**Modification of NOAA Programmable Flask Package manifold to support atmospheric O₂ measurements**

Emily Johnson, Britton Stephens, Todd Bernatsky

### Background (Legacy Design)

The NOAA Programmable Flask Package (PFP)

- Automated air sampling system with 12 glass flasks
- Used to monitor gas concentrations
- A flexible stainless-steel manifold connects the flasks
- Before filling the flasks, the manifold is first flushed with air to remove any old air that would affect the sample
- Tee that connects the flask with the manifold is circled in red

### Airborne O₂ Measurement Challenges

- Airborne O₂ has a high background concentration and therefore requires a fine precision of measurement
- The current PFP manifold tubing has a large surface area due to the convoluted structure
- The flask valves have large dead volumes
- Surface interactions between the PFP’s metal and glass components and the air sample
- Test results are influenced by changes in pressure, temperature, and water vapor

### Tee Redesign

**Design Goal:** Add “dip tube” to flush out old air

**Design Considerations:**
- Maintain consistent air flow path cross-sectional area
- Retain the current clamp and seal methods to glass flask
- New tee should have mass of current Tee and a low profile

**Tee/Valve Legacy Design**

- Air does not fully flush out the glass valve (circled in red)
- White nut compresses the green O-ring into the groove to seal manifold to glass vessel

**O₂ Design Modifications**

- Dip tube directs the air flow
- Forces air in and out of the valve
- Flushes out remaining air left from previous sample

**O₂ Elements**

- Dip tube
- Clamp
- O-Ring
- Valve

### Manifold Tubing Redesign

**Design Goal:** Replace convoluted tubing with constant ID tubing to further reduce surface area

**Design Considerations:**
- Electropolish surface finish to maximize smoothness
- Minimize pressure drop
- Retain some flexibility of tubing

**Manifold Tubing Legacy Design**

- Convoluted tubing is flexible which allows for irregularities in the glass dimensions and movement
- O₂ adsorption / desorption increases with greater surface area of convoluted tubing

**O₂ Design Modifications**

- Smooth wall tubing means less surface area for O₂ interactions
- Custom tube profile allows for some flexibility for irregularities or misalignments

### Deliverables

- Tee Part Drawing
- Manifold Tube Part Drawing
- Tee and Tube Assembly Drawing
- Assembly Model of Entire Prototype Version

### Next Steps

- Fabrication of tee, dip tube, and manifold tube (Aug 2020)
- Assembly of parts
- Testing of manifold assembly
- Finish developing a welded version of manifold
- Fabricate 6 copies of the welded version

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**Contact Info**

Emily Johnson
Mechanical Engineering Major
emilyj@ucar.edu

**Design iterations of custom tube profiles:**

- Design 1
- Design 2
- Design 3

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**Finite Element Analysis**

- Provided comparative flexibility analysis of tubing geometries
Finite Element Analysis to improve intuition about flexibility
NOTES:
1) REMOVE BUERS AND BREAK SHARP EDGES
2) BREAK LEAD-IN SHARP EDGE .005" MAX
3) MEASURE P/N 106XXX OD. MAKE DIMENSION +.001"/.002
4) PASSIVATE PER QQ-P-35
NOTES:
1) MADE FROM XXXX, 125" OD, AND 1.05" ELECTROPOLISHED ID
2) REMOVE BURRS AND BREAK SHARP EDGES
NOTES:
1. SEAT MATING SURFACES OF TEE AND TUBE BEFORE WELDING
2. MAINTAIN ALIGNMENT OF TUBE IN TEE