

## Testing Exhaust from Small Engines

Getting pure exhaust is critical if carbon monoxide is used to set up propane fueled engines. The exhaust pulsations that occur in a small engine's exhaust pipe will cause inaccurate readings when measuring CO.

The three figures below show how the muffler's exhaust pipe mixes air and exhaust with an engine at idle. When a power stroke is exhausted, a plume of pure exhaust is emitted from the exhaust pipe as shown in Figure 1 below.

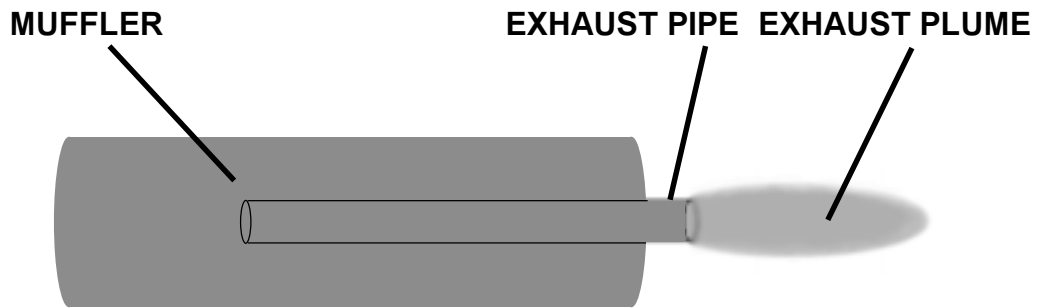


Figure 1. Exhaust Pulse

Between power pulses, atmospheric pressure forces air to flow backward into the exhaust pipe as shown in Figure 2 below. Here, a CO analyzer would be pulling in pure air with no CO.

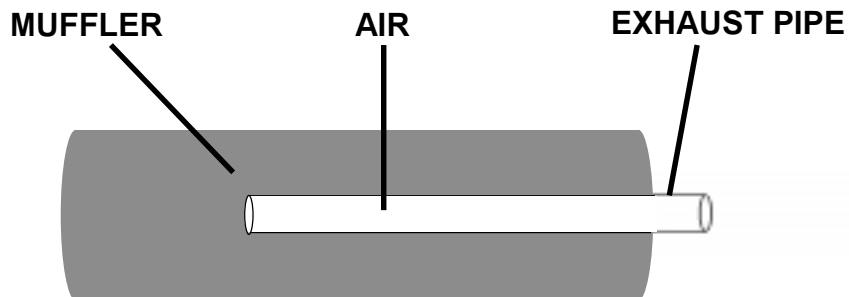


Figure 2. Air Back-pulse

Figure 3 below shows the average effects of exhaust mixed with air as the pulses surge in and out of the exhaust pipe. CO at the baffle is about 1/2 to 2/3 the true CO from the engine. This will cause the installing technician to overfuel the engine to get what appears to be a proper level, which will cause wasted fuel.

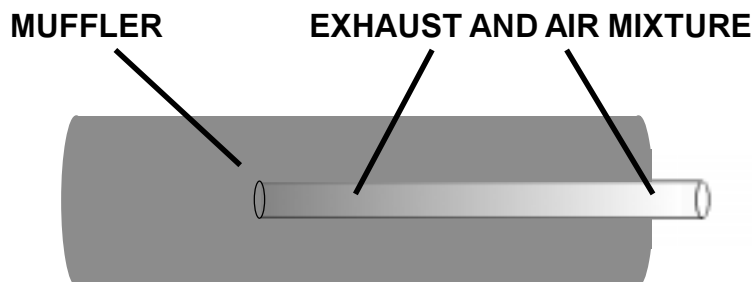


Figure 3. Average CO Versus Depth

To get a true CO level from a commercial lawnmower an exhaust pipe extension is needed. To avoid a diluted sample, the tip of the sample probe should be about 15 inches into the exhaust system. This cannot be done when baffles are 6 to 8 inches from the end of the exhaust pipe.

Figure 4 below shows an example of how the exhaust/air mixture acts with an exhaust pipe extension tube.

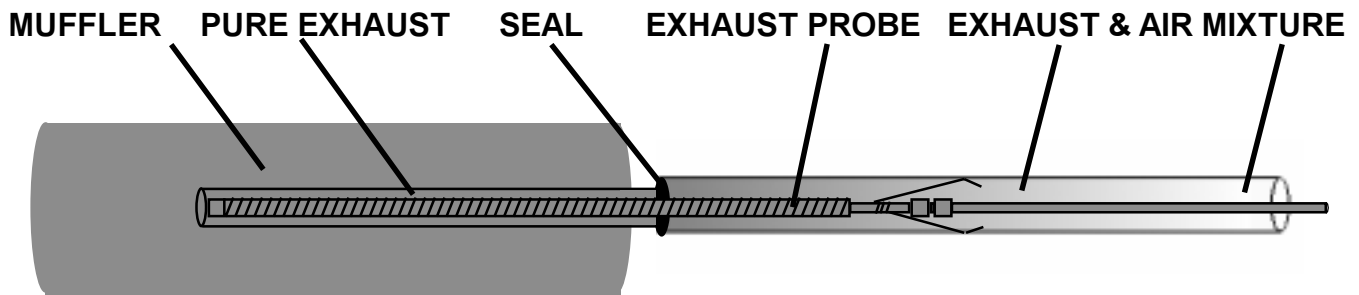


Figure 4. Average CO Using Exhaust Pipe Extension Tube

Use of an exhaust pipe extension tube like this will insure pure CO readings and will eliminate air dilution for the CO analyzer. The seal is grade #0000 steel wool wrapped around the exhaust pipe so the larger exhaust pipe extension tube fits tightly over it. This heat resistant seal minimizes air pulses from entering the gap between the exhaust pipe extension tube and the exhaust pipe.

The outside dimensions (O.D.) of exhaust pipes varies from 1 3/8" to 1 1/2". The outside dimension of the exhaust pipe extension tube should be 1 3/4". A 12" or 15" length of 1 3/4" O.D. tailpipe extension tube will work well and can be purchased at your local car parts store for less than \$10. Just google "ROL Gaskets P.N. 548642" for 12" long or "ROL Gaskets P.N. 548621" for 18" long tailpipe extensions.

Grade #0000 steel wool makes a reusable packing material. Spiral wrap strips of steel wool around the exhaust pipe a bit larger than the 1 3/4" exhaust pipe extension tube. Twist and push the exhaust pipe extension tube over the compressed steel wool for a tight fit. When properly applied, the exhaust pipe extension will fit tightly enough so it will not slip off the exhaust pipe while the engine is being tested.

## WARNING

**Muffler, probes, exhaust pipes and exhaust pipe extenders are very hot and will burn the operator if touched. Exhaust pipe temperatures of an engine will be close to 600° F under load and about 400° F at idle. Anyone wrapping the exhaust pipe with steel wool, or handling the exhaust pipe extension should be wearing gloves to prevent burns. Only handle the hot exhaust probe by its insulated handle.**

**At the end of testing, gloves should also be worn when sliding the exhaust pipe extension off the exhaust pipe and removing the steel wool seal. The temperature of the exhaust pipe extension tube on an idling engine can quickly become 400° F. After removal, set it where it will not burn or melt anything and leave it there until it can be safely handled.**

## CONCLUSION

Proper setup of a propane fuel system requires a CO analyzer to adjust for idle and full load CO. Dilution of the exhaust by air will cause the fuel system to be set too rich when making this adjustment, causing the engine to run too rich in all operating modes. A 30% to 50% dilution will cause the engine to use up to twice the required propane in all operating modes, thereby wasting major fuel dollars.

The number one purpose of using propane is to save money. Use the exhaust pipe extension tube and seal described above to be sure to minimize exhaust dilution and maximize fuel economy. Insure your customer the maximum return for his fuel dollars with proper initial setup and regular maintenance using a CO analyzer.

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