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Analysis of Speed controller for three phase induction motor in 125/60 TPH Aggregate crushing Sand Plant

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Abstract*—This paper deals about the Analysis of Speed controller for three phase induction motor in 125/60 (Tons per hour) TPH Aggregate crushing Sand Plant. Three phase induction motor speed control is necessary to do the various operations of the aggregate crushing sand plant especially in the vibrating grizzly feeder and also in the vertical shaft impactor. As speed control of the three phase induction motor is required, it is also mandatory requirement of the speed controller. In this paper, crushing sand Plant operation is delineated and also shortcomings of the conventional speed controller PLC which is used in this plant *is discussed.

Index Terms - PLC,TPH,VSI,VFD,MM.

I. Introduction

Three phase induction motors are mostly used in all industries. Speed control of this motor necessary to control the plant operations. In this paper, 125/60 TPH aggregate crushing sand plant is considered. Three phase induction motors are playing a vital role in this plant. Speed control of this motor makes the efficient running of this plant. Therefore in this paper, operation of the 125/60 tph aggregate crushing sand plant is explained and disadvantages of conventional PLC controller used in this plant is discussed here.

II. Operation of 125/60 TPH Aggregate Crushing Sand Plant

Block diagram of 125/60TPH aggregate crushing sand plant is shown in fig (a).Maximum output capacity of this crusher plant is 125 to 160 tonnes/hour. Crushers are used to reduce the size, or change the form of stone materials so that it can be easily disposed or recycled or to reduce the size of a solid mix of raw materials which is used in the construction field such as manufacturing sand (m-sand).

Operation of the plant can be understandable by reading the following:

A. Hopper to Jaw Crusher Unit:

(i)HOPPER UNIT:

Stones extracted from the mines (Bolters) is in the range between 0MM to 600MM (-600MM) is gradually applied to the hopper unit. This hopper is storing raw materials (bolters) which are obtained from the dump trucks, excavators or wheeled front end loaders. Then bolters are applied to the grizzly feeder unit which is in the size of -600MM.

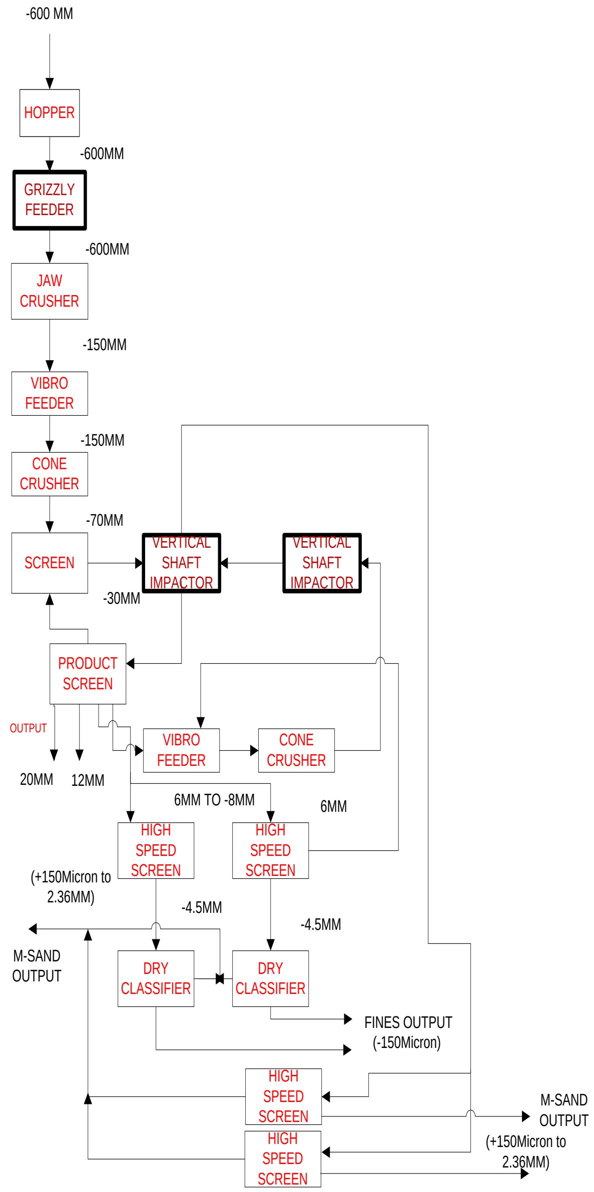
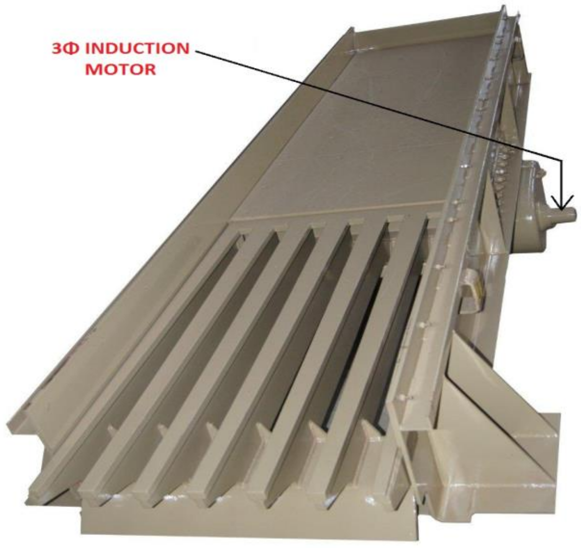


Fig (a) Block diagram of 125/60TPH aggregate crushing sand plant

(ii)GRIZZLY FEEDER UNIT:

Grizzly feeder is shown in fig (b).Grizzly feeder is a unit which is having vibrating plates called feeder. This feeder is attached with two springs as well as two three phase induction motors which is fed by PLC(Programmable Logic Controller) based VFD (variable frequency drives) to change the speed.

Three phase induction motors are used to operate this grizzly feeder in an effective manner as these motors are connected with the VFD (variable frequency drives).



Figure(b) Grizzly feeder

Rating of these three phase induction motors are mentioned below.

S.NO	DESCRIPTION OF THE MOTOR-A	RATINGS
1.	Supply	3Φ
2.	POWER (HP)	20
3.	POWER (kW)	15
4.	Voltage	415V
5.	Current	29.5A
6.	Frequency	50Hz
7.	SPEED in rpm	1455
8.	Efficiency(η)	88%
9.	Power factor	0.81
10.	Insulation	Class-F

Table 1: Rating of motor-A

Rating of motor-A is shown in table-1.This motor-A is a three phase induction motor. Speed of this motor is maximum of 1455 rpm. Lesser than this 1455 rpm (sub synchronous speed) is used to run this grizzly feeder. Speed ranging from 800 rpm to 1300 rpm is used to operate this grizzly feeder. Then only required vibration can be achieved in the grizzly feeder so as to move the bolters to the jaw crusher unit. If bolters are of big size, high speed of the motor around 1300rpm is fixed else 800rpm, 900rpm, 1000rpm, 1100rpm, 1200rpm is fixed based on the bolters size which is arrived at the grizzly feeder. Other than the motors, two springs are used to absorb stress which is formed by the grizzly feeder.

S.NO	DESCRIPTION OF THE MOTOR-B	RATINGS
1.	Supply	3Φ
2.	POWER (HP)	20
3.	POWER (kW)	15
4.	Voltage	415V
5.	Current	29.5A
6.	Frequency	50Hz
7.	SPEED in rpm	1455
8.	Efficiency(η)	88%
9.	Power factor	0.81
10.	Insulation	Class-F

Table 2: Rating of motor-B

Rating of motor-B is shown in table-2.This motor-B is also identical motor as motor –A because ratings of this motor is same as motor-A. This motor-B is having the maximum speed of 1455rpm. But for the efficient operation of the grizzly feeder, this motor- B must follow the same speed of motor-A. Therefore two induction motors are operated at the same speed as well as both motors are allowed to run at lesser than synchronous speed to deliver the variable speed. In order to achieve this variable speed operation of the three phase induction motors, PLC (Programmable Logic Controller) based is used. While using PLC based VFD drive to control the speed of the three phase induction motors, the VFD drive is encountered some problems.

Disadvantages of PLC based VFD drive which is used in this plant is listed below:

1. Speed tracking performance is poor.
2. Sensible to short circuit fault.
3. Sensible to earth fault.
4. Easily affected by high voltage.

(iii)JAW CRUSHER UNIT:

Jaw crusher is used to pulverize the bolters which are delivered by grizzly feeder. In order to reduce to fine particles of the bolters (stones) this jaw crusher is used. The eccentric rotating drive shaft which is in the jaw crusher causes the movable jaw to oscillate crushing the aggregate against a fixed jaw. Jaw crushers are run on belt drives driven by an electric motor. Jaw crushers are used extensively throughout the aggregate and mineral processing industry. Less than 600MM (-600MM) is given as input to the jaw crusher. From the jaw crusher, less than 150MM (-150MM) comes out as aggregate (Low size stones).

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B.VIBRATING FEEDER TO VERTICAL SHAFT IMPACTOR:

(i) VIBRATING FEEDER:

Vibrating feeder is used to transfer crushed aggregate from crusher to the cone crusher which is having the value of less than 150MM (-150MM).

(ii) CONE CRUSHER:

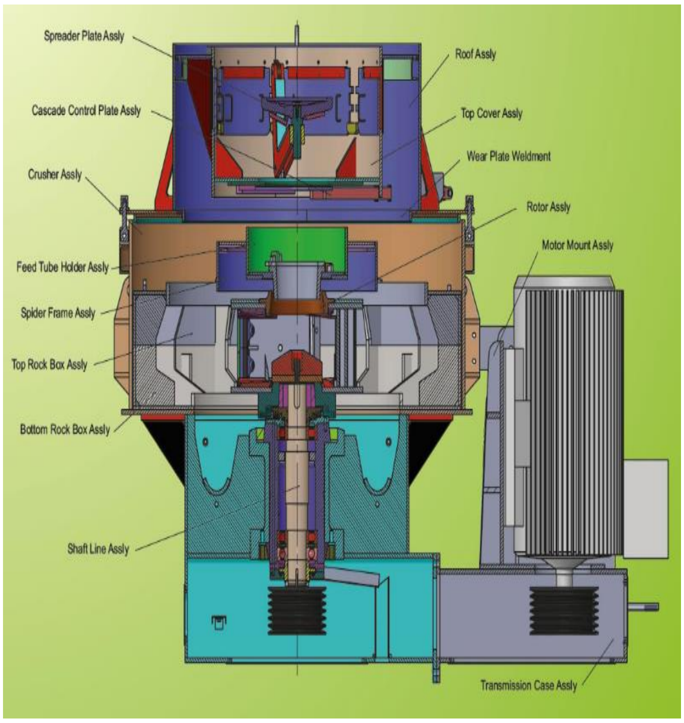
Cone crusher collects the -150MM aggregate followed by it crushes the aggregate into less than 70MM (-70MM).

(iii)Screen unit:

Screen consists of different types of messes. Each mess is specified with some standard size. For example, 30MM mess is used in the screen is to allow less than 30MM aggregate.

(iv)Vertical shaft impactor:

Vertical shaft impactor is shown in figure(c).Vertical shaft impactor collects the -30MM aggregate from the screen.



Figure(c) Vertical shaft impactor

On the top of the vertical shaft impactor (VSI) -30MM aggregate is given as input. It gives the shape to the aggregate and then shaped aggregate is fed to the product screen. In this VSI, three phase induction motor is mainly used for the effective operation. This three phase induction motor is operated at variable speeds ranging from 850rpm to 1300rpm. PLC based VFD drive is used here to achieve the variable speed. Rating of the three phase induction motor used in VSI is given below:

S.NO	DESCRIPTION OF THE MOTOR USED IN VERTICAL SHAFT IMPACTOR	RATINGS
1.	Supply	3Φ
2.	POWER (HP)	250
3.	POWER (kW)	185
4.	Voltage	415V
5.	Current	311A
6.	Frequency	50Hz
7.	SPEED in rpm	1485
8.	Efficiency(η)	96.2%
9.	Power factor	0.85
10.	Insulation	CLASS-F

Table 3: Rating of motor used in VSI.

This motor power rating and current rating is high around 250HP and 311A respectively.

C.PRODUCT SCREEN TO M-SAND OUTPUT:

(i) PRODUCT SCREEN:

Product screen gets the input from the VSI. Product screen comprises of three messes.Mess-1 has the capacity of delivering 20MM output. Mess-2 has the capacity of delivering 12MM. Mess-3 has the capacity of delivering 6MM to -8MM ouput.From the product screen, screen, vibro feeder and high speed screen receive the input as aggregate.

(ii)Vibrating feeder:

Vibrating feeder is linear-direction feeding equipment in this crushing plant. After aggregate is received from product screen, vibrating feeder sends the aggregate to the cone crusher followed by aggregate is dispatched to the VSI.

(iii)High speed screen:

There are four high speed screens used in this crushing plant. Two high speed screens receive the input from the product screen in the range between 6MM to -8MM.High speed screen has its own mess. This mess is used to deliver -4.5MM output. Another two high speed screen receives the input from VSI.These two high speed screens is able to deliver the output M-sand ranging from +150 micron to 2.36MM.

(iv)M-Sand:

M-sand is abbreviated as manufactured sand. Concrete plants require a consistent, quality sand to optimize their production and minimize their cement usage. In many regions of the world, the extraction of sand is heavily taxed or banned completely to try to preserve remaining deposits. The industry must find alternatives to meet the growing demand for fine aggregates. M-Sand is one of the best alternatives for the fine aggregates.

D.DRY CLASSIFIER TO M-SAND OUTPUT:

There are two dry classifiers are used in this crushing plant. These two dry classifiers receive the input from two high speed screens. It's about -4.5MM.Dry classifiers are able to deliver two different outputs. One of the output is M-Sand. This M-sand is in the range of +150 micron to 2.36MM. Another one output from this dry classifier is fines output. Fines are nothing but dust. Fines are in the range between "0" micron to "150"micron.Therefore it is named as -150micron.

III. CONCLUSION

Aggregate crushing Sand Plant works in the maximum output capacity ranging from 125-160 tones/hour is analysed.Various blocks of this aggregate crushing Sand Plant is described in the elaborative manner. Application of three phase induction motors and its PLC based VFD drive used in this plant is delineated. Disadvantages of PLC based VFD drive which is used in this plant is clearly analysed. In future, with this same motor specifications which is mentioned in table(1),table(2),table(3) with disturbance environment, matlab simulation work will be carried out by interfacing PID controller, fuzzy logic controller, neural network controller, neuro fuzzy controller individually. At the end, comparison chart will be formed by comparing each and every controller performance with this three phase induction motor with another controller. Then robust controller for this three phase induction motor will be identified.

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References

[1] Atta, Khalid Tourkey, Andreas Johansson, and Thomas Gustafsson. "On-line optimization of cone crushers using Extremum-Seeking Control." In Control Applications (CCA), 2013 IEEE International Conference on, pp. 1054-1060. IEEE, 2013.

[2] Snyman, J., J. C. Vosloo, and G. D. Bolt. "Limestone crushing plant load management." In Industrial and Commercial Use of Energy Conference (ICUE), 2012 Proceedings of the 9th, pp. 1-4. IEEE, 2012.

[3] Fischer, Tino. "Stationary vs. semi-mobile crushing plant in comparison." In Cement Industry Technical Conference, 2016 IEEE-IAS/PCA, pp. 1-7. IEEE, 2016.

[4] Martin, Jose L., Unai Bidarte, Carlos Cuadrado, and P. Ibanez. "DSP-based board for control of jaw crushers used in mining and quarrying industry." In Industrial Electronics Society, 2000. IECON 2000. 26th Annual Confjerence of the IEEE, vol. 3, pp. 2019-2024. IEEE, 2000.

[5] Watanabe, T., T. Fukushima, H. Narazaki, M. Konishi, S. Shimamaki, S. Kuraoka, and M. Mino. "Intelligent lay-out design model for sand and aggregate plant." In Systems, Man, and Cybernetics, 1999. IEEE SMC'99 Conference Proceedings. 1999 IEEE International Conference on, vol. 2, pp. 475-479. IEEE, 1999.

[6] Kotz, G. R., and M. P. Regan. "Motor applications for hydraulic roll crushers." In Cement Industry Technical Conference, 1994. XXXVI Conference Record., 36th IEEE, pp. 99-116. IEEE, 1994.

[7] Errath, R. A. "Roll crusher with variable speed DC drive." In Cement Industry Technical Conference, 1994. XXXVI Conference Record., 36th IEEE, pp. 67-83. IEEE, 1994.

[8] Fischer, R. T. "Crusher and Screen Drives for the Mining, Aggregate and Cement Industries." In Cement Industry Technical Conference, 1992. IEEE, pp. 108-147. IEEE, 1992.

[9] Arrofiq, Muhammad, and Nordin Saad. "PLC-based fuzzy logic controller for induction-motor drive with constant V/Hz ratio." In Intelligent and Advanced Systems, 2007. ICIAS 2007. International Conference on, pp. 93-98. IEEE, 2007.

[10] Kumar, Amit, and Tejavathu Ramesh. "MRAS speed estimator for speed sensorless IFOC of an induction motor drive using fuzzy logic controller." In Energy, Power and Environment: Towards Sustainable Growth (ICEPE), 2015 International Conference on, pp. 1-6. IEEE, 2015.

[11] Barazane, L., M. Laribi, M. M. Krishan, and R. Ouiguini. "A new Gaussian radial basis function neural network controller for induction motor control drives." In Control & Automation (MED), 2010 18th Mediterranean Conference on, pp. 545-550. IEEE, 2010.

[12] Baharin, Muhammad Kamarul, Nordin Saad, and Taib Ibrahim. "State-space approach controller design for PLC-based PWM-driven variable speed drive." In Industrial Electronics and Applications (ISIEA), 2011 IEEE Symposium on, pp. 720-725. IEEE, 2011.

[13] Sowmiya, D. "Monitoring and control of a PLC based VFD fed three phase induction motor for powder compacting press machine." In Intelligent Systems and Control (ISCO), 2013 7th International Conference on, pp. 90-92. IEEE, 2013.

[14] Hussain, Shoeb, and Mohammad Abid Bazaz. "ANFIS implementation on a three phase vector controlled induction motor with efficiency optimisation." In Circuits, Systems, Communication and Information Technology Applications (CSCITA), 2014 International Conference on, pp. 391-396. IEEE, 2014.

[15] Sathishkumar, H., and S. S. Parthasarathy. "Space vector pulse width modulation for DC-AC converter." In Science Technology Engineering and Management (ICONSTEM), Second International Conference on, pp. 310-314. IEEE, 2016.

[16] Viola, Julio, José Restrepo, and José Aller. "Current controller for induction motor using an Artificial Neural Network trained with a Lyapunov based algorithm." In 2015 IEEE 24th International Symposium on Industrial Electronics (ISIE), pp. 468-475. IEEE, 2015.

[17] Uddin, M. N., M. M. Rashid, Ahmad M. Tahir, M. Parvez, M. F. M. Elias, and M. M. Sultan. "Hybrid Fuzzy and PID controller based inverter to control speed of AC induction motor." In 2015 International Conference on Electrical & Electronic Engineering (ICEEE), pp. 9-12. IEEE, 2015.

[18] Vahedpour, Mohammadreza, Abolfazl Ranjbar Noei, and Hedyeh Agheh Kholerdi. "Comparison between performance of conventional, fuzzy and fractional order PID controllers in practical speed control of induction motor." In 2015 2nd International Conference on Knowledge-Based Engineering and Innovation (KBEI), pp. 912-916. IEEE, 2015.

[19] Sitharthan, R., M. Geethanjali, and T. Karpaga Senthil Pandy. "Adaptive protection scheme for smart microgrid with electronically coupled distributed generations." Alexandria Engineering Journal 55, no. 3 (2016): 2539-2550.

[20] Zahraoui, Yassine, Abderrahim Bennassar, Mohamed Akherraz, and Adil Essalmi. "Indirect vector control of induction motor using an extended Kalman observer and fuzzy logic controllers." In 2015 3rd International Renewable and Sustainable Energy Conference (IRSEC), pp. 1-6. IEEE, 2015.

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