on bolt to avoid any looseness of nut during operation. Also while replacing the blades the welding have to be removed by gas cutting process. It consumes lot of time & money

Fig. 4 deformed & weared blade

Fig 5 neck formation of bolt

Material of blade: Mild Steel

Low carbon steel**: -** up to 0.30% of carbon.

Hardness - 40 HRc.

III. PROPOSED ALTERNATIVE SOLUTIONS

After detail analysis of problem in molding sand recycling machine we have decided to go for trail an error method. At first for solving the problem we decided to fix the blade on the shaft so there will no relative motion and so no wear of the blade at the contact point of blade and bolt but we realize that this will increase the load on the motor as now if the sand mould piece would not crush in one stroke of the blade, the blade will rotate around the bolt and crush the sand mould piece in next stroke but when we fix the blade on the bolt then blade will try to crush the sand mould in one stroke so the load on motor increase and if somewhat hard piece is there for the crush then machine will stop the working, so we not go for fixing the blade and go for following other options-

1. Providing hardened bolt and locknut
2. Heat treatment of existing blade material
3. Provision of alternative material for blade
4. Providing bush to existing blade
5. Providing bush to hardened blade

IV. TRIAL OF HARDENED BOLT AND LOCKNUT

In company the bolts used for fitting of blades are general soft bolts so we decided to go for hardened bolts also by using locknut the problem of welding of nut can also be solved so we decide to take trial of hardened bolt and locknut. There are different hardened bolts available in market but we go for following

a) TVS

b) UNBREKO

These bolts are easily available at low cost and have good properties.

After fitting of hardened bolt and locknut we take result after 15 days-

Result of trial -

We see that there is wear of blade as usual rate and failure of blade takes place but there is significant change in life of bolts. The wear of these hardened bolts is very less as compare to the earlier bolts. We compare the both the bolts and we see that the wear of hardened bolts is just about half of the earlier bolts so there is increase in life of bolts by twice.

Fig 6 hardened bolt and locknut after 15 days of work

Fig. 7 existing soft bolt after 15 days of work

So by observing the conditions of bolts we decide to use the hardened bolts which are easily available in market as mention above TVS and UNBREKO are preferred for our solution. Also we observe that there is no any looseness of locknut it remain in its position throughout its operation so locknut is the best option for welding the nut so by using the locknut there is saving of time of welding also cost of welding, also time is consumed in removing of welding by gas cutting is also saved.

Though the cost of hardened bolt and locknut is somewhat greater than the general bolt but after comparing life of both bolts there is significant difference between life of general bolt and life of hardened bolt, it should almost more than double so use of hardened bolt and locknut is beneficial. So our first trial is successful to use Hardened bolt and locknut

V. TRAIL OF HEAT TREATMENT

The heat treatment is a very broad term and includes any heating and cooling operation or any sequence of two or more such operation- applied to any material in order to modify its internal structure or to alter its physical, mechanical or chemical properties. It increase hardness, wear and abrasion resistance and cutting ability of steels. We carried out heat treatment of mild steel & EN 31 material.

5.1Case hardening and tempering of Mild steel

A unique feature of salt bath nitro carburized layers is the menopause Fe-N compound layer, with a nitrogen content of 6-9% and a carbon content of around 1%. Compared with double phase nitride layers which have lower nitrogen concentrations, the monophase Fe-N layer is more ductile and gives better wear and corrosion resistance by improvement with case hardening.

Fig. 8 case hardened and tempered mild steel blade

5.2 Hardening and Tempering of EN31

Fig 9 hardened and tempered EN31 blade

VI. TRAIL TAKEN ON ALTERNATE MATERIAL

By doing different processes on the blade material it would increase the cost of the blades also valuable time is spend so it affect on the productivity of machine, so we decided to go for alternate materials for blade which are easily available with low cost and better properties than mild steel. The alternate materials rather than mild steel are directly purchases from market.

Following are the different alternative materials:

1)EN31

EN31 is a high carbon alloy steel which achieves a high degree of hardness with compressive strength and abrasion resistance. It is high carbon alloy steel which achieves a high degree of hardness with compressive strength and abrasion resistance. it is available in stock in plate or bar form.

2) EN8

EN8 is an unalloyed medium carbon steel with good tensile strength. It is normally supplied in cold drawn or as rolled. Tensile properties can vary but are usually between 500-800 N/mm2. EN8 is 0.4% unalloyed medium carbon steel with good tensile strength. It is normally supplied in cold drawn or as rolled. Tensile properties can vary but are usually between 500-800 N/mm2. EN8 is available from stock in bar and can be cut to your requirements

Along with these we studied other material such as tool steels, carbides but at the end we are going with EN 31 material for blade

VII. TRIAL TAKEN BY USING BRASS BUSH

A bushing, also known as a bush, is an independent plain bearing that is inserted into a housing to provide a bearing surface for rotary applications; this is the most common form of a plain bearing. Provision of bush

1. To existing blade

2. To hardened blade

In earlier trial of heat treatment of existing blade material, we observed that there is considerable improvement in life of blade so we decided to go for bush with hardened blade. So it contains hardened blade with wear resistant blade.

Bush materials-

1. Brass

Brass is an alloy of copper and zinc; the proportions of zinc and copper can be varied to create a range of brasses with varying properties. Brass is a substitution alloy. It is used for decoration for its bright gold-like appearance; for applications where low friction is required such as locks, gears, bearings, doorknobs, ammunition, and valves

2. Bronze

Bronze is a metal alloy consisting primarily of copper, usually with tin as the main additive. It is hard and brittle, and it was particularly significant in antiquity, so much so that the Bronze Age was named after the metal such as Phosphor bronze which is an alloy of copper with 3.5 to 10% of tin and a significant phosphorus content of up to 1%. The phosphorus is added as deoxidizing agent during melting. These alloys are notable for their toughness, strength, low coefficient of friction, and fine grain. The phosphorus also improves the fluidity of the molten metal and thereby improves the castability, and improves mechanical properties by cleaning up the grain boundaries.

As brass is easily available at low cost we decided to go for brass bush so we press fitted the brass bush to general mild steel blade and also to the hardened blade.

Fig. 10 general mild steel blade with brass bush

Fig. 11 hardened mild steel blade with brass bush

VIII. LIFE AND COST ANALYSIS

Condition of blades after 15 days of work-

Fig. 12 general mild steel blade after 15 days of work

Fig. 13 case hardened and tempered mild steel blade after 15 days of work

Fig. 14 hardened and tempered en31 blade after 15 days of work

Photo 8.4Mild steel blade with bush after 15 days of work

8.1Cost analysis

Sr. No.	Material	Initial Cost (Rs.)	Life (Days)
1	Mild steel	65	15
2	Heat treated mild steel	85	26
3	EN 31	110	40
4	General bolt and nut	75	15
5	Hardened bolt with locknut	120	29

Table no. 1 Cost analysis

IX. RESULT

As compare to M.S. material EN 31 and heat treated M.S. is cost effective. Comparing the life of blades the life of EN31 and Hardened M.S. is more than double than that of M.S. Also use of Hardened bolt and Locknut is beneficial as it also have double life with no welding cost.

IX. CONCLUSION

Design and development of rotor blade for molding sand recycling machine is the project related to that a problem of actual working of rotor blade, that is to improve life of blade, so we had given different solutions to the problem of the rotor blade. Because of these much solutions machine can work efficiently and also at the same time efficiency is proportional to the cost and life.

In the proposed solution the three solutions are readily accepted by company those are Provision of Hardened Bolt and Locknut, Heat treatment of existing blade and Alternate material such as EN31. As EN31 material is easily available and it has life of 29 days which is almost double than life of mild steel (15 days), company go for EN 31 material instead of Mild Steel. Also by using locknut they save the cost and time of welding the nut. The life of Hardened bolts is also double (29 days) than that of regular general bolts, So the solution Hardened bolt with locknut is also accepted by the industry.

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