

Ventilation Lab #7

Ventilation Pressure Survey

March 22, 2000

Purpose

Ventilation survey has long been a means for evaluating the resistance of mine airways. It is an organized procedure of acquiring data that quantify the distribution of airflow, pressure and air quantity throughout the main flowpaths of a ventilation system. The purpose of this lab is to familiarize the students with the concept and practice of a ventilation pressure survey.

Background

The primary purpose of conducting pressure surveys is to determine the frictional pressure drops between stations underground, so frictional figures (and ultimately, K-factors) for the airways concerned can be obtained for trouble-shooting and/or planning purpose. This is accomplished by using the following pressure and air quantity relationship:

$$R = \frac{H}{Q^2}$$

With the resistance (R) known the friction factor (K) for individual airways can be found using the Atkinson Equation:

$$K = \frac{5.2 R A^3}{O L}$$

where R is mine resistance (calculated from H and Q), A is airway cross-sectional area, O is perimeter, and L is airway length.

Procedure

1. Meet at the mine classroom for discussion.
2. Organize personnel/equipment
3. Prepare mine maps; decide measurement stations; and establish the base altimeter station. Synchronize watches and make pressure readings for both base and roving altimeters.
4. Obtain sequential altimeter and velocity readings (and airway dimension) at all underground stations.

Refer to §6.6: Air-Pressure Measurement (pp. 200-206) and §6.7: Ventilation Surveys (pp. 206-~225) for further details.

Instructions and Equipment

Two survey methods can be used in the ventilation survey: *Direct and Indirect Methods*. Due to time constraint, only the Single-base Station Method from the latter will be performed in this experiment using two Wallace & Tiernan and two Paulin altimeters.

This method involves setting one altimeter at the base station while the other is taken throughout the mine to the previously established underground stations. Altimeter readings will be taken at 5-minute intervals at the base station, and the times which the roving altimeter readings are made will be recorded. The base and roving altimeter readings and times will be correlated after all of the data is gathered.

In addition to the altimeter readings, velocity measurements will be made at each station. This will be accomplished with the use of a vane anemometer.

Lab Report

In addition to the other section required in the regular report, this report should include (use your own words):

- 1) Purpose of pressure survey
- 2) Surveying procedure
- 3) All calculations related to the Single-base Station Method, including the completion of the Pressure Survey and Air Volume Tables provided
- 4) pressure gradient graph should be developed from the calculations for this survey
- 5) Any relevant comments and conclusion

Measuring Stations are as follows:

Base V1 (182)
V2 (between 202 & 176)
V3 (between 177 & 201)
V4 (between 201 & 48)
V5 (between 14 & 145)
V6 (DW11)
V7 (between DW11 & 146)
V8 (147)
V9 (between 21 & 1)
V11 (between 0 & 12)
V12 (120B)

Additional Information

Although the theoretical pressure-quantity relationships for airways in a ventilation system may be calculated from the physical conditions and dimensions, by using published data determined by early investigations, the physical conditions usually are so variable and unpredictable, that a direct and thorough ventilation survey *must* be conducted to obtain such essential information as friction factors, airway resistance, etc.

Furthermore, as the mine gets deeper and larger, the ventilation network becomes more complex accordingly. When it is required to predict changes in critical flows in such complex networks caused by switching the location of fans, adding new fans or by driving new airshafts, computer simulation becomes necessary, for solving such problems manually is extremely tedious and time consuming. Information derived from such surveys is often used,

- to accurately assess the primary mine air distribution system,
- to establish the extent of the existing ventilation network and its role in meeting safety and operating requirements, both state and federal regulations,
- to determine friction coefficients for various types of airways,
- to provide information for short- and long-term ventilation planning
- to predict the economic feasibility in order to improve airflow distribution by changing regulation, adding a booster fan, enlarging mine openings, or driving new airways and new airshafts. And,
- to optimize ventilation practices by playing "what if" games.

Another intangible factor is that conducting such surveys is the best possible way to train a ventilation engineer and to provide him with an insight for the system. The reason being that the real ventilation world is quite different from the theoretical textbook world. It is essential to have hands-on underground experience to enable a ventilation engineer to adopt and maintain sensible and practical ventilation plans.

Ventilation Survey

Although the primary purpose of conducting pressure surveys is to determine the frictional pressure drops and air quantities for airways underground, a wide variety of other types of checks for different purposes are also practiced and different instruments are used, depending upon the type of mining method, coal or metal/non-metal, and specific conditions. According J.R. Marks from Homestake, the usual types of surveys may include:

Quantity and/or Temperature Surveys

These are the most common surveys and are used to ensure that design airflow reach the mining sections. They are also used to investigate complaints; to specify changes in airflow or air conditioning; and to upgrade level, stope, isometric, and escape maps. Ventilation personnel check infrequently-visited airways for falls-of-ground, sand-spills and the condition of ground support; and check the condition of air doors, regulators and seats during their travels through the mine. MSHA mandates that all accessible areas of the mine be surveyed once per year. Depending upon the condition of the mine, temperature survey may or may not be necessary for coal mines where temperature fluctuation is rare.

Intake and Exhaust Surveys

These indicate how the fresh air is distributed to work areas and how the exhaust is collected. Naturally, fresh air should be distributed based on work area requirements. For most metal mines, work areas are continually moving where the job of a ventilation engineer can be

Vent Lab. #7
Ventilation Pressure Survey

likened to a duck hunter trying to hit a moving target. In mine sections with heat problems, the exhaust air should be at or near the design reject temperature or the airflow will not be totally utilized in removing heat. A cool airflow entering exhaust often indicate leakage (short-circuiting) of fresh air.

☐ *Pressure/Quantity Surveys*

These are conducted to provide branch resistance data for ventilation network input and to find resistance bottlenecks in the circuit. The barometric pressure is also needed for accurate psychrometric calculations, although it can be estimated from the elevation and the circuit pressure gradient for most cases. Measuring the pressure on doors, regulators and seals is an excellent diagnostic tool.

☐ *Air Quality Surveys*

These are conducted to ensure that gaseous contaminants, dust and diesel emissions are kept within their TVs. Heat/humidity, fog, and at some mines, noise illumination can be included.

☐ *Equipment Surveys*

These surveys are necessary for metal mines to make sure that primary & auxiliary fans, ductwork, service water systems, and air-conditioning units are functioning properly. Ventilation equipment is much too expensive to tolerate inefficient operation.

Most of the surveys listed above require some means to measure airway size, and air velocity, temperature, and pressure using either of the following two methods.:

- (1) Direct Method, a rubber tubing or hose is laid between the two points which pressure difference is to be measured. A manometer mounted on a tripod and equipped with a leveling bubble is then connected either at one end or at some other convenient point along the tube. The manometer reading is the pressure difference between the two points.
- (2) Indirect Method uses a pair of precision aneroid barometers or altimeters which are used for obtaining the pressure difference between any two points in an airway. Since they indicate only the absolute static pressure at a point, the difference in pressure must be calculated from adjacent readings rather than read directly. Altimeter readings are recorded during the survey in ft (m) elevation and then later converted to pressure in inches of water.

In conducting a survey using indirect method, either of two methods may be used, both requiring two instruments. The first method is called the *leapfrogging method* where both instruments are taken underground and read simultaneously at adjacent stations. The preceding instrument is the advancing instrument for each successive measurement. Both instruments are adjusted to the same reading at each station, and with simultaneous readings with the aid of synchronized watches, the effect of atmospheric-pressure changes is eliminated. Since readings at each station are also duplicated, the results are more accurate.

The second method is the *single-base method* where one instrument is used underground in making the traverse while the second one remains on the surface or at some base point underground. Readings at both are taken on a prearranged time schedule. A recording barometer can also be used for the base instrument. Three corrections to altimeter data (atmospheric pressure changes, velocity differences, and elevation differences) are necessary to calculate the pressure difference between stations.