

# Ventilation Surveying and Modeling of Longwall Bleeder and Gob Areas

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**ABSTRACT:** Longwall bleeder and gob areas have long been one of the most challenging and uncertain areas in a ventilation model. There is a tendency to “black box” the bleeder and gob areas in a model, however this can lead to problems when examining the addition of contaminants in the air stream as they pass through these undefined areas. Additionally, the interaction between the bleeders and the gob is important to understand when attempting to control gas concentration at bleeder evaluation and mixing points. This paper discusses several experiences and common problems encountered with developing an accurate model to represent bleeder and gob areas. Common techniques used to quantify the bleeder systems and the shortcomings associated with these techniques are also discussed.

## 1 INTRODUCTION

In establishing a ventilation network model of a longwall coal mine, it is natural to place a high emphasis on the modeling of the measurable main airways. These areas include main intake and returns, belt lines and the headgate, longwall face, and tailgate. Areas difficult to quantify, such as the gob and bleeder systems, are often modeled simplistically. However, these areas of the mine can be a critical component of the overall ventilation system. An inaccurately modeled bleeder system can result in under or overestimating the bleeder efficiency. This in turn may result in an unreliable base model.

During a typical coal mine ventilation survey only a few hours are devoted to gathering measurements in bleeder areas. This is due to the natural tendency to place more focus on the higher profile outby areas that have a greater impact on the accuracy of the resulting model. However, it is the bleeder and gob ventilation that may directly control the effectiveness of the ventilation system.

To insure contaminant levels fall below legal limits, the airflow through the bleeders are monitored for gas content. When these limits are reached, more air must circulate through these areas to dilute the contaminants in order to achieve acceptable levels. If a ventilation model accurately portrays the bleeder and gob areas, then it may be used with confidence to determine the proper ventilation settings required throughout the mine. Therefore, accurate measurements need to be taken in these areas to adequately represent them in a network model.

There are two approaches to ventilating gob areas. The first approach is to create a high differential pressure across the gob region in order to induce airflow through the gob. In doing this, the gas can be drawn out of the gob and removed from the system through the bleeder. The second approach is to maintain a low differential pressure across the gob region in efforts to draw little or no air through the gob and into the bleeder. Each approach has different pros and cons as well as different surveying and modeling techniques.

## 2 BLEEDER SURVEYS

To model a bleeder system the frictional pressure drop along the airways and the airflow quantities need to be determined through out the bleeder system for both ventilation approaches, Figure 1 shows a simplified schematic of a high differential pressure bleeder system. This type of system actively draws air up the headgate and through the semi caved tailgate (three entry system), abandoned gate road entries and the gob. A traditional gauge and tube type ventilation survey can be used to determine the differential pressure around the bleeder areas provided access is not limited by ground conditions. Due to the high quantities of air entering the bleeder at points “C”, “D” and “E” it may be sufficient to only take measurements in the actual bleeder airways. The difference in the airflow measurements taken before and after these three points should be sufficient to determine the quantity of air leaking through the gob.

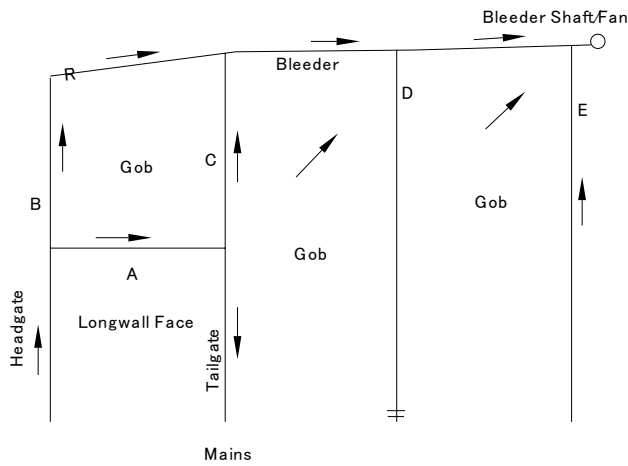


Figure 1. High Differential Pressure Bleeder

When the airflow entering through the gob is low it is very difficult to differentiate between an increase in airflow across an injection point and the instrument error encountered with a traditional anemometer. To minimize this error, direct measurements on gob regulators may be required. Care should be taken when taking measurements around gob regulators due to the poor ground conditions and higher gas contents typically encountered in these areas. The quality of the air (e.g. CH<sub>4</sub>, O<sub>2</sub>, CO, CO<sub>2</sub>, etc.) should be continuously monitored because of the possibility of rapid fluctuations and the measurer's proximity to the gob airstream.

Figure 2 illustrates a low differential pressure bleeder system. Rather than actively drawing air through the gob, this low pressure bleeder system monitors the gob and the release of gas from the gob area at position F. With this type of arrangement the airflow through the bleeder system is substantially reduced. Therefore, the gauge and tube method for the measuring differential pressure differentials around the gob area will be difficult to use. A barometer survey can be used to determine the pressure differentials between the longwall face, mains, and key bleeder locations. However, because of the very low flows in the bleeder, measuring differential pressures will be very difficult to accomplish whether using barometers or the gauge and tube. Airflow measurements must be taken at each point where gob air is introduced into the system (points C and D).

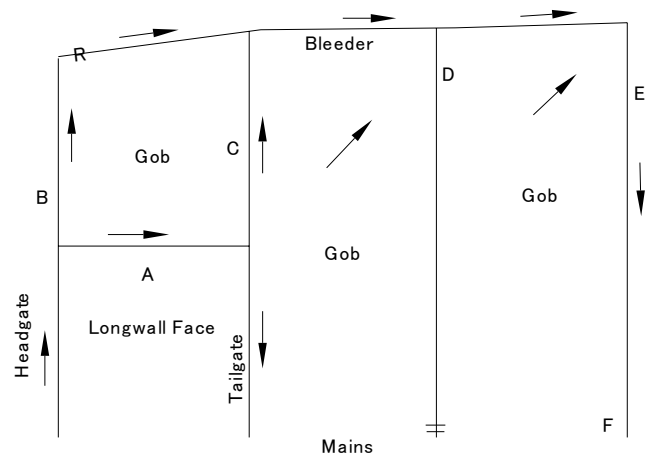


Figure 2. Low Differential Pressure Bleeder

### 3 GAUGE AND TUBE MEASUREMENTS IN BLEEDER AIRWAYS

Generally, if there is enough air flow, the gauge and tube technique can be used to measure frictional pressure drops through the bleeder system. This technique allows the direct measurement of frictional pressure differentials using a digital manometer or a magnehelic gauge connected to a length of 6 mm (1/4 in) nylon tube. The ends of the tube are connected to the total pressure port of pitot static tubes. Lengths of up to 300 m (1,000 ft) can be used, depending on the application. The nylon tube, which is strong, semi-rigid, and relatively inflexible, is strung along a drift from one marked station to another marked station. Both ends of the tube are connected to their respective pitot tube and are positioned near the middle of the drift and facing into the airstream. A manometer is placed in-line with the gauge and tube set-up. Figure 3 shows how this set-up is achieved with two people.

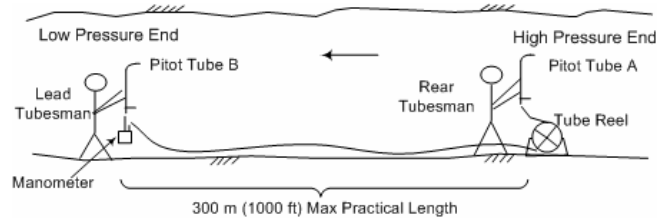


Figure 3. Gauge and Tube Technique

The measurement technique is independent of minor changes in elevation, psychrometric parameters, and air velocity measurements. No additional equipment, other than the pitot tubes, nylon tube and the manometer is necessary to carry out these measurements. The simplicity of the measurement allows for rapid reduction of data, field accuracy and verification checks, and is

unhindered by the need for additional parameters to be measured by the survey team.

This method can be used to measure very low pressure differentials, resulting from low airflows. However, when several measurements are to be combined, the possible combination of small errors associated with each measurement can pose a problem. Bleeder systems can require 10,000 to 15,000 ft of tube measurements in some cases and with a large number of measurements the instrument associated errors can inadvertently add up. This could cause a falsely high or low calculated resistance in the bleeder.

Using this method of measuring the frictional differential pressure drop in the bleeder drifts omits the need for other measurement techniques, such as tracer gases. Due to the constant fluctuations in the airflow through the gob, the higher accuracy measurements obtained with these more expensive techniques will not contribute much to the accuracy of a model. Therefore the gauge and tube method is preferred.

### 3 MODELING OF A BLEEDER SYSTEM

If there is sufficient airflow to obtain good pressure differential measurements in the bleeder system, then the system should be modeled in a conventional manner as with the rest of the mine. Since it is not possible to obtain measurements in the gob areas, the pressure and airflow in these areas must be determined using indirect methods. The input values for these branches in the model must be determined by closing pressure loops through the known bleeder system, around the gob to the intake air for the gob areas and then back to the bleeder. Several things can be inferred by examining the differential pressures across the gob regulators and the separation stoppings along the bleeder. These pressures can indicate how tightly the gob is caving or if the central tailgate entry is open for airflow. Additionally, gas concentrations and air temperature can be used to infer leakage routes through the gob areas. Figure 4 shows a developed bleeder system model with the leakage branches through the gob. The resistance of these leakage branches is determined by difference, closing pressure loops through the longwall tailgate. The resistance of the branch representing the old gateroad at note D cannot be determined in this model, however, the resistance of all leakage branches radiating from the longwall tailgate can be determined. The resistance values of these branches will change as the position of the longwall

progresses toward the mains, and as the gob further settles.

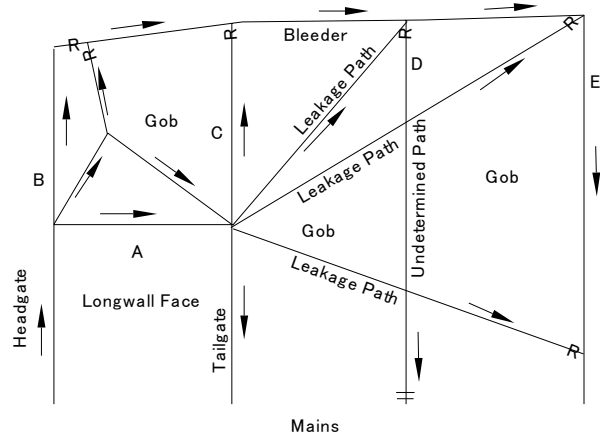


Figure 4. Developed Bleeder System Model

Figure 5 shows a simplified bleeder arrangement. The letters represent the pressure measurements for each of the branches that will be representing the bleeder system in the model. The branches represented by "C" and "L" are not measured directly and must be determined by difference using Kirchoff's Laws.

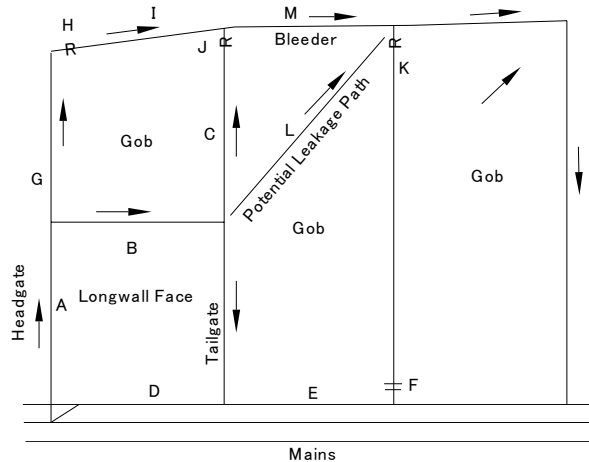


Figure 5. Determination of Leakage Path Pressure Differential

From Kirchoff's second law it is known that the summation of pressures around a closed loop must equal zero. For realistic modeling purposes, a 10% error is permissible. To determine the differential pressure in branch C a summation around branches G, H, I, J and B would be calculated. The pressures are added in the direction of the airflow, or from low to high, therefore  $C = G + H + I - J - B$ . Likewise, to solve for branch L the following would be true,  $L = G + H + I + M - B$ . If the stopping shown at point F is blocking leakage into the gob, then it can be inferred that the air at point K is coming off of the longwall, as shown above.

Both a pressure and an airflow balance of this area can be accomplished using this simple methodology. This is done to add confidence to all the measurements taken. If the pressures or airflows do not balance properly, then the faulty measurement can be identified and retaken as necessary. Also, by balancing the measured airflows, approximate airflow routes through the gob can be determined. Perimeter airways and former gate roads must be considered as likely airflow routes when determining leakage paths.

#### 4 SUMMARY

Bleeder systems and gob areas can be adequately surveyed and modeled using traditional techniques. Problems arise when low airflows are encountered in low differential pressure bleeder systems. However, due to the fluctuations in airflow through the gob areas, a traditional and simple method of measuring frictional differential pressures in the bleeder drifts is preferred.

Because the ventilation system is directly affected by the bleeder and gob areas, these areas should be a primary focus during a ventilation survey. They should also be accurately represented in the ventilation model.

Although a tracer gas survey can be conducted to determine the absolute origin of air flowing through a bleeder/gob system, this level of detail may not ultimately be necessary for the development of a viable ventilation model. The dynamic nature of the airflow through the gob areas combined with the continuous movement of the longwall make accurate measurements difficult.

#### 5 REFERENCES

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