Optimization of the Auxiliary Fan Installation in Large-Opening Room-–and–Pillar Underground Limestone Mines
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Abstract

Due to the large cross-sectional airways developed in local limestone mines, most of the working sites are entirely dependent upon the auxiliary ventilation system. For this purpose, high-capacity axial-flow fans are commonly employed with tubings to supply fresh air to the working area. However, several problems with this type of fan-with-tubing auxiliary ventilation system are observed to be significant and closely associated with the poor ventilation efficiency experienced in almost all mines. To name a few, the inefficiency of high-capacity fans, poor management of fan and tubings and improper location of the system are those. However, it is challenging to optimize the auxiliary ventilation system for large-opening airways since the mine ventilation system is not properly implemented along with the production plan.

In this study, a different type of low-capacity fan, propeller fan, and a fan-without-tubing ventilation scheme are discussed by the empirical and CFD analysis, while fan locations are optimized with respect to longitudinal intervals and cross-sectional position. Propeller fan is an axial-flow and relatively large-diameter fans and is operated at low rpm, while it can generate lower static pressure but higher flow rate compared to the fans currently installed in underground mines. Due to its different operating characteristics, a 15-KW propeller fan with a diameter of 1.6m is found to be much more efficient than the popular axial-flow fan with the same capacity. Since the jet stream discharged from the auxiliary fan is flowing faster than 15 m/s in most of the cases, the stream collided with floor, sides or roof is likely to lose large portion of its inertial force and then its ventilation efficiency drops considerably. Therefore, the optimal fan installation interval is defined in this study as an interval which maximizes the uninterrupted flowing distance of the jet stream, while the optimal cross-sectional position can be optimized to minimize the chance of the inertial impaction with the airway sides. Consequently, the optimization of the fan location will improve ventilation efficiency and subsequently the ventilation energy cost. The ultimate goal of this study is to find a low-cost and high-efficiency auxiliary ventilation system in the local large-opening mines.

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