Optimization of rock disintegration using the acoustic signal

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Optimalizácia rozpojovania hornín použitím akustického signálu

Rock disintegration is one of the most important operations of mineral resources excavation and treatment technologies. This paper deals with a possibility of rock drilling optimization by acoustic signal. During the disintegration process, the thrust of the drilling tool, revolutions, drilling speed and disintegration power have been monitored. Within the co-operation with the Department of Applied Informatics and Process Control of the BERG Faculty of Technical University Kosice, a system for noise monitoring during the rock disintegration has been designed and mounted. This paper analyses experiment results for disintegration process optimization with use of acoustic signal.

Key words: *optimization, drilling, acoustic signal*

The Figure 1 shows a plot representing the dependence of the working capability of drilling tool on the pressure at various modes of separation of andesite and its dependence on thrust. Based on this plot we can determine the value of φ and mutually compare individual working modes of the trial stand at equivalent revolutions and various pressures. It has been observed that there is an evident increase of equivalent sound level in the 1000 Hz band when drilling at various revolutions. Let us denote this octave band as frequency f = 1000 Hz and as representative one in andesite drilling. Then the optimal mode of rock separation (φ maximum) will be at such thrust and revolutions where the equivalent sound level reaches the maximum value.

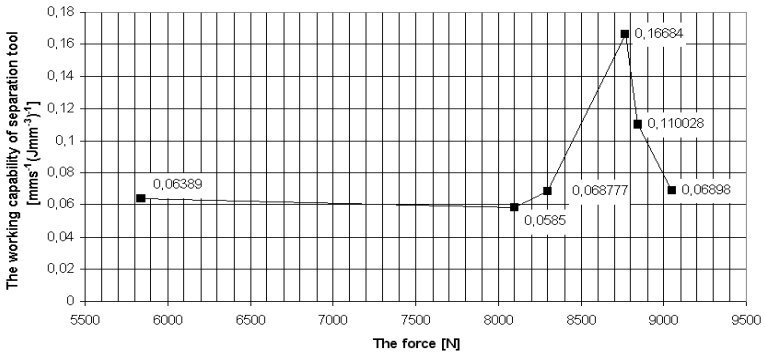

Fig.1. The dependence of the working capa–bility of drilling tool on the thrust at various drilling modes of andesite.

For the purpose of optimization, the representative frequency can be extended to the frequency band

$$f \in \left\langle f_{d1}, f_{u1} \right\rangle \qquad (1)$$

which in this case will be f_{d1}=1000Hz and f_{u1}=4000 Hz.

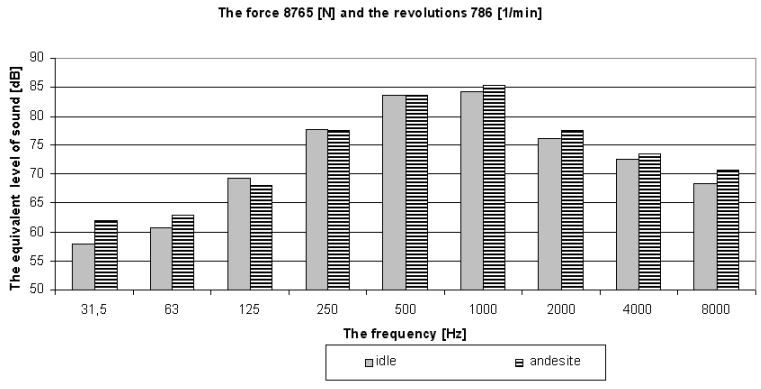

Fig.2. The comparison of equivalent levels of sound at various frequencies in idle run and during the andesite disintegration.

In Figures 2 to 4 the plots show the change of equivalent sound level at idle mode and equivalent revolutions in andesite drilling. Their common characteristic is a steady increase of the equivalent sound level in the 1000 Hz band. Dramatic increase of the equivalent sound level for all modes occurs in 2000 to 4000 Hz bands.

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The Figures 2 to 4 compare the L_{Aeq} for different thrusts, revolutions of the stand and various values of the optimization criterion φ corresponding to them. Let us emphasize that the darker is the column colour, the higher is the value of the φ-criterion. The darkest colour of the columns is in the plot at Figure 2. This means that this mode has the maximum value of φ, i.e. it is optimal. When comparing Figures 2, 3 and 4, the characteristic of the optimal control is as follows: "*To achieve the minimum difference between the equivalent sound level at the load and idle modes only at the representative frequency (f= 1000 Hz)".*

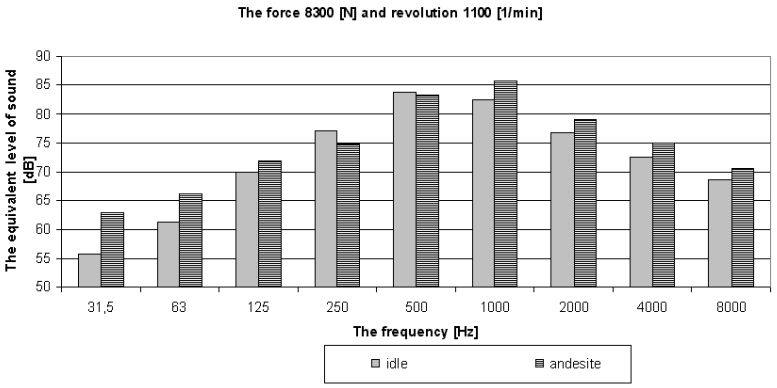

Fig.3. The comparison of equivalent levels of sound at various frequencies in idle run and during the andesite disintegration.

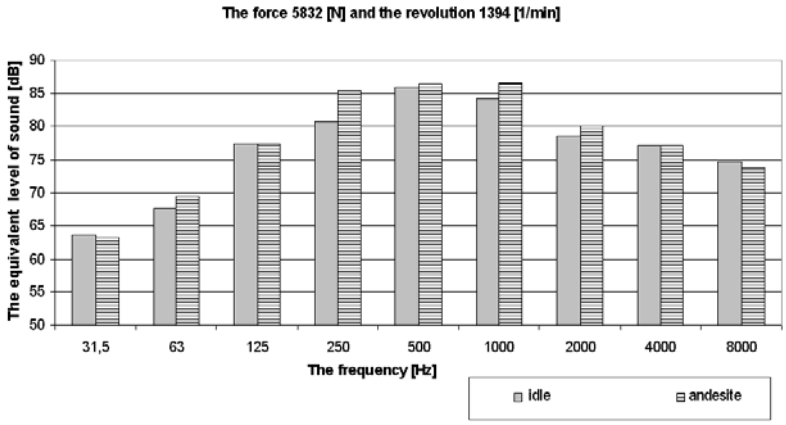

Fig.4. The comparison of equivalent levels of sound at various frequencies in idle run and during the andesite disintegration.

The optimal regime may be determined by the following algorithm.

1. To determine the equivalent sound level at idle mode of drilling machine
2. To determine the equivalent sound level during rock disintegration
3. The finding of the equivalent sound level $L_{A,eq}$ by changing of drilling regime

a) If the difference of $L_{A,eq}$ between first and second step is increasing then the input drilling conditions need to be changed

b) If the difference of $L_{A,eq}$ between first and second step is decreasing then continue according the second step

4. The third step will be repeated until the required accuracy is achieved.

Conclusions

Experimental measurements have shown the possibilities of utilizing the acoustic signals for optimal control of the drilling machine. Results of research in this field were used for the formation of optimal control algorithm. This algorithm was verified in laboratory conditions. The equivalent level for representative frequency depends also on the rock types. Therefore $L_{A,eq}$ can be used for identification of the rock type.

Acknowledgements

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