Trompe Technology for Mine Drainage Treatment

B.R. Leavitt, T. Danehy, R. Mahony, B. Page, C. Neely, C. Denholm, S. Busler, M.H. Dunn

Introduction

At many mine water treatment facilities, aeration is needed to oxidize ferrous iron or to remove dissolved carbon dioxide from the water. Many methods have been used to accomplish this throughout the years including surface diffusion, cascade aeration, or in some cases oxidation has been accomplished using chemical reagents such as hydrogen peroxide. The trompe is an ancient technology which has recently been applied to mine water treatment to provide the benefits of mechanical aeration without the need for electricity, motors, or any moving parts. Trompes may also be utilized at many other sites where compressed air is needed.

Figure 1. Bruce Leavitt measuring air velocity using an anemometer.

Figure 2. Aeration using a trompe at the North Fork Passive Treatment System.

Trompe Background

A trompe (Figure 3) is a device that uses falling water to compress air. Water is directed through an airhead (Figure 4) where the effect of falling water draws air into a vertical downpipe. The velocity of falling water in the pipe is high enough that entrained air is carried down the pipe along with the water. A chamber located below the discharge elevation separates the air from the water. The compressed air is then captured for use while the water is discharged from the trompe. The trompe contains no moving parts.

History of the Trompe

Trompe-based technology has been used for many applications, with the earliest known dating back to the Catalan Forge developed in the 17th century. In Figure 5, water falling down a pipe (most likely a hollow log) carries air that is separated in the air box. Compressed air was then directed to the forge, replacing the bellows.

During the late 19th and early 20th century the trompe reached its zenith. Mr. Charles Havelock Taylor rediscovered the working principle of a trompe inde-

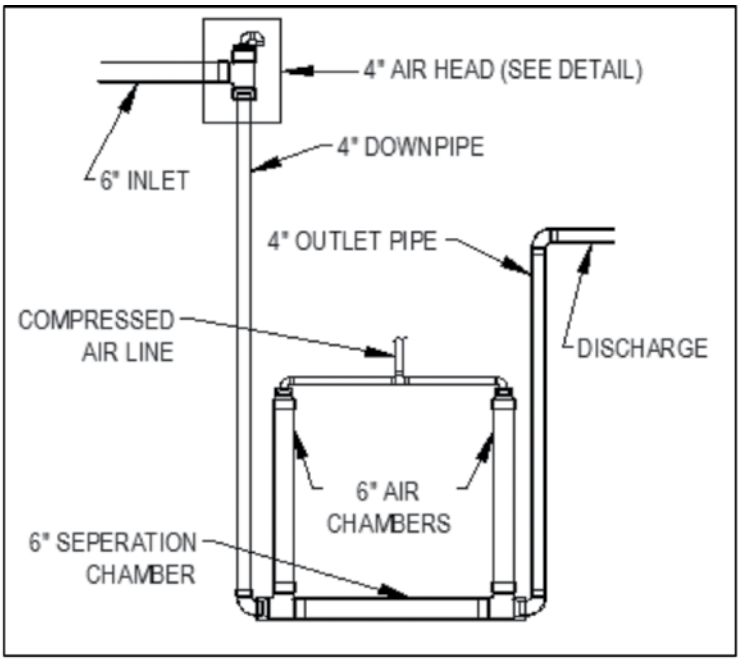

Figure 3. Trompe Section View

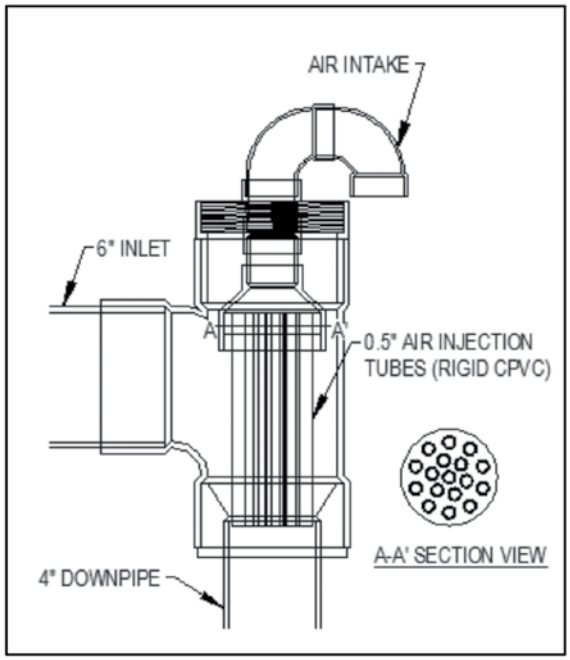

Figure 4. Trompe Airhead Detail

pendently. In 1896 a compressor was built at Magog, Québec, to supply compressed air to a cotton mill. This method of air compression became very well known at the time and Mr. Taylor built a number of trompe-style compressors in the United States (Washington, Michigan, Connecticut), Canada, Peru, and Germany. These compressors became so associated with Mr. Taylor that they became known as Taylor Compressors. In 1910, Mr. Taylor designed and built a compressor called Ragged Chute near Cobalt, Ontario, Canada. Figure 6 is a diagram of the Ragged Chute facility. This unit was in nearly continuous operation from 1910 until the headworks were destroyed by fire in the 1980's. The compressed air generated at Ragged Chute was used to operate rock drills in nearby mines.

Basic Trompe Installation Requirements

Approximately 4 feet of drop is needed as measured from the difference of elevation between the inlet head and the discharge pipe. The air pressure that can be generated is controlled by the height of the discharge pipe and can vary based on the depth at which the separation chamber can be buried. Trompes have been recently installed for flow rates ranging from 25 – 400 gallons per minute and we have designs developed for flow rates greater than 3,000 gallons per minute. Approximately 1 cubic foot per minute of air can be produced for every 25 gallons per minute of available flow. If site conditions allow, multiple trompes can be installed in series. Variable flow rates can be accommodated by installing trompes with multiple airheads and downpipes.

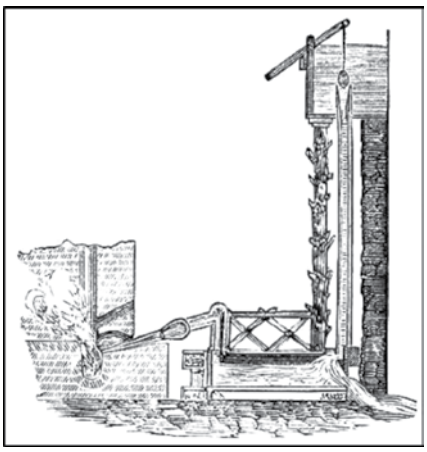

Figure 5. Catalan Forge

A trompe can use water from any appropriate point in the treatment process, or from any other available water source. However, clean water from the final discharge helps minimize iron deposition within the trompe and associated maintenance requirements. In addition, the variation in discharge flow is proportional to the need for compressed air in the treatment process. The compressed air that is generated in the trompe can be piped to any point in the treatment system.

Trompe Applications in Water Treatment

In recent years, trompes have been installed for multiple applications with successful results. Trompes have been

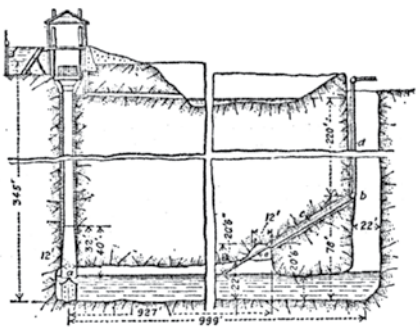

Figure 6. Ragged Chute Trompe

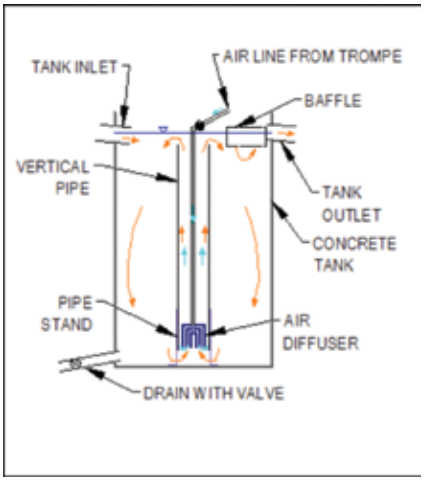

Figure 7. (above left) Diagram of the "A-Mixer".

installed in both passive treatment and semi-active mine drainage treatment systems.

Trompe technology powers a device called an "A-Mixer" (pat. pend.), which is similar to an air-lift mixer, located at the Manor Treatment System in Clearfield County, PA. This device consists of a tank which provides residence time for pebble quick lime dissolution. In the center of the tank is a vertical pipe suspended off the bottom of the tank and rising to just below the water level in the tank. An air pipe, with an air distributor (diffuser), is suspended in the middle of the vertical pipe and is connected to a trompe. In this case, compressed air from the trompe is used to increase chemical utilization efficiency of pebble quicklime at the site.

Trompe-powered aeration helps remove carbon dioxide and increase dissolved oxygen in order to enhance the oxidation and precipitation of ferrous iron. Sites currently using trompes for this purpose include the Curley Passive Treatment System in Fayette County, PA, and the North Fork Passive Treatment System in Allegheny County, PA. Both of these sites utilize fine bubble disc diffusers to aerate the mine water shown in Figure 9. ■

Figure 9. Fine bubble disc diffusers used at the Curley Passive Treatment System.

Figure 8. (above right) Manor "A-Mixer" used to enhance lime mixing and dissolution.

Selected References

Leavitt, B.R., 2011. Aeration of Mine Water Using a TROMPE. In: 2011 West Virginia Mine Drainage Task Force Symposium. Morgantown, West Virginia. http://wvmdtaskforce.com/

Leavitt, B.R., 2012. Passive Mixing to Improve Calcium Oxide Dissolution: 2012 West Virginia Mine Drainage Task Force Symposium. Morgantown, West Virginia. http://wvmdtaskforce.com/