

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 6, June 2019

# Real Time Controlling and Analysis of Cone Crusher Plant with Data Acquisition System

Narayan Lal Purohit<sup>#1</sup>, Shashank Sultaniya<sup>#2</sup>

M.Tech (Power system), Jaipur Institute of Technology, Jaipur, Rajasthan Technical University, Kota, India <sup>#1</sup>

Assistant Professor, Jaipur Institute of Technology- Group of Institutions, Jaipur, Rajasthan Technical University, Kota, India <sup>2</sup>

**ABSTRACT:** As per the application and process now a days rapidly growth in every industries with respect to demand of requirements. Efficient and profitable aggregate production depends as much on the crusher operator as it does on the machine itself. Good operating practices can typically extend the lifetime of the cone crusher by a significant amount. An alert operator can often detect an imminent component failure that might otherwise be overlooked, thus avoiding mechanical damage and costly downtime. Cone crushers are versatile machines, but they should be used according to the way they are set up. A 4:1 reduction ratio is a standard crusher application. Opting to use it for a 6:1 or 8:1 reduction of material could fall outside the parameters of its usual function, with a negative impact on the machine. Cone crushers can be used in various stages of a sequential crushing process, but some applications are more effective than others. The owner-operator of a cone crusher should distinguish among tasks for best performance. A Cone crusher advanced control systems are widely used for machine protection, wear compensation and increasing production. These systems ordinarily focus on the crusher and not the yield of production process. An unplanned failure can result in significantly higher repair costs than a planned maintenance or repair. As per the system requirements programmable logic controller (PLC), human machine interface (HMI), energy meter and its peripheral devices used to access data of plant then stored for future reference as a feedback. The developed algorithms are tested and executed at stone crushing plants. Crushing safety improve & stage performance increased 4.5% in terms of production yield compared to a fixed CSS when the algorithm was implemented in addition to the existing method. The algorithm automatically compensates for changes in the feed material and also decreases the need for calibration of the CSS (close side setting). In real life however, the performance was increased by almost 10% since an inappropriate speed was selected during installation. As a bonus, on one of the test plants for the dynamic speed, the lifetime of the manganese & mix wear parts increased 27% on the evaluated crusher, as a consequence of changed crusher dynamics. For cone crusher plant overall performance increase with increase in production due to upgrade technology. All analysis and observation completed on site with actual data feeding.

**KEYWORDS:** CONE crusher, crushing, real time optimization, process optimization, CSS, PLC, HMI.

### I. INTRODUCTION

For the development a programmable logic controller (AH series PLC), ADC and their programming software is ISP Soft. Also used Human machine interface (DOP W-series) with Ethernet connectivity and their programming software is DOP-Soft. Other software are also used like DOP- E-Remote and DOP-E server. All these software and hardware used for monitoring, controlling and data acquisition of cone crusher plant. Some electrical devices like power transducer, relay, circuit breaker and converter are used to provide relevant data to these controlling device. Also used temperature & pressure sensor for the control of hydraulic system. The energy meters used for power compensation with monitoring & linear scale interlock with piston position to maintain CSS. All these components and hardware used to provide customize solution as per customer requirements with cost effective [1]. When the cone crusher is equipped with our automatic setting system it automatically adapts the crusher to variations in feed conditions. By continuously

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 6, June 2019

measuring and compensating for crusher liner wear, the automation system allows you to fully utilize crusher liners and schedule liner replacements to coincide with planned maintenance stops. It also assists in keeping your crusher choke fed.

Dust rising from a crushing operation can be dampened by water sprays, but actual crushing performance will suffer. Material that is wet when it falls into the hopper will generally cause problems. The water molecules mud together with dust molecules and finer material becomes pasty. The sticky material does not fall out of the crushing chamber, leading to unwanted pressures in the chamber, unnecessary liner wear and reduced performance.

## II. SYSTEM OVERVIEW

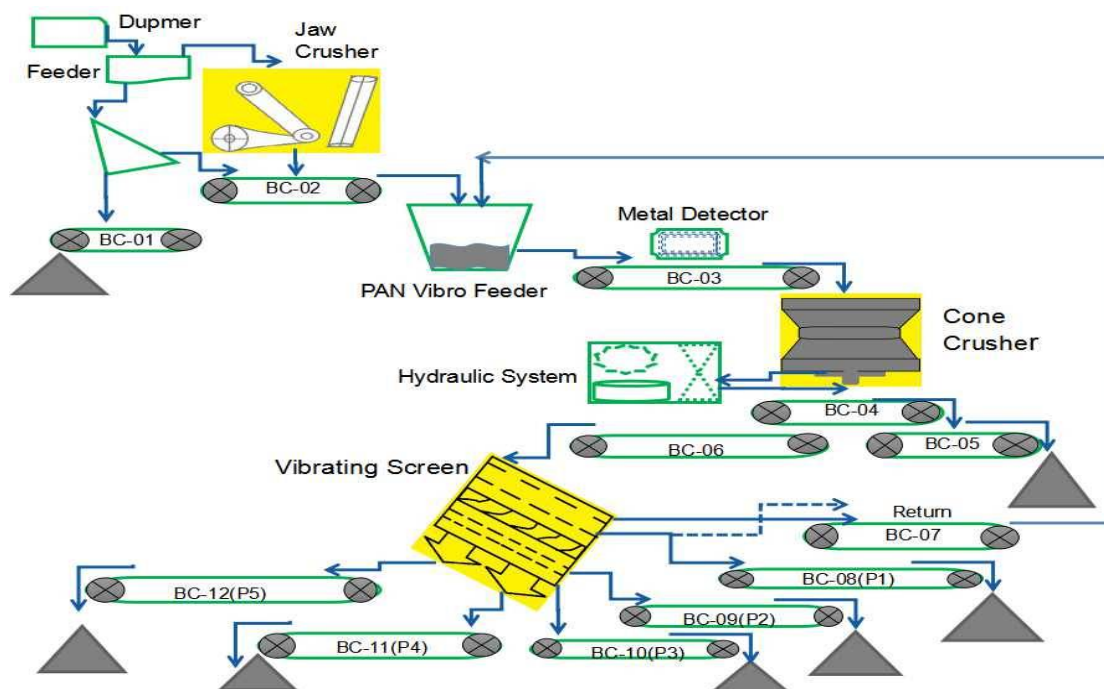


Figure: 1. Process flow diagram of cone crusher plant.

A) **Classification** : A crusher may be considered as primary, secondary or fine crusher depending on the size reduction factor[11].

1. **Primary crusher** – The raw material from mines is processed first in primary crushers.. The input of such crushers is relatively wider and the output products are coarser in size. Example - Jaw crusher, Gyratory crusher.
2. **Secondary crusher**- The crushed rocks from primary crusher are sent to secondary crusher for further size reduction. Example - Cone crusher, reduction gyratory crusher, spring rolls, disk crushers etc[6].
3. **Fine crushers**- Fine crushers have relatively small openings, and are used to crush the feed material into more uniform and finer product. Example - Gravity stamp[3].
4. **Jaw Crusher** : Jaw crushers are widely used crushing machines. They are used for disintegration of hard and medium-hard materials to obtain various product size. They are robust, their design and construction is relatively simple, they are easy to operate and maintain. The mechanism of jaw crusher is based on the concept “crushing without rubbing”. Jaw crushers consist of two jaws. One fixed and the other reciprocating. The opening between them is largest

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 6, June 2019

at the top and decreases towards the bottom. The pitman moves on an eccentric shaft and swing lever swings on centre pin. The rock is thrown between two jaws and crushed by mechanical pressure.

[4].

Jaw crushers are classified on the basis of the position of the pivoting of the swing jaw.

- a) Blake crusher-the swing jaw is fixed at the upper position
- b) Dodge crusher-the swing jaw is fixed at the lower position
- c) Universal crusher-the swing jaw is fixed at an intermediate position[8].

**B) Cone Crusher :** Working Principle of cone Crusher - The cone crusher reduces the feed material by means of pressure. The adjustable gap width can be varied by a hydraulic piston, which is located in the lower part of the housing. The upper section of the housing accommodates the wedge-shaped crushing tools. The crusher drive is situated between those two sections. The crushing force is produced by an eccentric bush, which moves the crushing cone towards the crushing shell in a circular oscillating movement. Due to the friction of the material to be crushed, the crushing cone moves slowly in opposite direction towards the driving rotation. The rotation produced by the crusher shaft has no influence on the crushing action itself. The variation of the gap width is performed by the hydraulic piston. On request the crusher can be provided with a fully automatic gap measurement system. In case of a temporary overload, the gap width is increased by means of a rapid hydraulic lowering of the crushing cone to ensure quick passing of foreign particles. After completion of this process, the gap is set automatically to the previously selected width. With the rapid development of mining technology, the cone crusher can be divided into four types: compound cone crusher, spring cone crusher, hydraulic cone crusher and gyratory crusher[7].

C)

**D) Feeder :** PAN vibro feeder is a combination of surge hopper & vibrator. In this section special design motors used with AC drive for motor speed control & feeder speed control in PID loop. AC drive(C200) delta make model used & speed control in form of (0-50)Hz or (0-100)%. AC drive data read- write function executed via modbus communication(RS 485) with PLC system[8].

E)

**F) Screen & conveyor :** Here total 12 number of conveyor belt used for crushing plant. These quantities increase or decrease as per the system requirements. All conveyor used as per the specification of load & length of travelling. Screen are used in mining, aggregate & mineral industries to separate particles of different size from each other & thereby form of products. Screen consists of steel wire of punched rubber cloths which oscillate in transport the material and to let particles pass through the apertures. Here we used different size for material to be separation then transfer to conveyors. Conveyors are frequently used in crushing plants for transportation of feeding material & output product. The size of the particles are often less than 200mm. A conveyor belt is much more energy effective then vehicles for short distance[9].

G)

**H) Hydraulic System :** The Hydraulic system provides safety and setting adjustment functions, and incorporates a heavy-duty hydraulic cylinder which supports the main shaft and adjusts its position. The Hydraulic system provides automatic overload protection to permit the passage of tramp iron or other uncrushable material. The system then automatically returns the main-shaft smoothly to its original position. .

**I) Field Sensor & connectivity :** In this section we introduced sensor used for operation control. In plant operators are busy and do not have enough time to control an open-loop crusher as effectively as well-configured computer or PLC software. Such software coupled with adequate sensors can facilitate closed-loop control. Here we used linear scale, pressure, temperature, photo sensor, all are (4-20)mA. These sensors configure with PLC module(4-20)mA to control & monitor CSS setting, actual values, set values etc[10].

J)

**K) PLC & advanced control system :** As per the system design & requirements below devices used for control & monitoring of crusher plant.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 6, June 2019

a) **PLC** : Programmable logic controller belongs to main controlling family & here used modular PLC(AH series -AHCPU500-RS2). It is a basic CPU module with two built-in RS-485 ports, one built-in USB port, rack based PLC and one built-in SD interface. It supports 768 inputs/outputs. The program capacity is 16 ksteps. The programming languages which are supported are instruction lists (IL), structured texts (ST), ladder diagrams (LD), sequential function charts (SFC), and function block diagrams(FBD). I used ladder diagrams as per the process



Figure : 2. PLC hardware configuration with expansion module rack based

b) **Expansion Module** : The cone crusher plant control through digital, analog & special modules interface with main CPU. The sensors are used hydraulic pressure, lubrication pressure, linear scale and feeding level sensor then control via analog modules. As per the process demand temperature controlling, monitoring and interface in system very important factor. So developed a network system RS-485 communication of DTC1000/2000 temperature module with main CPU. For the temperature sensing here used RTD, Thermocouple and temperature switch.

c) **HMI** : A complete crusher plant monitor in single HMI(Human machine interface) device. It is communicated with PLC & other peripherals devices thorough RS232, RS485 and Ethernet TCP/IP protocols. For this application HMI model used DOP-B127B with ether facilities. First data access from peripheral devices then via controller to fetch in HMI and report is generated[12].

d) **AC Drives & Energy Meters** : AC drive used to control speed of the PAN vibro feeder. It is working as per the process and cycle demand. The energy and power factor are also important part of my system control. The design & manipulation executes the point of algorithms for the power and energy. All the data I was getting on my HMI through using advance technology.

Sr.	Current	Power	Lub.(°C)	Hyd.(°C)	CSS(mm)	Lub.(Bar)	Adj.(Bar)	Feed(Hz)	Load(%)
1	88	13.464	45.1	45.4	30	1.52	2.25	45	6
2	88	13.037	45.2	45.6	30	1.56	2.2	45	6
3	117	51.924	47.8	47.6	30	1.41	5.45	45	25
4	124	54.541	47.8	47.4	30	1.48	6.48	45	27
5	142	57.941	47.9	47.6	30	1.49	6.15	45	28
6	134	59.915	47.9	47.6	30	1.3	16.6	45	29
7	153	68.385	47.9	47.6	30	1.22	8.65	45	34
8	141	72.161	47.9	47.6	30	1.5	2.95	46	36

Table : 1. Cone crusher control parameters.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 8, Issue 6, June 2019

## III. SCOPE OF ANALYSIS

This analysis is helpful for me as well as all organization, institution and system house who exactly want to know the real values and parameter of cone crusher plant applications and other peripherals devices. This analysis major objective is that how to we can use advance technology for the controlling, monitoring and access through worldwide. The major thing is that due to advance technique increase ratio of production and decrease maintenance cost. As per my observation future is going to digitization so we need to improve our industries with respect to demand. This project report helpful for all stone industries as well as students for work on real time data base.

## IV. CONCLUSION

In this paper introduce basic components and data fetching for reference. As per the my observation all data are important for present and future for analysis. The cone crusher plant is based on totally automation and smart technology to improve performance, reliability and decrease maintenance. We can collect all the data base from controller to HMI and then fetch to E- Server, monitoring using E-Remote. This one is customize solutions because user friendly with easily understandable. The system cheap and economical compared to other system with high resolution, many features available. Finally i would like to say that this system can adopt for small projects as well as big size projects.

## REFERENCES

- [1] Narayan Lal Purohit, Dr. Ravi Kumar Goyal., Smart energy meter and application of solar photo voltaic system, National Symposium on "Geomatics for Digital India" & "Annual Conventions of ISG & ISRS" 16-18 December, 2015.
- [2] Samanta, B., "Reliability Analysis of Shovel Machines Used in an Open Cast Coal Mine." *Mineral Resources Engineering*, Vol. 10, No. 2 (2001) 219-231.
- [3] Gupta Ashok, Yan D.S. "Mineral Processing Design and Operation-An introduction", Published by Elsevier, 2006, Pages 99-127.
- [4] [http://www.sbmchina.com/jaw\\_crusher\\_working\\_principle/structure\\_characteristics](http://www.sbmchina.com/jaw_crusher_working_principle/structure_characteristics).
- [5] M. Bengtsson, *Quality-Driven Production of Aggregates in Crushing Plants*, Ph.D. thesis, Chalmers University of Technology, Sweden, Chalmers University of Technology, Göteborg, 2009, pp. 1-67.
- [6] M. Lindqvist, *Energy considerations in compressive and impact crushing of rock*, *Minerals Engineering*, 21 (2008), pp. 631-641.
- [7] M. S. Stafhammar, *Screening of crushed rock material*, Ph.D. thesis, Chalmers University of Technology, Sweden, 2001, pp. 1-40.
- [8] [www.wikipedia.com](http://www.wikipedia.com).
- [9] *Belt Conveyors for Bulk Materials (5th Ed)*, Conveyor Equipment Manufacturers Association, 1997.
- [10] T. W. BoBo Jr and M. Taylor, *On-line imaging of aggregates for process control*, *2005 SME Annual Meeting: Got Mining - Preprints*, 2005, pp. 81-88.
- [11] C. M. Evertsson, *Cone crusher performance*, Ph.D. thesis, Chalmers University of Technology, Goteborg, Sweden, 2000, pp. 1-49.
- [12] Narayan Lal Purohit, Anshika "Data Acquisition of Solar Power Plant Using Scada System", *International Journal of Engineering Trends and Technology (IJETT)*, V23(4),189-194 May 2015. ISSN:2231-5381.