Phase 1: Low-Cost Gas Mixture Setup Using Peristaltic Pump

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What are your sources of information and inspiration

or any topic regarding a mix of gases.

Objective

The objective of this first phase is to build and test one metering line based on a peristaltic pump driven by a stepper motor, to evaluate whether this low-cost approach can provide sufficiently stable and repeatable gas delivery for use in future 3-gas mixing systems.

This is not yet a final gas-mixing system.
This phase only aims to validate whether the concept is worth further development.

Motivation

Last year's student built a low-budget gas line using a rotameter and stepper-controlled valve as feedback loop. My approach tests an alternative low-cost method (no feedback loop, just simple):

- Using a peristaltic pump to meter gas volume by controlling motor rotation.
- Flow rate = proportional to motor speed (steps/sec) after calibration.
- Simpler mechanical control (no delicate valve actuation).
- Potentially easier automation later using ESP32.

(Cost comparison will be done after validation of this project.)

Components Already Purchased

Core hardware

- Peristaltic Pump G528 DC 12V (3 × 5 mm hose)
  – Used to displace gas volume proportionally to stepper rotation.
- Nema 17 Stepper Motor (1.5A, 42Ncm)
  – Drives the pump rotor.
- Arduino UNO Starter Kit
  – For early testing, programming practice, wiring experiments.
- ESP32 Dev Board
  – For final version: faster control, better IO, optional Bluetooth/WiFi logging.

Components available at CERN (expected)

- Argon gas cylinder (for safe testing).
- Pressure regulator (0–2 bar outlet).

- Tubing, fittings, valves from gas workshop or lab stock.
- Beto tubes (small borosilicate displacement tubes often used for gas-volume measurements). These can be used to visually measure gas volume or confirm calibration using water displacement.

(If unavailable, I will request the items.)

Planned Setup (Single Gas Line Test)

The first test setup will consist of:

1. Argon cylinder →
2. Regulator (low pressure, ~50–200 mbar) →
3. Manual on/off valve (not necessary for system to work) →
4. Peristaltic pump (driven by stepper) →
5. Tubing to water column/Beto tube →
6. Water displacement reservoir to measure delivered gas volume.

The ESP32 or Arduino will:

- Drive the Nema17 stepper motor at controlled speed.
- Count steps per rotation.
- Log motor speed vs. delivered gas volume during calibration.

Validation Method

Because I currently only aim to test one gas line, the validation will be simple:

A. Calibration

- Run the pump at different stepper speeds (e.g., 50, 100, 150, 200 steps/s).
- Collect gas into an inverted water-filled container (standard water displacement method).
- Measure volume displaced over a fixed time (e.g., 60 seconds).
- Repeat 3-5 times per speed to quantify repeatability.

B. Compute calibration curve

- Steps per second → volume per minute (L/min or mL/min).

why?

- Determine:
  - Linear region
  - Efficiency vs. pressure
  - Stability over time

what is this?

C. Stability test

very short time. It has to run for days

- Run for ~10–15 minutes continuously to see if:
  - Flow fluctuates
  - Tubing compresses differently
  - Pump slip occurs

—?

2?

D. Optional

3

If available, compare with a Beto tube for finer volume measurements.

This methodology confirms whether the peristaltic-pump concept gives repeatable gas delivery.

No. the results may confirm if there is sufficient precision and

Goals of Phase 1

By the end of this first stage, I aim to deliver:

1. A fully functioning single-gas metering line (argon).
2. Calibration plots:
   - Motor speed vs. delivered volume
   - Repeatability analysis
3. A short report evaluating whether this method is feasible for multi-gas use.
4. Identification of improvements (buffer, pressure stabilization, tubing type).
5. A decision:
   - Continue to Phase 2 (two/three gas branches),
   - OR discard the concept if unstable, revert to valves or other solutions.

You need some values of what is required. It must be quantitative.

3