New Design of Quarry Gravitricity

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Abstract

The consumption of electric energy in open pit mines or quarries maybe can achieve the consumption of all inhabitants of a city which it is according to their size and production of ore. In the other hand, View that the demand crescent of energy electric in the world, the limits of energetic resources in the third world, the increase of prizes operation and the maintenance of classic energy, the environmen
tal consequences of classic energy and the benefic for using the autonomy system for production of electricity incites for searching the other sources responds the demands. To do this, we propose in this work a system equipped by generator for the creation of electrical energy resulting from the traffic of trucks in open pit mines whom situated in mountainous reliefs as knows a new kind of gravitricity.

Keywords: gravitricity, sustainable development, renewable energy, open pit mining design, quarry, truck

1. Introduction

Much of electrical energy used by humanity comes from fossil fuels. According to the international energy agency, its conventional resources represent 80.4% of global energy produc
tion, they are responsible for 40% of global emissions of CO2 [1]. In the context of sustainable development, in the face of the double global challenge posed by the risks of scarcity of fossil fuels and their effects on climate change, governments committed to the Kyoto Protocol must therefore multiply their actions in the energy production sector. In order to develop renew able, clean and inexhaustible sources of energy, the latter represent a considerable deposit at the global level [2].

The development and exploitation of renewable energies has grown strongly in recent years. From here and in the future, any sustainable energy system will be based on the rational use of traditional sources and increased use of renewable energies, for which purpose several research projects have been launched in several research laboratories in the field of sustainable development, in order to satisfy the demand for energy consumption on the one hand and on the other hand to reduce the negative effects of fossil resources on the environment [3].

Ore deposits close to the surface are generally developed by open pit mining. Due to the hardness of the rock, mining is usually carried out by means of drilling and blasting. Large excavators load the material directly onto big trucks which convey the uncrushed rock from the mine. Most of the rock is overburden which is transported to one or several dumps close to the mine. On the other hand, the ore is driven to a crusher close to the processing plant. Apart from the simple way the uncrushed material is handled, this form of convey
erance has the advantage of the trucks being able to be flexibly driven to the varying loading points and to be tipped at diverse points depending on actual requirements [4].

In the case where the quarry is situated in mountainous terrain, blasted rock is transported from benches in top to the crushing station at the bottom. Therefore, our work is to produce electricity from truck traffic in quarry. On the oth-
are built according to the rotation of blade, so all of them form an arc. The batteries of energy storage is put in order to avoid the cut of electricity in the case where the blade stops for the embarkation or the descent of the truck from platform of system. Also an electricity regulation inverter is installed before dedicating electrical energy to the users.

For best understanding of this new kind of gravitricity system, we can take an example for more explanation.

We have the gravity \( g = 9.81 \text{ m/s}^2 \). We have the mass of loaded truck \( m = 60000 \text{ Kg} \), with a high \( H = 30 \text{ m} \).

So, for calculation of power created from generator, we must in begin calculate the power generated from free fall of mass. This latest is lowering to inferior bench in open pit mining; its free fall will take a time as follow:

\[
\begin{align*}
\tau &= \sqrt{\frac{H}{g \cos \beta}} = \sqrt{\left(\frac{30}{9.81 \cos 50}\right)} = 2.18 \text{ s}.
\end{align*}
\]

\( \beta = \) it is the inclination of moving of platform loaded by truck with a certain angle (fig.03); 

we have the law of power \( P \):

\[
P = c \cdot \omega, \text{ Kw}.
\]

\( c \): torque; \( \text{Nm} \).
\( c = F \cdot \cos \beta \cdot L = 60000 \cdot 9.81 \cdot \cos 50 \cdot 30 = 1130120 \text{ Nm} \)
\( \omega = v / L; \text{ rad/sec} \)

So the speed of mass in free fall \( v \) is:

\[
\begin{align*}
v &= \frac{H}{\tau} = \frac{30}{2.18} = 13.76 \text{ m/s}.
\end{align*}
\]

\( \omega = 13.76/30 = 0.45 \text{ rad/sec} \)

The best speed of platform loaded by truck when it is lowering is \( v = 0.4 \text{ m/s} \), this latest is according to cadence of mine production (time of cycle of trucks to carry out the planned production)

\( L \): length of blade (fig.04) \( L = 30 \text{ m} \).

Now we can calculate the total power as follows:

\[
\begin{align*}
Pt &= 1130120 \cdot 0.45 \cdot (1-0.3) = 3559852.8 \text{ w} = 3559.85 \text{ Kw}
\end{align*}
\]

We can consider the ratio of friction of generator and multiplier wearing of resistance is assimilated for 30 percent from total power (according to system of hydraulic energy). Therefore, the value (1–0.3) represents the yield of system.

If we want to minimize this linear speed from 13.76 \( \text{m/s} \) to 0.4 \( \text{m/s} \), we must slow down the free fall with a retarding force, for doing this, it is necessary to put multiplier as shown in fig.02, which is records also with a generator. The forces of resistance of this generator equal a retarding force which let the speed minimize to 0.4 \( \text{m/s} \).

Than; the lost power \( PL \) in the movement of mass when the speed \( v = 0.4 \text{ m/s} \) is as follows.

\[
\begin{align*}
t &= \frac{H}{v} = \frac{30}{0.4} = 75 \text{ s},
\end{align*}
\]

So; the acceleration is:

\[
a = \frac{30}{(75)^2} = 0.0053 \text{ m/s}^2
\]

The angular speed: \( \omega = v / r = 0.4 / 30 = 0.013 \text{ rad/sec} \)

\[
c = F \cdot \cos \beta \cdot L = 60000 \cdot 0.0053 \cdot \cos 50 \cdot 30 = 6105.6 \text{ Nm}
\]

\[
PL = 6105.6 \cdot 0.013 = 79.37 \text{ w} = 0.0079 \text{ Kw}.
\]

The subtraction of this two powers given the power energy generated \( Pg \) from the generator whom represents the retarding power which cited above.

\[
Pg = PL - Pt = 3559.85 - 0.0079 = 3559.84 \text{ Kw}.
\]

Electric energy generated from a generator during one hour:

If we analyze the electricity production of the generator, we should put into consideration all times of movement of trucks, so we have:

- Time of riding of truck into platform. \( Tr \)
- Time of lowering of truck. \( Tl \)
- Time of descend of truck. \( Td \)

In all of these times cited above, we find only the time of lowering of truck whom can product energy from its moving, but other timeout the system is stopping and there is no energy created. So from the example taken above we can calculate the energy created from the generator in one hour.

In general, in the mine, the trucks take 10 seconds to ride or descent from the balance to measure their weights.

\( Tr = Tr + Tl + Tr = 10 + 75 + 10 = 95 \text{ sec} \)

\( Tr \) time of energy product.

\( Tl + Td = 5 + 5 = 10 \text{ sec} \)

The timeout \( Tl + Td \) is 10 second

In one hour the movement of system is 154 rotations (3600 / 23.33 = 154.3 )

To know the timeout in one hour \( Toh = 154*10 = 1540 \text{ second} \)
So the time of energy product is $154 \times 13.33 = 2052.82 \text{ second}$.

We have the power of generator installed is 3559.77 Kw but it work 2052.82 second in one hour, so the generator can product $2029 \text{ Kw/h} \left( \frac{2052.82 \times 3559.77}{3600} \right) = 2029 \text{ Kw/h}$.

The electric energy created by the generator connects to the batteries for stock it to provide the continuous of this energy for users without interruption and to transform it from the direct to alternating current, we must use inverters corresponding the power of energy created.

As the study of SIEMAG TECBERG, the advantage lies in the transport time being curtailed by the difference in height being rapidly overcome. While the trucks move upwards at less than 3 m/s on a slope of 10% at the maximum, a slope hoisting plant can overcome the mine's natural angle of repose of over even 50° at 8 m/s. This means that a truck is hoisted to surface in only 2 minutes while driving on the haul road incline takes some 20 minutes (from 300 m depth, time for driving on and off the TruckLift platform included). Whereas one vehicle is on the slope with the TruckLift plant at one time, conventional haulage requires a large number of trucks only on the inclined part of the road for achieving the same transport volume. Thus, the truck fleet can correspondingly be reduced. Comparing the costs by the present value method using an interest rate of 10% on future costs and considering an annual price increase of 3%, investing in a slope hoisting plant usually pays off within less than five years. During a plant's running time of 20 years, a volume of up to 60% can be saved with regard to gradient transport (fig.05).

3. Conclusions

The study requires more details on the performance of this new kind of gravitricity to know its feasibility. Therefore, several factors influence the realization of this system such as: the shape of the deposit, the method of exploitation, the mode of opening. On the other hand, there is a chain of correspondence of many trucks and their capacities of dumps, also the planned production and all that to avoid the cut of blade rotation which will influence on the production of electrical energy.
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Nowe spojrzenie na odzysk energii w kopalni odkrywkowej

Zużycie energii elektrycznej w kopalniach odkrywkowych lub kamieniołomach może osiągnąć poziom zużycia energii w mieście, zużycie energii w kopalni zależy od rodzaju kopaliny i wielkości wydobycia. Przedstawiono zmiany popytu na energię elektryczną na świecie, ograniczenia zasobów energetycznych w Trzecim Świecie, proporcje udziału energii konwencjonalnej, konsekwencje środowiskowe wykorzystania energii oraz korzyści z wykorzystania z systemu autonomicznego produkcji energii elektrycznej. Wszystko to zachęca do poszukiwania alternatywnych źródeł energii. Autorzy zaproponowali w pracy system wyposażony w generator energii elektrycznej bazujący na odzysku energii z przemieszczania się ciężarówek w kopalniach odkrywkowych.

Słowa kluczowe: odzysk energii, zrównoważony rozwój, energia odnawialna, projektowanie kopalni odkrywkowych, kamieniołom, ciężarówka