Data Article

Dataset on the electrical energy consumption and its conservation in the cement manufacturing industry

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A R T I C L E   I N F O

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A B S T R A C T

The cement industry consumes huge amount of electrical energy than the other sectors. The higher percentage of the energy cost was found in its total cost of production. The available resources and environmental constraints are becoming increasingly severe because of the continuous development in the economy of the country. Therefore, the energy-saving and the reduction in the emission of gases in the cement industries have become one of the choices for the process development. The concept of energy-saving determines the realization of the national goals of energy conservation. Taking the reference of one of the cement industry in India (Emami Cement Ltd, Baloda Bazaar, Chhattisgarh) as the main focus, this paper investigates on the energy-saving by implementing the variable speed drives (VSD) along with the cooling fan and motor across the system. This report also analyses the energy-saving potential of the cement manufacturing industry by assuming some different scenarios. The data analysis show that the electrical energy-saving potential of the cement industry is 53.5% with VSD and 51.89% with the use of light-emitting diode (LED) instead of using metal halide (MH) ultraviolet source. Thus, the improvement in energy efficiency can reduce the emission of the carbon dioxide from fuel, use of electrical energy and consequently it has the potential of reducing the cost of the cement production unit.

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1. Data

The technology of variable speed has been applied to different types of industries. Herein, the cement factory (Emami Cement Limited, Baloda Bazaar, Chhattisgarh) has been using variable speed drives from 2017 for energy saving. At present, variable speed drives are used on the compartments of the clinker cooler, the panel of conveyors and mills, the panel of kiln main drive and the panel of the preheater fan, etc. Table 1 shows the data obtained after and before the installation of variable speed drive (VSD) across the different types of equipment in the given cement production unit for the saving of electrical energy.

Moreover, the halide lamps in the plant have been replaced with the LED lights. The LED technology is also helpful for minimizing the consumption of electrical energy and its effective utilization. Table 2 shows the power saving in the cement production unit after the installation of the LED light instead of a metal halide (MH) ultraviolet source in the cement industry.

The electrical energy-saving potential of the cement manufacturing industry has been found to be 53.5% after the installation of variable speed drives and 51.89% after using the light-emitting diode (LED) technology instead of using metal halide irradiation source.

2. Experimental design, materials and methods

The variable speed drives are electrically located at the motor, which acts as a power factor correction capacitor to the distribution system. The control strategies will be better for the motor drives as they are crucial and consume a significant portion of power in the cement manufacturing industry [1]. VSDs are helpful in the reduction of the consumed KW. There is an exponential reduction of consumed KW into the system. The affinity law assists in getting the idea of energy consumption with the variable speed of the motor. The general equation for the affinity law is written in the form as (Eq. (1)):

\[ \text{Consumption in KW}_{\text{reduction}} = (\text{speed}_{\text{reduction}})^3 \]  

(1)

For the financial justification and the calculation of the reduction in KW, the standard RPM of the motor with their varying KW and the existing running RPM after the installation of variable speed
Table 1
Data shows the variable speed drive energy saving in a cement manufacturing unit.

| S. No | Application                        | KW Rating of Motor | Standard RPM | Volt | Existing Running RPM | Running RPM | Power consumed KW (Considering Average rpm) | Power saved KW (Considering Average rpm) |
|-------|-----------------------------------|--------------------|--------------|------|----------------------|-------------|---------------------------------------------|------------------------------------------|
| 1.0 Panel Board 1 (Cooler Compartment) |                     |                    |              |      |                      | Min.       | Max.       | Average    | %          |                      |                          |                          |                          |
| 01    | Cooler Fan                        | 300                | 1500         | 415   | 1327.3               | 1335.2      | 1331.4                              | 0.89        | 209.8           | 90.2                  |                          |                          |                          |
| 02    | Cooler Fan                        | 225                | 1500         | 415   | 1363.8               | 1366.7      | 1365.9                              | 0.91        | 169.9           | 55.1                  |                          |                          |                          |
| 03    | Cooler Fan                        | 400                | 1500         | 415   | 1305.1               | 1336.1      | 1321.5                              | 0.88        | 273.5           | 126.5                 |                          |                          |                          |
| 04    | Cooler Fan                        | 355                | 1500         | 415   | 990.1                | 1063.4      | 1002.5                              | 0.67        | 106.0           | 249.0                 |                          |                          |                          |
| 05    | Cooler Fan                        | 425                | 1500         | 415   | 1365.3               | 1367.6      | 1366.2                              | 0.91        | 321.1           | 103.9                 |                          |                          |                          |
| 2.0 Panel Board 2 (Cooler Compartment) |                     |                    |              |      |                      | Min.       | Max.       | Average    | %          |                      |                          |                          |                          |
| 01    | Cooler Fan                        | 300                | 1500         | 415   | 1441.1               | 1442.7      | 1441.4                              | 0.96        | 266.2           | 33.8                  |                          |                          |                          |
| 02    | Cooler Fan                        | 225                | 1500         | 415   | 1336.8               | 1338.5      | 1337.1                              | 0.89        | 159.4           | 65.6                  |                          |                          |                          |
| 03    | Cooler Fan                        | 400                | 1500         | 415   | 1296.8               | 1327.3      | 1313.7                              | 0.88        | 268.7           | 131.3                 |                          |                          |                          |
| 04    | Cooler Fan                        | 330                | 1500         | 415   | 892.2                | 990.5       | 967.3                               | 0.64        | 88.5            | 241.5                 |                          |                          |                          |
| 05    | Cooler Fan                        | 250                | 1500         | 415   | 907.4                | 1108.7      | 1056.4                              | 0.70        | 87.3            | 162.7                 |                          |                          |                          |
| 06    | Primary Air Fan                   | 200                | 1500         | 415   | 846                  | 848         | 847.0                               | 0.56        | 36.0            | 164.0                 |                          |                          |                          |
| 07    | Primary Air Fan                   | 200                | 1500         | 415   | 802                  | 803         | 802.5                               | 0.54        | 30.6            | 169.4                 |                          |                          |                          |
| 3.0 Panel (415 VAC)                   |                     |                    |              |      |                      | Min.       | Max.       | Average    | %          |                      |                          |                          |                          |
| 01    | Apron Feeder                      | 90                 | 1500         | 415   | 1478.2               | 1482.4      | 1415.2                              | 0.94        | 75.6            | 14.4                  |                          |                          |                          |
| 02    | Wobbl er Feeder                   | 55                 | 1500         | 415   | 1430.5               | 1490.5      | 1457.8                              | 0.97        | 50.5            | 4.5                   |                          |                          |                          |
| 03    | Belt Conveyor                     | 132                | 1500         | 415   | 1030.1               | 1476.5      | 1043.7                              | 0.70        | 44.5            | 87.5                  |                          |                          |                          |
| 04    | Belt Conveyor                     | 200                | 1500         | 415   | 986.8                | 1494.1      | 1003.6                              | 0.67        | 59.9            | 140.1                 |                          |                          |                          |
| 05    | Belt Conveyor                     | 160                | 1500         | 415   | 1388                 | 1495.5      | 1418.5                              | 0.95        | 135.3           | 24.7                  |                          |                          |                          |
| 06    | Belt Conveyor                     | 15                 | 1500         | 415   | 1485                 | 1500        | 1490.0                              | 0.99        | 14.7            | 0.3                   |                          |                          |                          |
| 07    | Raw Mill Separator                | 355                | 1500         | 415   | 630.8                | 855.5       | 733.8                               | 0.49        | 41.6            | 313.4                 |                          |                          |                          |
| 08    | Coal Mill Classifier              | 75                 | 1500         | 415   | 790                  | 1165        | 840.6                               | 0.56        | 13.2            | 61.8                  |                          |                          |                          |
| 09    | Rotary Air Lock Classifier        | 11                 | 1500         | 415   | 1488                 | 1500        | 1495.0                              | 1.00        | 10.9            | 0.1                   |                          |                          |                          |
| 10    | Water Injection Pump for Raw Mill | 11                 | 1500         | 415   | 975                  | 1500        | 979.8                               | 0.65        | 3.1             | 7.9                   |                          |                          |                          |
| 11    | Rotary Air Lock Feeder for Cement Mill | 11 | 1500 | 415 | 1490 | 1500 | 1494.0 | 1.00 | 10.9 | 0.1 |
| 12    | Water Injection Pump for Cement Mill | 11 | 1500 | 415 | 810 | 1500 | 812.0 | 0.54 | 1.7 | 9.3 |
| 13    | Water Injection System for Coal Mill | 11 | 1500 | 415 | 460 | 1450 | 464.6 | 0.31 | 0.3 | 10.7 |
| 14    | Belt Conveyor                     | 315                | 1500         | 415   | 700                  | 911.6       | 701.3                               | 0.47        | 32.2            | 282.8                 |                          |                          |                          |

(continued on next page)
| S. No | Application              | KW Rating of Motor | Standard RPM | Volt | Existing Running RPM | Running RPM % | Power consumed KW (Considering Average rpm) | Power saved KW (Considering Average rpm) |
|-------|--------------------------|--------------------|--------------|------|----------------------|--------------|---------------------------------------------|------------------------------------------|
| 15    | Belt Conveyor            | 45                 | 1500         | 415  | 610 - 830 - 622.1    | 0.41         | 3.2 - 41.8                                 | 41.8                                    |
| 4.0 Panel (690 VAC) |                         |                    |              |      |                      |              |                                            |                                          |
| 1     | Cooler ESP Fan           | 670                | 750          | 690  | 335.7 - 545.1 - 517.8 | 0.69         | 220.5 - 449.5                              |                                          |
| 2     | Kiln Main Drive          | 1800               | 5.5          | 690  | 1.4 - 3.7 - 3.5      | 0.64         | 463.9 - 1336.1                             |                                          |
| 5.0 Panel (11 KV)  |                         |                    |              |      |                      |              |                                            |                                          |
| 1     | Pre-heater Fan           | 3400               | 1000         | 11   | 839.2 - 915.2 - 906.1 | 0.91         | 2529.3 - 870.7                             |                                          |
| 2     | Bag House Fan            | 2250               | 750          | 11   | 138.5 - 524.2 - 427.9 | 0.57         | 418.0 - 1832.0                             |                                          |
| TOTAL |                          |                    |              |      |                      |              |                                            | 6146.2 - 7080.8                           | 53.5%                                   |

Total % of power saved through variable speed drives
drives should be considered. The affinity law can calculate the consumed KW reduction using the observed values of the existing running RPM. Thus, it can be quickly identified how much power has been saved after the installation of variable speed drives. Much efforts have been continuously put for the reduction in the consumption of electrical energy in the cement sector. The increased consciousness towards the use of electrical power and it's conservation in this sector has contributed significantly to the electrical energy savings [2]. Also, the other way for electrical energy saving is the replacement of metal halide lamps in a cement production unit with LEDs. LEDs also consume less electricity compared to the metal halide lamps and save power.

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Conflict of Interest

The authors declare that they have no known competing for financial interests on personal relationships that could have appeared to influence the work reported in this paper.

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