



1st Progress Report Automated Trace Gas Trapping System (ATGTS)

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Mechanical Related Progress

Overall Design

As detailed in our proposal, the overall design of the ATGTS remains the same with the exception of a few details. As before, the device will be composed of four separate levels starting from the ground used for the soil flux chamber, chemical and sieve traps, electrical components storage, and rainfall reservoir. The first level or the flux chamber is where the major design changes have been made.

First, in regards to the sub chamber housing design, no longer are the sub chambers exposed to the flux chamber via a servo controlled door. It was the idea of the M.E. students to open the sub chamber with a 6.35mm thick Aluminum sliding door controlled by an electric linear actuator. It eliminates problems with a conventional swinging door design in reference to sealing the chambers. Using the sliding door design with ball bearings mounted in tracks allows for a sandwiching of the door by sealant material and makes sealing the chambers a certainty. This idea was proposed to Dr. Ostrom in the October 1st weekly meeting, with mild success. Some changes needed to be made as follows.

Initially, the team presented to Dr. Ostrom a flawed sub chamber design with a dead volume in the N₂O chamber. This was a result of insufficient flow through the sub chamber. As per Dr. Ostrom's direction in the October 8th weekly meeting, the team incorporated a second door on one end of the sub chamber. This smaller door allows air in the flux chamber excited by the fan to

move throughout the N₂O chamber, eliminating the concern of a dead volume occurring in the chamber. This new sub chamber may be viewed in figure 1.

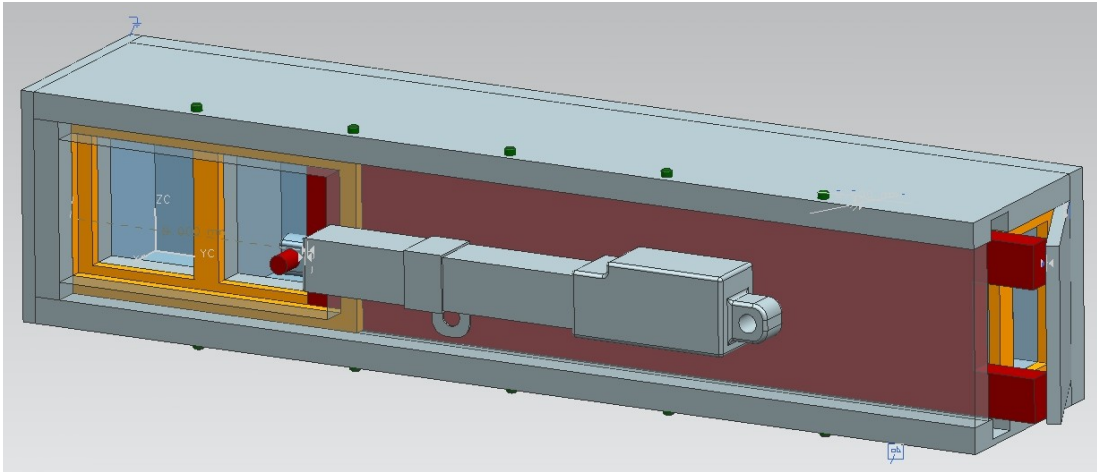


Figure 1. Computer Model of the ATGTS Sub Chamber Housing

Initial design for the flux chambers equilibrate system utilized a valve mounted on the wall of the outer casing which when opened exposes the flux chamber of the ATGTS to the ambient environment. This valve was eliminated as a design choice by the team due to its high cost, high power consumption, and oversized geometry. A replacement was presented to Dr. Ostrom on the October 15th weekly meeting as follows. In its place, the team chose to use a linear actuator sliding door design very similar to that used on the sub chamber housing. This design also uses a 6.35mm thick Aluminum door with ball bearings mounted in a PVC track. Mounted on the inside of this sliding gate is the waterproof fan used to equilibrate the flux chamber.

Parts List and Ordering

Parts choice for the ATGTS is almost entirely the same as when the proposal was written. Differences lie in relation to the sub chamber housing control mechanism and flux chamber door mechanism. For both devices, a

Firgelli 12V linear actuator was chosen with 60mm of stroke. These two devices along with all other mechanical components of the final design are listed in table 1 found below. As of October 20th, all technical part orders have been placed via Dr. Ostrom's laboratory. Basic structural components such as hinges, wire screen, and miscellaneous hardware were purchased from October 5th through October 19th.

Table 1. ATGTS Final Parts List and Ordering Information

Item #	Status	Component	Component Details	Company	Part Number	Qua	Price/unit	Total
1	Ordered	Reducer (1/8 to 1/16)	Fitting that reduces the diameter from 1/8 to 1/16	Swagelok	SS-100-R-2	2	\$12.90	\$25.80
2	Ordered	Reducer (1/4 to 1/16)	Fitting that reduces the diameter from 1/4 to 1/16	Swagelok	SS-100-R-4	6	\$15.80	\$94.80
3	Ordered	Reducer (1/2 to 1/4)	Fitting that reduces the diameter from 1/2 to 1/4	Swagelok	SS-400-R-8	2	\$10.40	\$20.80
4	Ordered	Quick Connect stem (1/4) (Male)	Instrumentation Quick-Connect Stem w/o Valve	Swagelok	SS-QC6-S-4PM	6	\$24.10	\$144.60
5	Ordered	Quick Connect body (1/4) (Male)	Instrumentation Quick-Connect Body w/o Valve	Swagelok	SS-QC6-B-4PM	6	\$36.30	\$217.80
6	Ordered	Quick Connect stem (1/2) (Male)	Instrumentation Quick-Connect Stem w/o Valve	Swagelok	SS-QC8-S-8PM	2	\$29.30	\$58.60
7	Ordered	Quick Connect body (1/2) (Male)	Instrumentation Quick-Connect Body w/o Valve	Swagelok	SS-QC8-B-8PM	2	\$59.50	\$119.00
8	Ordered	Manual Valve (Female)	Bellows-Sealed Valve, Welded, SS Stem Tip, 1/4 in.	Swagelok	SS-4H4	4	\$139.40	\$557.60
9	Ordered	1/16" PEEK Tubing - Natural	5 m, 1/16" OD, 0.055" ID	VICI	TPK155-5M	1	\$95.00	\$95.00
10	Ordered	Conical Adapter Assembly	1/16" OD Rigid to 1/16"-3/32" ID Peristaltic	Upchurch Scientific	P-797	2	\$12.55	\$25.10
11	Ordered	Threaded MINSTAC Valve Fittings	PEEK, 1/16" OD, 0.01" ID	Upchurch Scientific	M-657	28	\$13.11	\$367.08
12	Ordered	Tygon SE-200 Inert Tubing	5', 1/4" OD, 1/8" ID	McMaster-Carr	5046K11	1	\$8.05	\$8.05
13	Ordered	Viton Foam Rubber Sheet Gasket	12" x 12", 1/8" thick	McMaster-Carr	3156T13	1	\$92.02	\$92.02
14	Ordered	2-Way Solenoid, 062 MINSTAC	12v, Normally closed	Lee Company	LFVA1210420H	5	\$139.79	\$698.95
15	Ordered	3-Way Solenoid, 062 MINSTAC	12v (available upon request), Normally closed	Lee Company	LFRX0501900B	5	\$145.15	\$725.75
16	Ordered	ADDA Waterproof Fan	60mm x 25mm frame, 12v	ADDA	AQ0612LB-A70GL-LF	1	\$11.50	\$11.50
17	Ordered	Cypress Microcontroller		Cypress	CY3214-PSocEvalUSB	1	donation (\$120)	\$0.00
18	Ordered	Micro Linear Actuator	L12 Series, 60mm stroke, 298:1 gearing ratio, 12v, power	Fergelli Automations	-	2	\$80.00	\$160.00
19	Ordered	2-Way Solenoid, Direct Acting	Normally Closed, 1/4" port size, 12v, Viton seal	STC Valve	2S040	1	\$48.00	\$48.00
20	Ordered	Ball Bearings	Made by NSK, 8mm OD, Shields on both sides	Motion Industries Inc.	693ZZ	8	\$11.68	\$93.44

Electrical Related Progress

Controls

With our mechanical design finalized, detailed design of control schemes can begin. The design is based of the state machine simulated in the microcontroller. Many of the components in the design are controlled by a simple on/off scheme. Shown in table two below are the components and their states relative to the state machine.

Table 2. State Table for the ATGTS

	Stir	N ₂ O Sample	CO ₂ Sample	Equilibriate	Rest	Control Type
N ₂ O Sub Sol In	X	O	X	X	X	On/Off
N ₂ O Sub Sol Out	X	O	X	X	X	On/Off
CO ₂ Sub Sol In	X	X	O	X	X	On/Off
CO ₂ Sub Sol Out	X	X	O	X	X	On/Off
Dessicant Trap Sol In	X	O/X/O	X/O/O	X	X	On/Off
CO ₂ Chem Sol In	X	O/O/X	O/X/O	X	X	On/Off
Sieve Trap Sol Out	X	O/X/O	X/O/O	X	X	On/Off
Sub Sol In	X	O/O/X	O/X/O	X	X	On/Off
Pump	X	O	O	X	X	On/Off
Sub Linmot	O	X	X	O	O	Position
Outer Door Linmot	X	X	X	O	X	Position
Circulation Fan	O	X	X	O	X	On/Off
Water Release Valve	X	X	X	O	X	On/Off

Legend for 3 Way solenoid valves	
Dessicant Trap Sol In	N ₂ O/CO ₂ /OUT
CO ₂ Chem Sol In	DES/CHEM/SIEVE
Sieve Trap Sol Out	N ₂ O/CO ₂ /OUT
Sub Sol In	IN/N ₂ O/CO ₂

General Legend
X=Closed/Off
O=Open/On

The only devices that require special care in their operation are the linear motors. To facilitate movement, the motor has one power line and a ground line. When the power line is raised to a positive voltage, the motor extends until the power is removed, or the stroke limit is reached. To move the opposite direction, a negative voltage is applied. Control of this device will rely on the built in

position sensor. Two reference voltages for control purposes are provided to the motor, and the motor returns a voltage on a third wire. This voltage varies linearly as the motor moves across its stroke. The voltage will be read in by the microcontroller, where we can then make control decisions afterwards. One feature we would like to implement would be varying speed control for the motor. As the motor reaches the end of its needed draw for the application, we will slow down the motor's movement. We hope to achieve this by regulating the amplitude of the voltage input to the motor using a PWM system. Experimentation will be needed to determine if regulating the voltage can alter the speed of the linear actuator.

Microcontroller

The current status of the microcontroller is a basic program that has been made for debugging purposes, and is currently running a state machine diagram shown in figure two.

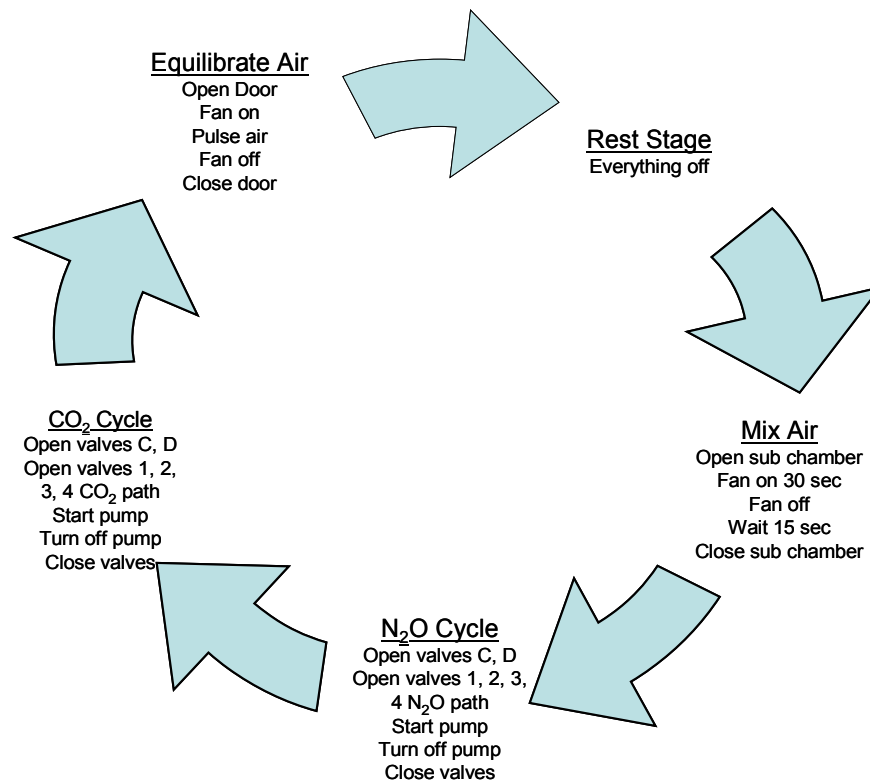


Figure 2. State Flow Diagram

The microcontroller currently transitions to each state every 10 seconds, with the current state displayed on the LCD screen to determine if the state transition is correct. Depending on which state the microcontroller is in, other relevant data will be displayed. For example, when the microcontroller is in the Mix Air state, the fans RPM will be displayed on the LCD screen. By connecting LEDs to the appropriate pins on the microcontroller, the components can be shown to be working at the appropriate state. Once the parts have come in the

program can be easily altered to incorporate the number of input and output pins required.

Power Control

The microcontroller will give the signal to control the solenoids as described above. However, the signal from the microcontroller must be amplified in order to power the solenoids. An analog circuit represented by the schematic illustrated in figure 3 will be utilized.

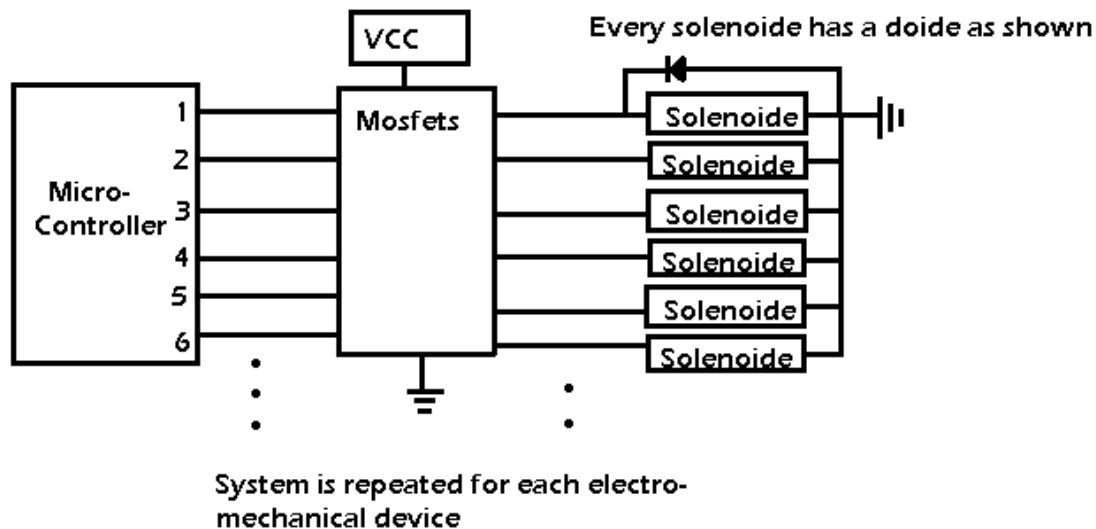


Figure 3. Microcontroller Switching Circuit Schematic

The MOSFETs are 2VN4206A and the diodes 1N4007 are both rated at one amp. The diodes are attached across the solenoid to allow a path for current to flow upon discharge. This will keep the MOSFET and microcontroller from being the path for this current discharge and thereby keep them safe from dangerously high current levels. VCC is the power supply of the battery which is

12 volts. The total system will amplify the output signal with respect to current only.