A MILP model for truck-shovel scheduling to minimize fuel consumption

D.M. Bajany*, X. Xia, L. Zhang

Department of Electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria 0002, South Africa

Abstract

This paper presents an optimization model, in which fuel consumption of dump trucks and shovels is minimised while the handling demand of dump sites are met in the case of an under-trucked open-pit mine. The model is build using an m-trucks-for-n-shovels dispatching strategy so that a truck could be allocated to different shovels during a shift. The performance of the optimal energy dispatching model was compared to the fixed dispatch method that is still being used in certain mines. The results show that the average litre of fuel consumption per tonne of mineral transported by trucks and that for the truck-shovel system are reduced by 8.82% and 4.49%, respectively. This further leads to a 4.64% fuel savings.

© 2016 The Authors. Published by Elsevier Ltd. Selection and/or peer-review under responsibility of ICAE

Keywords: Truck-shovel dispatch system, fuel minimization,

1. Introduction

It has been estimated that transportation cost of materials in open-pit mines represents up to 60% of the total mining costs and 32% of the total energy used in mines is consumed by the haulage operations[1-2]. The capital and the annual operating cost of a dump truck has been estimated to be 1.6 million dollars for a typical oil sand mine [3]. For this reason, a marginal improvement in the efficiency of the truck-shovel dispatching system in open-pit mines will result in a noticeably cost savings.

Nomenclature

\begin{itemize}
  \item \( y \) \quad Truck index
  \item \( i \) \quad Unloading point index
  \item \( j \) \quad Shovel index
  \item \( N_y \) \quad Fleet size of trucks
  \item \( N_i \) \quad Number of unloading points
  \item \( N_j \) \quad Number of shovels
\end{itemize}

* Corresponding author. Tel.: +27786299581; fax: +27123625000

E-mail address: dannybajany@gmail.com
Improving the energy efficiency of the truck-shovel dispatching system in an open-pit mine is an old hot topic which is still relevant. To this end, several heuristic methods have been presented in the literature. Three strategies were used for assigning a truck to the right shovel, namely the 1-truck-for-n-shovels, the m-trucks-for-1-shovel and the m-trucks-for-n-shovels strategies [4]. However, the work done so far does not minimise simultaneously the fuel consumption of both trucks and shovels.

In this study the m-trucks-for-n-shovels dispatching strategy is formulated as a mixed integer linear programing (MILP) model which optimizes route choice and minimizes the fuel consumption of both trucks and shovels with respect to the production goal in the case of an under-trucked mine. The advantage of the proposed MILP model is that technical specifications of equipment are considered so that this model could be used in homogeneous and heterogeneous fleets. Indeed, any difference in transportation capacities of trucks and in shovel capacities involve different power and traction of trucks, as well as the inter-trucks time variation during a fixed period of time. In the case of an under-truck mine, the inter-truck time variation influences the utilisation time of shovels therefore their fuel consumptions. Beside this, the loading time of a truck is directly depending on his capacity and the shovel capacity, thereupon the fuel consumption of a truck when loaded is function of the loader capacity. For this raison, in the case of a heterogeneous fleet, technical specifications of equipment must be taken into account for any optimisation problem of haulage operations in open-pit mines. Optimizing route choice, reduce vehicle emissions and contributes to air quality improvement [5].

2. Truck-Shovel dispatching problem

Fig.1 displays a generic open pit mine which has N_i unloading points, N_j shovels and N_i × N_j transport routes. During each shift, empty trucks located at unloading points are assigned to shovels and those who
دریافت فوری متن کامل مقاله

✅ امکان دانلود نسخه تمام متن مقالات انگلیسی
✅ امکان دانلود نسخه ترجمه شده مقالات
✅ پذیرش سفارش ترجمه تخصصی
✅ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
✅ امکان دانلود رایگان ۲ صفحه اول هر مقاله
✅ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
✅ دانلود فوری مقاله پس از پرداخت آنلاین
✅ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات