ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 4, April 2017

Automatic Coke Oven Pushing And Charging Schedule

[1] Sneha Bhimrao Joundale, [2] Devendra Sutar, [3] Sajit Sadanandan
[1] [2] Electronics and Telecommunications Dept., Goa College of Engineering, Farmagudi, Ponda Goa, India,
[3] Electrical and Instrumentation Dept., Met coke division, Vedanta Ltd. Amona Goa, India

***Abstract*— Most of the coke ovens plant has the manual schedule for pushing and charging sequence of the ovens. The manual schedule gives rise to several problems which affect the process time resulting in the decrease in the production. This paper presents the full automatic system for coke oven scheduling. Further, using this auto schedule battery machines can be made to work according to schedule leading to man-less operation of battery machines. The optimized auto schedule is created by process control system which uses plc logic based on the scheduling algorithm. This auto schedule system reduces all errors and all battery machines are made to work automatically using the schedule. This approach makes the system completely automatic in operation; which improves an efficiency of the plant and also reduces operator workload. Optimized auto pushing and charging schedule of coke ovens create the comfortable working environment.**

***Index Terms*—Battery Machine, Coke oven schedule, process control system, Programmable logic controller.**

I. INTRODUCTION

Coke oven battery includes battery machines along with the group of coke ovens. Charging of coal into the oven and discharging of coke from an oven is done by battery machines. The sequence in which ovens are discharged and charged again is scheduled by an engineer, which is done manually in most of the coke plants. The schedule is done on the computer and printed slips are given to operators. Though slips are given but later shuffling in the sequence is conveyed through verbal communication only. This verbal communication creates many errors which lead to increase in process time simultaneously affecting the production. This paper proposes optimized automatic pushing and charging schedule for coke ovens. Further, development of full automation of battery machines can be done using auto schedule since most of the commands are given by operators for charging and discharging function though they are highly automated. The work in this project is divided into two categories:1) optimized auto schedule and 2) automation of battery machines using the schedule. Section II describes basic coke oven battery charging and discharging function using manual schedule. Section III describes detection of coke oven number by the system using the PI sensor. Section IV describes the methodology, section V experimental results and finally, section VI covers conclusion.

II. BASIC COKE OVEN BATTERY SYSTEM

Coke oven battery involves carbonization process at the high temperature in an oxygen deficient atmosphere over an extended period of time. Charging and discharging of coke is done by battery machines, which include charge car, pusher car, and hot coke car. These machines are mobile and travel the length of the battery. Each car has a programmable logic controller (PLC) and human machine interface (HMI) for control and monitoring purpose. Process control system is a master control which is a distributed control system (DCS).

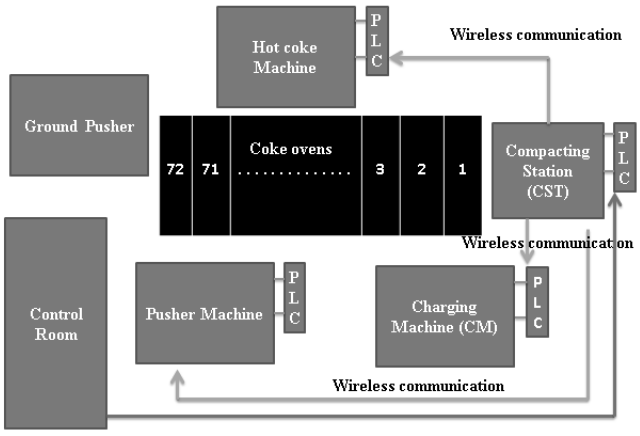


Figure 1: Basic coke oven Battery

PCS is much more than a traditional distributed control system. Communication between PCS and coordinating PLC is via profinet. Further, coordinating

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 4, April 2017

PLC is connected via the wireless system to all machine car PLCs. The wireless system is transparent radio system which behaves like normal Profibus cable. Master and slaves don't see the radio link. Since cars travel the entire battery on track, cable communication is not feasible so radio solution is chosen in coke plants [1] [2].
Coke oven schedule is an order in which coke ovens are discharged at the particular time and then charged again. When coal is charged into the oven, an oven takes approximately 47-48 hours to get ready. Industrial solution firms have developed a separate framework for automation which has different modules, out of which coke schedule is one of the module [4] [5]. Using this schedule battery machines are automated [3].

III. CHARGING FUNCTION

Charging function is charging of coal powder in the form of coal cake or direct powder into the oven. Coal is carried to the oven by charging machine. The oven doors are opened and closed by pusher car.

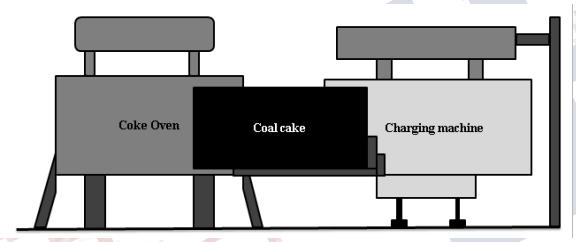


Figure 2: Charging Function

IV. DISCHARGING FUNCTION

The discharging function is discharging of coke from the oven. When coke is ready pusher car opens the oven door and pushes the entire ready coke into the hot coke car. Hot coke car is aligned at the same oven on the other side of the oven. It is ensured that hot coke car and pusher car are aligned properly at both sides of the oven before discharging function to avoid spillage of coke and hazardous accidents.

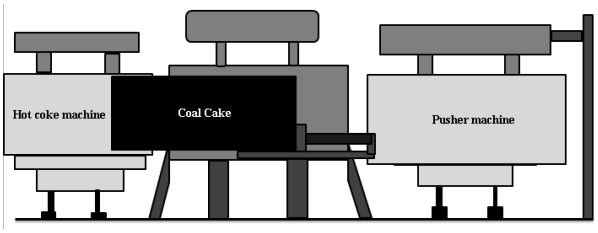


Figure 3: Discharging function

AUTOMATIC DETECTION OF COKE OVEN NUMBER

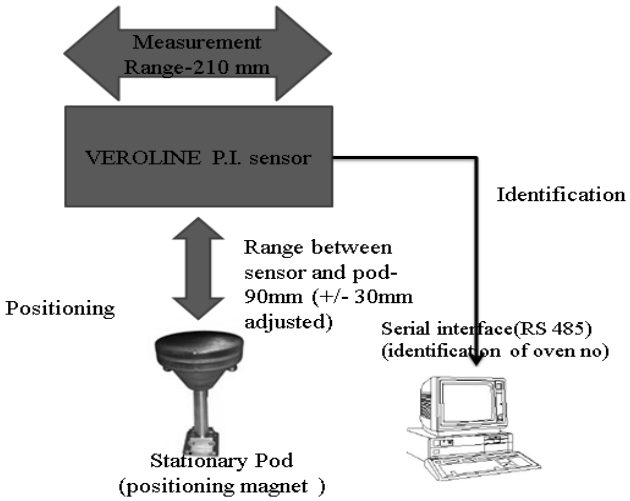


Figure 4: PI sensor

For the identification and positioning of coke oven sensors are used, which is called as Veroline® Positioning and Identification (PI) sensor. These sensors are pods (positioning magnet) which are located on track either in front of the oven or close to the oven. These pods have magnet and RFID tag inside which create the magnetic field when Veroline® sensor passes near to pod. The Veroline sensor is placed on the machine car. This has integrated reader which identifies coke oven number receiving 4-20 mA signals when the car passes near pod. The increase and decrease in signal value also depict the direction of the car.

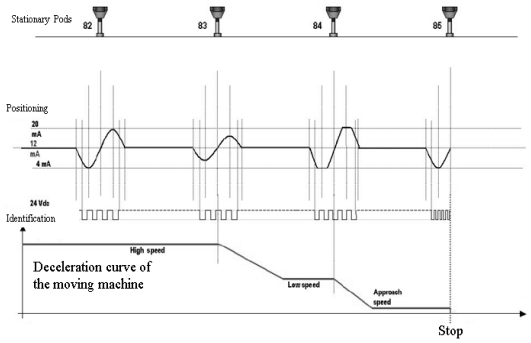


Figure 5: Deceleration curve of the car

ISSN (Online) 2394-6849

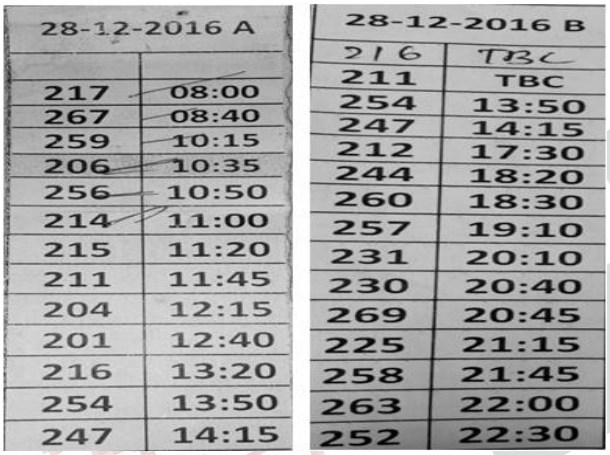
International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 4, April 2017

V. METHODOLOGY

Manual schedule creates following errors:

Wrong entry of oven number in the battery machine car by the operator. This can lead to pushing of the wrong oven, which causes spillage of coke and wastage of time. Hot coke car and pusher car alignment is different. If pusher car pushes the hot coke on the track it can cause the hazardous accident if any person is on the track.

Pushing of the same oven before oven gets ready. While making schedule if an engineer puts the same oven in the list which is already pushed in morning shift, the same oven can be pushed in the night shift causing spillage of coke.



28-12-2016 A

217	08:00
267	08:40
259	10:15
206	10:35
256	10:50
214	11:00
215	11:20
211	11:45
204	12:15
201	12:40
216	13:20
254	13:50
247	14:15

28-12-2016 B

216	TBC
211	TBC
254	13:50
247	14:15
212	17:30
244	18:20
260	18:30
257	19:10
231	20:10
230	20:40
269	20:45
225	21:15
258	21:45
263	22:00
252	22:30

Figure 6: Manual schedule

Above errors are removed by using automatic schedule. The auto schedule is schedule in which PCS system itself schedules the sequence of coke oven for pushing and charging of oven. For automatic schedule, PLC logic is written which uses the data from battery machine car. For scheduling the most important data are date and time which include the year, month, date, hour, minute, second and millisecond. Six data blocks are created in the PCS system. Data blocks are the memory location in PCS, which are accessed by functions in the logic. These data blocks hold the value of schedule date, schedule time, schedule delay, coke oven number, and coke oven tonnage. The most important data exchange between machine and PCS is:

Sending direction:

- Pushing oven number
- Pushing time

Receiving direction:

- Charging oven number
- Charging time
- Coke oven tonnage

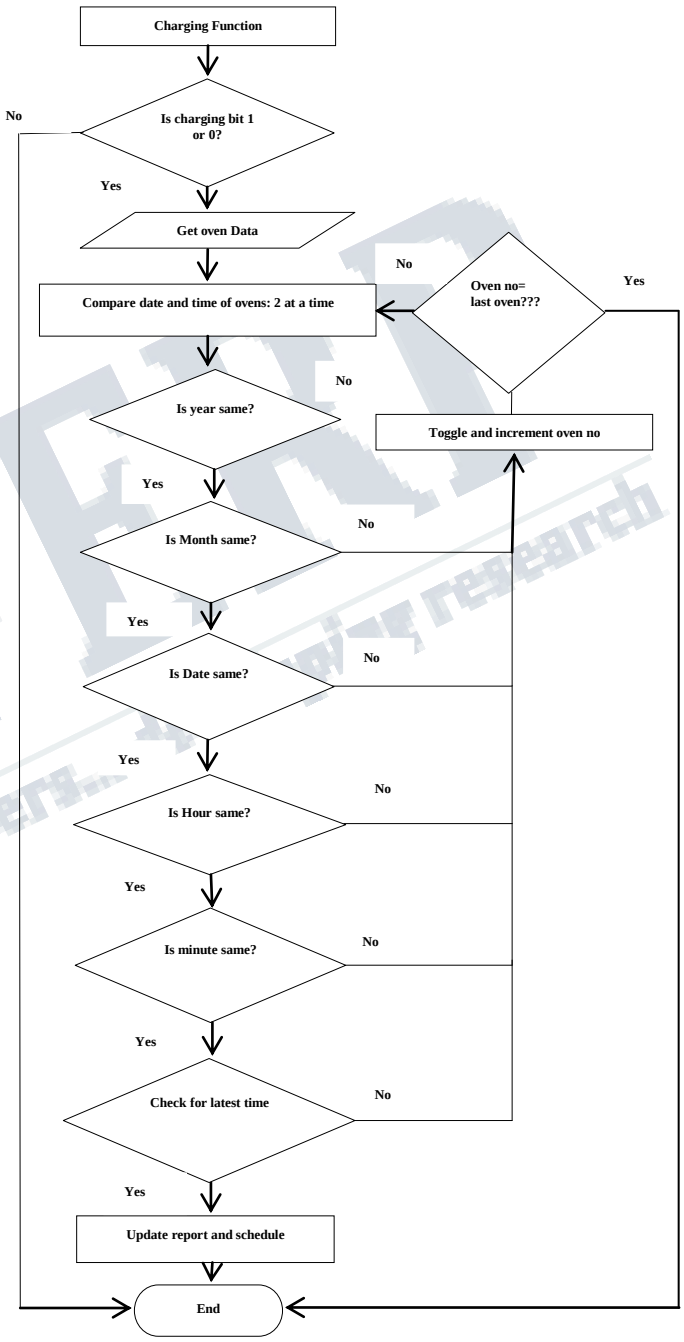


Figure 7: Scheduling Algorithm

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 4, April 2017

Figure7 shows the scheduling algorithm which works on the charging bit. When charge car charges the coke oven, the encoder produces a bit known as charging bit. When this charging bit is generated car PLC saves the time as charging time. This time is sent to PCS which saves it in the oven report. Since oven takes approximately 47-48 hours, scheduled delay added in the charging time is 48 hours. The addition of charging time and scheduled delay time gives the next pushing time of that particular oven. For the schedule which displays the coke oven numbers list in which oven which is due for pushing is first on the list and followed by next pushing ovens, comparison of the time of all ovens is done by the PCS system. PCS compares the time and date of the oven, two ovens at a time. This comparison is done for all ovens and the oven with the latest time is placed on top of the list. Similarly for the charging, when the oven is pushed that particular oven is sent to charge car for charging operation. For charging list the ovens which are charged latest are placed on top of the list, followed by previously charged ovens. Feasibility to change schedule delay is provided so that engineer can change delay according to the readiness of the oven. Also, provision to bypass oven from the schedule is provided so that oven can be bypassed from the schedule when the oven is under repair. Maximum days an oven takes for repair is 23 days, so separate logic is written which removes oven number from schedule using repair command. Once the oven is repaired it can be taken the schedule again using in circuit command.

Using this schedule the battery machine cars are automated which operates without operators. PCS sends the schedule to all PLCs of battery machines car and displays on the HMI screen. Interlocking is provided between al battery machine cars to operate in sequence. When the oven is supposed to push that particular oven number is flashes in the target oven area and the machine operates automatically pushing function. Similarly, charge car operates when it gets oven number which is due for charging.

VI. EXPERIMENTAL RESULTS

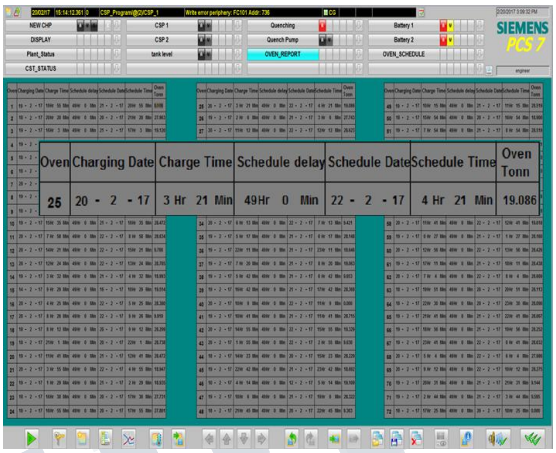


Figure 8: Oven Report

Figure 8 shows the main oven report in which shows data of all ovens in an ascending order of oven number. The report shows charging time, oven number, schedule delay, charging date, pushing time and pushing date of all ovens. Feasibility to change the schedule delay is provided so that engineer can change schedule delay according to the readiness of the oven.

Figure 9 shows schedule list and charging list. Schedule list displays the list of ovens which are ready for pushing along with the pushing time. Charging list shows the list of ovens which are recently charged along with the charging time.

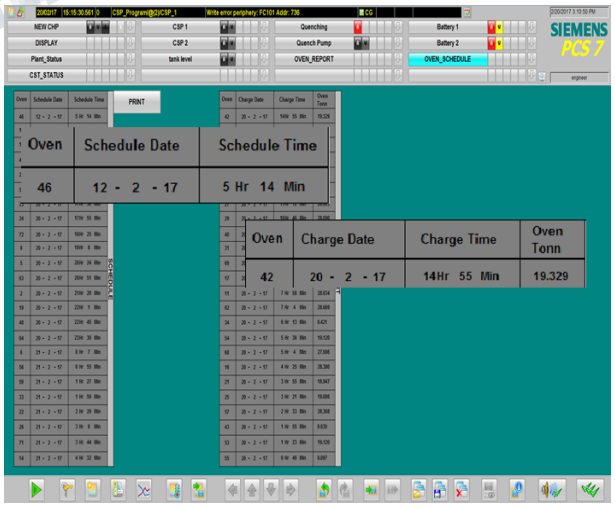


Figure 9: Pushing Schedule and Charging list

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
Vol 4, Issue 4, April 2017

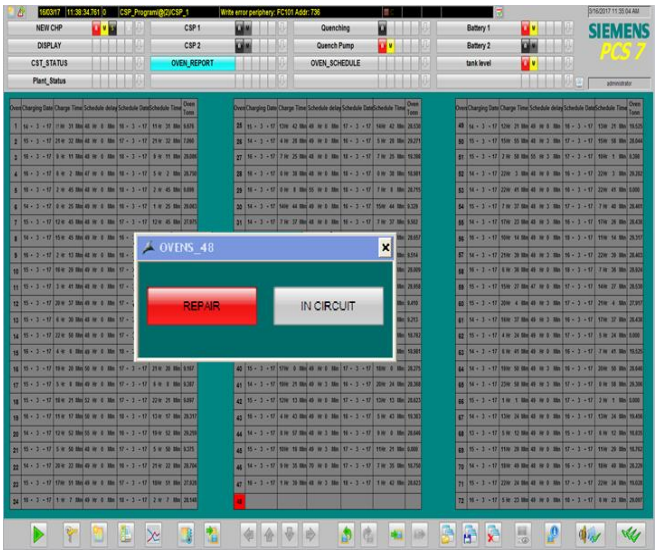


Figure 10: Oven Repair provision

Figure 10 shows provision provided for bypassing the oven from the schedule when the oven is under repair. Once the oven is repaired it can be taken in the schedule again using "IN CIRCUIT" command.

VII. CONCLUSION

New technique for development of automatic pushing and charging schedule is developed which reduces all the errors caused by manual schedule. Also using the schedule battery machines are automated completely for unmanned operation using the interlocking between the machines with coordinating PLC. This system increases the plant efficiency by reducing operator workload and also creates the comfortable working environment.

REFERENCES

1. D. Brent Strecker, "Wireless coke oven control and Data acquisition", Industry Applications Society Annual Meeting, Conference record of the 1994 IEEE, 1994, October,

2. James J. Tarasiewicz, Edward C. Nichols, "Coke oven Battery with Communication system", U.S. Patent 5600564,1997

3. Yoshimitsu Konno, Fujio Murkami, Ikuji Watanabe, Mitchitaka Sakaida, Yoji Nakagawa and Masao Matsunaga, "Development of coke oven Machine Automation Technology", Nippon Steel, Oita Japan Tech. Report no 69. (53-59), April 1996

4. Mr. Marcel Schulz (Author), Mr. Klaus-Peter Paul Leuchtmann, Mr. Jin Hyung Chung and Mr. Yong Mook Kang (Co-Authors), "Using Modern Coke Oven Technology at the new Hyundai Steel Coke Plant", Association for Iron and Steel Technology Conference 2015

5. Mr. Stephen Hlavach and Mr. Klaus-Peter Paul Leuchtmann (Authors), Mr. James Zelany and Mr. Marcel Schulz (Co-Authors), "Concept and Operating Results of a Higher level Automation system for the new C- Battery at the U. S. Steel Clairton Plant", Association for Iron and Steel Technology Conference Proceedings 2014.