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Enhancing Safety in Vertical Drilling Machine

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ABSTRACT - The proposal aims to implement Variable Frequency Drive (VFD) in vertical drilling machine to prevent hand injury. The hazard in drilling machine need to be found out through Hazard Identification and Risk Assessment (HIRA). The risk of hand injury imposes a major concern for an organization, where numbers of centrifugal machines are equipped. It is therefore important to properly resource, plan and organize the activity so that they can be carried out in a safe manner. In order to prevent any incidents, near misses and property damage due to improper procedure of work an accident prevention initiative is being implied. Safety in machine prevents any such accident from happening. This also provides a safe system of work and ensures the compliance with current legislation of the state and international standards and the company's Environment, Health and Safety (EHS) standards. By installing VFD drive in vertical drilling machine power savings is obtained in along with the safety of the equipment at its design stage itself, which is the need of the hour. This helps small scale to large scale industries to achieve target zero in accidents in their premises.

KEYWORDS - VFD drive, vertical drilling machine, Hazard Identification and Risk Assessment, EHS

I. INTRODUCTION

In the early years of safety movement, management concentrated heavily on correcting hazardous physical conditions. This produced remarkable results during the first 20 years. This was the first step, possibly because conditions were so obviously bad and possibly because people believed that these conditions were actually the causes of the injury [1]. It has been suggested that unsafe acts are the causes of a high percentage of accidents, that people cause more accidents than unsafe conditions. After Second World War only the industrial Safety movement started gain momentum. This was because of rapid industrialization caused more number of accidents in industries so management took much effort to prevention of accident and safety emerges as an engineering discipline. In recent years the government and various statutory bodies frames safety rules to promote the safety in working environment. Those bodies not only concentrate on the workers safety the focused on Environmental Issues which causes the environmental pollution and affect the surrounding environment directly. To create awareness about social responsibilities these bodies made various rules and regulations. The Safety Department focuses that rules and regulation to comply.

A risk assessment[2] is nothing more than a careful examination of what in your work process/area could cause harm to people so that you can weigh up whether you have taken enough precautions or should do more to prevent harm. In order to carry out risk assessment, the level of risk is determined first. Establishing the level of a risk requires clear specification of the actual components of the risk being considered. For example the specific scenario of sequence of events including the nature of consequences to be considered, the exposure to the chosen hazard, finally the probability or likelihood of that scenario taking place. In doing so the existing control are determined when exposure is assessed.

Any scenario involving particular hazard can lead to different consequences depending on the sequence of exposure events. Hence any risk needs to be assessed separately for each chosen sequence of events. The process of enhancing the Occupational Health and Safety (OH&S) management system, to achieve improvements in overall occupational health and safety performances, in line with the organization's

OH&S policy; according to OHSAS 18001:1999, clause 3.3[3]. The performance of the organization towards its policy can be measured using Hazard Identification and Risk Assessment (HIRA).

Accidents happen due to unsafe act and unsafe condition [1]. Of which unsafe act is the reason for most accidents as whatever be the training provided to the employee, because of his experience he acquires the mind of superman[4]. In some cases like in here accidents happen due to the combination of unsafe act and unsafe condition. They need to be prevented because no employee is willing to report his superior about the near misses, which need to be. According to heinrich, out of 300 near misses 29 result in minor injury and 1 result to major at times fatality[1]. Accidents happen due to stress, workload, improper activities, and incompatibility [4]. And in a factory premises one can't point put a particular reason for the accidents any little deviation from the standard operating procedure could result in accident. So instead of going for a safety from the man side, it's better to be from the machine side. Thereby the unsafe condition is eliminated and unsafe act could be prevented.

II. RELATED WORK

This section deals with various literature works which are related to optimizing safety in vertical drilling machine. Here we leverage the existing works in two categories under VFD drive and HIRA.

A. Variable Frequency Drive

William L. Puskas (1988)[5] the author has dealt with designing Variable Frequency Drive. An AC power system for a resonant load. A pair of switching networks and blocking networks are provided to drive the load for half a cycle in a resonant manner to a high energy state, and then maintained in that high energy state for a predetermined period. Then the load is driven for half a cycle in a resonant manner to the opposite polarity high energy state and maintained in that high energy state for the predetermined period. A controller adjustably controls the frequency of switching between the two high energy states and the length of the predetermined period, so that a desired frequency is obtained.

Hiroshi Ishida and Shigeki Kawada (1982)[6] the authors have dealt with an apparatus for controlling the operation of an AC motor wherein braking energy at the time of a reduction in motor speed is disposed of by regenerative braking. The apparatus includes a rectifier connected to the AC power source, a smoothing capacitor, a variable-voltage variable-frequency inverter, and a regenerative thyristor bridge circuit connected between the inverter and the rectifier through switching transistors. There is also provided a firing control circuit for controlling the firing of each thyristor in the thyristor bridge circuit and for controlling driving of the switching transistors in synchronism with the firing of the thyristors, the braking energy being fed back to the AC power source when the AC motor undergoes a reduction in speed. The apparatus is small and can be constructed simply and inexpensively.

B. Hazard Identification and Risk Assessment

Johan M. Sanne (2008)[7] says that, ―The number of reported occupational health and safety incidents was lower than the number of accidents. This makes the officer ashamed, because it is difficult to know if anything happened. In response to corporate and regulatory demands for a systematic safety management system, replacing previous incident-reporting documents schemes. This article argues that the official incident reporting scheme. The observations were followed by a small number of interviews. Getting access to the field was generally easy. Process in a hazardous environment that requires mutual trust in the team, there is no escape if you make a mistake.

AudunBrandsater (2008)[8], describes the implementation and use of risk assessment in the offshore industry relation to safety aspects (safety to people's life and health, as well as environment and property) .Although risk assessments may be based on both qualitative and quantitative methods, the main focus here will be on quantitative risk assessments (QRA).The development of offshore QRA has been lead by a mutual influence and interaction between the regulatory authorities. They require risk analyses at concept, design and construction stages for each mobile unit, but do not specify the precise form of the analysis, except that it is to include lists of dimensioning accidental events/accidental loads as well as recommendations related to possible risk reducing measures. The regulations specify that the overall risk to people, the unit and the environment is to be reduced as far as practicable, but the owner may specify additional acceptance criteria as well.

III. ZERO SAFETY DEVIATION PLAN AND ACCIDENT PREVENTION INITIATIVE

Continual improvement[3] of an organization is the key to sustain in the present market situation. As global market leaders continually improve in their standards, this start to echo in Indian market too to sustain them. In that cases increase in number of accident increase their product rate and thereby their quality decreases, as they both stand directly proportional to each of them. This lowers their market customers, which no employer likes it. There by continually improving the outcome of HIRA suggests that safety in vertical drilling machine need to be improved. Also Schedule VII, Section 4 of Tamil Nadu Factories Rules [9], 1950 suggests that

"All centrifugal machines shall be provided with effective breaking arrangements for bringing the cage, drum or basket to rest within a reasonable short period of time after the power to drive the motor is cut off."

In this way the spindle of the drilling machine need to be brought down to rest within reasonable short period. By using variable frequency drive [10] along with proximity sensors for sensing the position of the spindle (whether it is up or down) this can be obtained. By implementing so the safety of machine is enhanced and the time taken by the operation is reduced. Normally the spindle of the vertical drilling machine takes 20sec to stop even after the power to drive is cut off during maximum power. This much of time can‘t be wasted for taking a work piece out of the clamp.

Variable-Frequency Drive (VFD) is a type of adjustable speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage. Since motor speed (rpm) is dependent upon frequency. Varying the frequency output of the VFD controls motor speed:

“Speed (rpm) = frequency (hertz) x 120 / no. of poles”

Implementation of VFD drive in drilling machine:

1. The organization uses 3phase line of 440V of which one is neutral and the other three are hot lines.

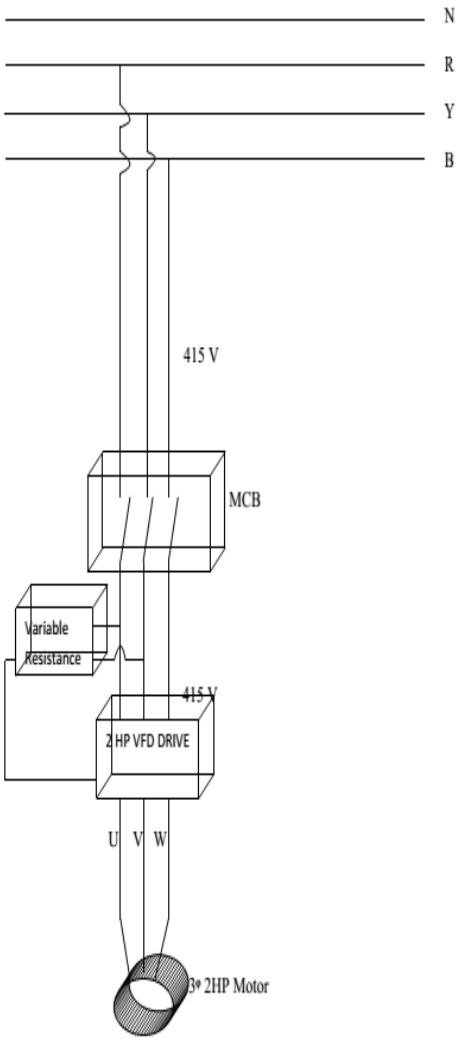

Fig. 1. VFD Fixed Motor line

2. Of this, from the hot lines for vertical drilling machine lines are taken and they are connected to a MCB for safety of the machine. Just in case if any overload passes.
3. From MCB they are connected to VFD drive which is kept in the vertical drilling machine‘s panel board. From it to the machine.
4. The motor used by the vertical drilling machine is a 3 phase 2HP motor. So corresponding to it the VFD implemented is also a 2HP one.
5. A VFD fixed vertical drilling machine is always kept ON, provided they operate only by the input given to the supply by the proximity sensor.
6. The proximity sensor is fixed nearby the spindle to monitor its movement.
7. If the spindle is pulled down the signals to the sensor will not be sent back and thus they allow the machine to operate.
8. If the spindle released back then the IGBT changes the polarity of the supply and a negative power is supplied to the machine and it nullifies the speed of the drilling machine. Fig. 1. Illustrates the VFD fixed motor line
9. By implementing VFD drive in vertical drilling machine, the time taken by the chuck to rest is reduced by 18 sec.
10. Thus to the normal time taken by the drilling machine of 20sec is reduced to below 2sec, which paves the way for reduction in hand injury.

The Braking unit gets its supply from Insulated Gate Bipolar Transistor in VFD drive. The braking unit is nothing but just a resistance which has a value of 1ohm to 2 ohm. This unit is connected to the hot lines of the supply to the VFD drive. When the proximity sensor senses the spindle coming back to its original position, the supply stops flowing to the motor bypasses and flows to braking unit. When this is activated it changes the polarity of the hot line and tries to reverse the direction of rotation of motor. Thus nullifying the motor‘s inertia speed and making it to come to rest.Fig. 2. illustrates the brake direction.

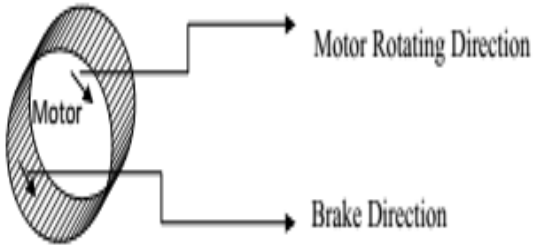

Fig. 2. Brake Direction

Benefits of VFD in vertical drilling machine:

Variable Frequency Drive provides the following advantages:

1. Safety to the operator
2. Energy saving
3. Low motor starting current
4. High power factor

IV. TEST RESULTS

Table 1 depicts time taken by the drilling machine to come to rest after it's switched off. These results were obtained before VFD being installed.

TABLE 1. BEFORE VFD BEING INSTALLED

No. of observation	Time taken by the drilling machine to come to rest after its switched off(in sec)
1	20.56
2	21.18
3	19.50
4	20.04
5	19.94

Table 2 depicts time taken by the drilling machine to come to rest after it's switched off. These results are obtained after VFD being installed.

TABLE 2. AFTER VFD BEING INSTALLED

No. of observation	Time taken by the drilling machine to come to rest after its switched off(in sec)
1	1.47
2	1.56
3	1.96
4	1.32
5	1.77

Table 3 depicts the accident details in vertical drilling machine in claw alone, before VFD being installed.

TABLE 3. ACCIDENT DETAILS IN VERTICAL DRILLING MACHINE IN CLAW ALONE, BEFORE VFD BEING INSTALLED

Month	Accident Numbers
July	12
August	10
September	14
October	19
November	16

After VFD being installed,

1. After VFD being installed in CLAW units vertical drilling machine it has been kept under observation for moreover 3 weeks.
2. The accident figures were reduced drastically to nil so far.

V. CONCLUSION

Thus by installing VFD drive in vertical drilling machine the safety in claw manufacturing process is optimized. As VFD can save current it's a mutual profit for the organization in safety and savings. By working in a VFD installed vertical drilling machine the operator need not to unwear gloves for operating it. Work with the glove in hand which reduces the time taken by the operator to finish a product. As the section 4 of schedule VII of Tamil Nadu Factories Rules, 1950 is satisfied. Thereby hand injury is prevented in vertical drilling machine.

ACKNOWLEDGEMENT

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