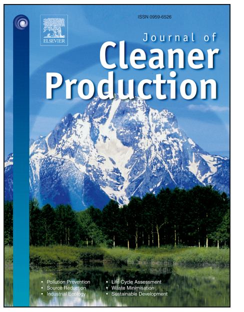

A design approach for multiple drive belt conveyors minimizing life cycle costs

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PII: S0959-6526(18)32373-4

DOI: 10.1016/j.jclepro.2018.08.040

Reference: JCLP 13824

To appear in: *Journal of Cleaner Production*

Received Date: 2 February 2018

Revised Date: 2 August 2018

Accepted Date: 4 August 2018

A design approach for multiple drive belt conveyors minimizing life cycle costs

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Abstract

Energy efficiency of belt conveyors has recently gained in importance worldwide. While significant research efforts were consecrated to the operational aspects, the literature study shows the design optimization problem was scarcely investigated in the past. Among the various type of belt conveyors, the multi-drive technology is now increasingly acknowledged as involving further cost saving opportunities as a result of the possible reduction of the belt weight. In this paper, a multi-drive belt conveyor sizing model that aims to minimize the life cycle cost of the conveyor is presented. The effectiveness of the proposed approach in improving their economic benefits over the single-drive conveyors has been established through extensive simulations on a practical case study. The robustness of the best design solution against the variation in the inflation rate have been also validated.

Keywords: Belt conveyor, life cycle cost, multiple drive, optimal design, component sizing, energy management.

1. Introduction

Energy shortage is a major concern to many countries around the world. With 83% of electricity generated by coal-fired power plants [1], statistics from the largest South African energy company, Eskom, indicated that while the entire mining sector consumed 15% of its annual electricity supply, approximately 23% of this consumption was used for material transportation purposes only [2]. Amongst the existing technologies, belt conveyors are largely used for bulk material transfer over short and medium distances because of their low energy consumption per tonne of material transported in comparison to other alternatives [3, 4, 5]. A significant number of belt conveyors are, however, either oversized or inadequately operated, resulting in poor energy efficiency and economic performances [6, 3, 7]. As a result, any improvement in energy efficiency achieved at the design or operation stage of a conveyor can reduce its capital investment and/or operating expenditures.

Generally, energy efficiency activities can be clustered into four categories, namely initiatives focusing on technology, operation, equipment, and performance efficiencies [8, 9, 10]. With indicators such as feasibility, life cycle cost, and return on investment, technology efficiency refers to the efficiencies of energy conversion, processing, transmission, and usage. Equipment efficiency is a measure of the energy output of isolated individual equipment with respect to given technology design specifications. Typical indicators include capacity and maintenance. Operation efficiency focuses on the degree of coordination of the different components of an energy system. Physical coordination, time coordination and human coordination are the indicators usually considered at this level. Performance efficiency is a measure of the global efficiency of the energy system, and is evaluated by external but deterministic indicators such as the production, cost, and environmental footprint. Readers interested in more detailed definitions of technology, operation, equipment, and performance efficiencies are referred to reference [8].

Findings from the literature indicate that most of the previous efforts to improve belt conveyor's energy efficiency were done at the equipment level, operation level, and technology level. Equipment efficiency

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