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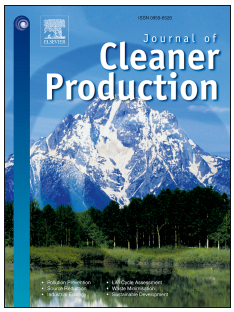

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PII: S0959-6526(14)00932-9

DOI: 10.1016/j.jclepro.2014.09.003

Reference: JCLP 4687

To appear in: *Journal of Cleaner Production*

Received Date: 30 April 2014

Revised Date: 21 August 2014

Accepted Date: 1 September 2014

Please cite this article as: Liu G, Yang Z, Chen B, Ulgiati S, Zhang J, Liu X, Zhang Y, Su M, A Comparative Emergy Analysis of Sewage Sludge Synergic Reduction and Reuse in Clinker Production towards Regional Eco-industrial Development, *Journal of Cleaner Production* (2014), doi: 10.1016/j.jclepro.2014.09.003.

A Comparative Emergy Analysis of Sewage Sludge Synergic Reduction and Reuse in Clinker Production towards Regional Eco-industrial Development

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ABSTRACT

The synergic treatment benefit of reducing the amount of raw material and fuel and its contribution to the GHG total emissions are of great interest for cement manufacturing. Additionally, it should be considered that the major sources of GHG in clinker production are CO_2 from the calcination of raw materials and CO_2 from fossil fuel combustion. Calcination CO_2 can be reduced by the substitution of raw materials with noncarbonated calcium sources. Taking into account its potential reduction effect, a comprehensive research in the use of sewage sludge as a raw material alternative in clinker production, is required and is likely to provide valuable improvement. An emergy analysis to evaluate the synergic reduction effect of urban sewage sludge use as alternative raw material or fuel in clinker production was carried out. The main steps of the synergic treatment process, namely (1) sewage sludge disposal, (2) transport of materials and (3) clinker production, were assessed by means of the emergy accounting approach. This evaluation aimed to assess the environmental resource demand in terms of equivalent solar energy, extending the energy quality hierarchy principle from ecosystems to eco-industrial process. The achievable synergic reduction effects, in terms of alternative raw material or fuel and recycling process, due to the different methods of sludge disposal, are analyzed in this study. The resulting unit emergy values of cement were compared with previous emergy assessments in order to

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