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A smart look at monitoring while drilling (MWD) and optimizing using acoustic emission technique (AET)

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Monitoring while drilling (MWD) is a crucial task in mining operations. Accurately measuring drill and rock-related operating parameters can significantly reduce the cost of drilling operations. This study explores the potential of monitoring drilling specific energy (SE) and optimizing drilling operations by processing vibroacoustic signals generated while drilling. For this purpose, 30 samples of different rocks, are used for drilling tests. During the drilling process, the acoustic and vibration signals are recorded and analyzed in the time, frequency, and time–frequency domains., and parameters related to the resulting spectra are extracted. After obtaining the vibroacoustic parameters for drilling, the relationship between them and the drilling SE was investigated. There is evidence that the progression of SE contributes to the magnitude of rock drilling vibroacoustic features, which could be employed to indicate energy conditions during drilling. Results obtained in this study have the potential to be used as the basis for an industrial monitoring system that can detect excessive energy consumption and advise the user of the end of the bit's useful life. This method can be an intelligent technique for measuring the behavior of real-time drilling operations based on the SE simply by installing vibroacoustic sensors on the drilling machines.

Keywords Rock drilling, Specific energy (SE), Acoustic emission technique (AET), Acoustic and vibration signals, Real-time monitoring

Drilling operation is one of the most critical and expensive parts of exploration, extraction, and production of minerals, oil, and gas. More than 25–35% of mining operation costs are related to drilling. Various factors influence drilling costs, including deep excavations, complex drilling designs, extensive exploration operations, and complex geological conditions. Therefore, assessing drilling performance should be included in the feasibility and economic analysis of any project[1–4]. Drilling is a complex process with various factors that affect its performance[5–7]. The parameters affecting the drilling operation include three general categories of parameters related to the drilling machine and cutting tool, rock properties, and operational or technical parameters[8,9]. The combination of various parameters can significantly impact the performance of drilling operations. However, predicting and evaluating the outcomes of such complex conditions often becomes challenging. Therefore, it is essential to have a comprehensive method or an indicator that can accurately measure the impact of these factors or monitor the operation without disrupting the ongoing operation. Such a method can be highly beneficial in monitoring and optimizing the drilling process.

Basically, monitoring of drilling condition avoids unexpected changes, reduces energy consumption, and eventually reduces production costs and labor[10,11]. Cost and energy optimization and productivity became the main purpose in operation monitoring[12]. Based on field experience, there are many ways to optimize drilling operations and reduce costs[13]. One of these methods is the optimization of drilling parameters to achieve minimum Specific Energy (SE).

The SE is a useful tool to determine whether a system is operating efficiently or not. When a drill bit is functioning at its highest efficiency, the energy-to-rock volume ratio stays relatively constant[14]. This relationship is used in drilling operations to determine whether SE changes while adjusting different drilling parameters such as WOB (Weight on Bit) or rotational speed. If the SE remains constant while increasing the WOB, the bit is still efficient. However, if the SE increases significantly, the bit needs to be replaced[15,16]. This helps drillers to determine

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