An overview of energy savings measures for cement industries

N.A. Madlool\textsuperscript{a,c,n}, R. Saidur\textsuperscript{b,c}, N.A. Rahim\textsuperscript{c}, M. Kamalisarvestani\textsuperscript{b}

\textsuperscript{a} Department of Mechanical Engineering, University of Kufa, Faculty of Engineering, 21 Kufa-Najaf, Iraq
\textsuperscript{b} Department of Mechanical Engineering, University of Malaya, Faculty of Engineering, 50603 Kuala Lumpur, Malaysia
\textsuperscript{c} University of Malaya, UM Power Energy Dedicated Advanced Centre (UMPEDAC), Level 4, Wisma R&D UM, 59990 Kuala Lumpur, Malaysia

\textbf{A R T I C L E   I N F O}

Article history:
Received 13 April 2012
Received in revised form 24 October 2012
Accepted 27 October 2012
Available online 1 December 2012

Keywords:
Energy saving
Electrical saving
Emission reduction
Cement industry

\textbf{A B S T R A C T}

Due the advances in the industrial processes, in which the cement industry is a major contributor, energy consumption and greenhouse gas emission has increased significantly. This paper reviews previous studies on energy saving, carbon dioxide emission reductions and the various technologies used to improve the energy efficiency in the cement industry. Energy efficiency measures for raw materials preparation, clinker production, products and feedstock changes, general energy efficiency measures, and finish grinding have been surveyed. It was found that the largest recorded amounts of thermal energy savings, electrical energy savings and emission reductions to date are 3.4 GJ/t, 35 kW h/t and 212.54 kgCO\textsubscript{2}/t, respectively.

© 2012 Elsevier Ltd. All rights reserved.

\textbf{Contents}

1. Introduction ......................................................... 19
  1.1. Specific energy consumption.................................. 19
  1.2. Cement manufacturing process .............................. 20
2. Energy-efficiency measures for raw material preparation in cement industry ...................................... 22
  2.1. Efficient transport systems for raw materials preparation (dry process) ....................................... 22
  2.2. Raw meal blending (homogenizing) systems (dry process) ............................................................. 22
  2.3. Raw meal process control for vertical mills (dry process) .............................................................. 22
  2.4. Use of roller mills (dry process) ................................ 22
  2.5. High-efficiency classifiers/separators (dry process) .......................................................... 22
  2.6. Slurry blending and homogenizing (wet process) ........................................................... 23
  2.7. Wash mills with closed circuit classifier (wet process) .............................................................. 23
  2.8. Roller mills for fuel preparation .................................. 23
3. Energy-efficiency measures for clinker production in cement industry ................................................... 23
  3.1. Improved refractoriness for clinker making in all kilns .............................................................. 23
  3.2. Energy management and process control systems for clinker making in all kilns ............................ 23
  3.3. Adjustable speed drive for kiln fan for clinker making in all kilns ............................................... 23
  3.4. Fan modifications and optimization in all kilns ..................................................................... 23
  3.5. Installation or upgrading of a pre-heater to a pre-heater/precalciner kiln for clinker making in rotary kilns .......................................................... 23
  3.6. Conversion of long dry kilns to pre-heater/precalciner kilns for clinker making in rotary kilns ............ 23
  3.7. Dry process upgrade to multi-stage pre-heater kiln for clinker making in rotary kilns ...................... 24
  3.8. Increasing number of pre-heater stages in rotary kilns ........................................................... 24
  3.9. Conversion to reciprocating grate cooler for clinker making in rotary kiln ....................................... 24
  3.10. Kiln combustion system improvements ............................................................... 24

\textsuperscript{*}Corresponding author. Tel.: + 60 173 900 518.
E-mail address: dr.naseer1978@gmail.com (N.A. Madlool).

1364-0321/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rser.2012.10.046