



## TROMPE: From The Past Will Come The Future

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### Project Description and Objectives:

A trompe was constructed to generate compressed air off the grid for use in the treatment of mine drainage. Trompes produce compressed air with no moving parts. Testing was conducted to help understand the operating parameters of this ancient technology, provide efficiency data, and to improve overall function by optimizing the design. A full-scale demonstration trompe was installed using commonly-available PVC plumbing parts at the North Fork Montour Run passive treatment system on property owned by the Allegheny County Airport Authority (Pittsburgh International Airport) for use as an outdoor classroom to disseminate this technology.

### Applicability to Mining and Reclamation:

Compressed air can be used to enhance mine drainage treatment at sites where electricity is unavailable and can be of particular value at sites where cascade aeration is limited due to topographic constraints. Air-lift pumps powered by trompe-generated compressed air can be used for enhanced aeration, to power mixing tanks or power a variety of other devices.

### Methodology:

Both a test trompe and a full-scale demonstration trompe were constructed. Three trompe sizes, as determined by the diameter of the downpipe, were tested including 2", 3" and 4". Several air tube configurations were developed to evaluate efficiency, as measured by volume of air compressed per volume of water flowing through the trompe. The volume of air drawn into the trompe was measured with an anemometer for

each trompe size and configuration over a range of flow rates. The demonstration trompe installation included both a triple-pipe inlet to accommodate seasonal flow rate variability and three trompes in series to take advantage of the available drop and increase the total volume of air compressed.



Bruce Leavitt, PE, PG uses an anemometer to measure volume of air being compressed by the demonstration trompe at the North Fork Montour Run passive treatment system. Pictured is the inlet of the first of three triple-inlet trompes installed in series.

### Highlights:

Important conclusions of the study include the following:

1. An ancient technology originally developed in 17<sup>th</sup> century Italy for iron forge work has been resurrected to develop an air compressor that

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can be fabricated from commonly-available PVC plumbing parts.

2. A trompe has no moving parts and the power input is solely a stream of water.
3. A trompe can be installed anywhere within a treatment system or along any stream of water where about at least three feet of hydraulic head is available.
4. Air is entrained and compressed in flowing water and then separated from the water in a buried horizontal collection chamber.
5. Compressed air can be used for bubble aeration with diffusers or used to power air-lift pumps for both aeration and/or mixing.
6. The maximum pressure developed is dependent on the height of the uppipe (outlet) and pressures more than 4 psi can readily be generated.

### Results and Findings:

Smaller diameter trompes were found to be more efficient: a 2" trompe produced ~6 CFM air/100 GPM water compared to a 4" trompe which produced ~4 CFM air/100 GPM water.

Air volume production per GPM increased with hydraulic head.

Air induction heads that included numerous, smaller-diameter air tubes tended to produce more air and perform better over a wider range of flows than induction heads constructed with fewer, larger-diameter air tubes.

Better efficiency was realized when the sum of cross sectional area of air tubes was approximately one-half of the inside diameter of the downpipe, and when the bottom elevation of the air tubes was set at the top of the downpipe.

Maximum flow through a trompe is controlled by the size of the downpipe (trompe size) and air separation tube configuration.



The test trompe apparatus included adjustable outlet pipe (uppipe), and clear horizontal separation chamber and air induction head piping. Various air tube configurations and 2", 3" and 4" downpipes were tested over a range flow rates.



A primary objective was to construct a trompe using inexpensive and readily available materials. Bruce Leavitt, PE, PG assembles a triple-inlet trompe using standard PVC plumbing parts.

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