Positioning and Clamping Mechanism for Coriolis Flow Meter

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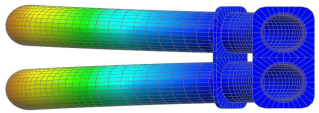
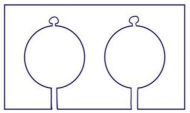
Background

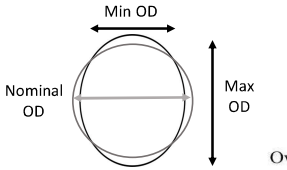
- F300S Coriolis Flow Meter vibrates Flow Tubes at their natural frequency to measure mass flow rate and density
- Advertised achievable specifications of +- 0.05% liquid mass accuracy, up to +- 0.5 liquid density accuracy, assembly jig needs to be more precise



Tubes oscillate in opposition, creates sine wave time delay via voltage, proportional to mass flow rate

Brace bars provide structural stability and maintain parallelism of tubes



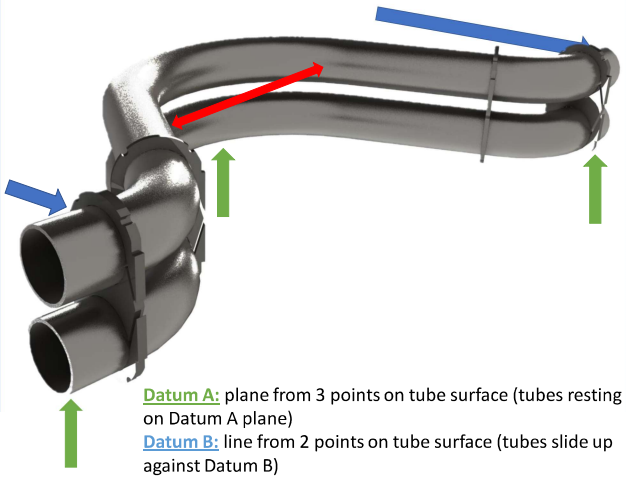


Tube cross section exhibits "ovality" or deviation from perfect circularity of 4%, must be accounted for in structure by brace bar conformance

$$\text{Ovality \%} = \frac{(\text{Max OD} - \text{Min OD})}{\text{Nominal OD}} \times 100$$

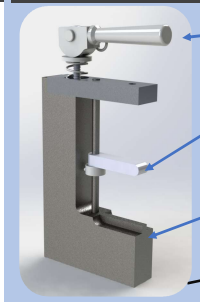
Objectives

- Position Flow Tubes and Brace Bars with respect to each other and datums
- Achieve tolerances specified in assembly drawings provided by client
- Design new Brace Bar geometry that improves conformity to tubes
- Integrate Brace Bar clamping mechanism into Positioning Jig
- Reduce handheld tooling needed in assembly process
- Simplify assembly process (utilize Design For Assembly Metrics)



Datum A: plane from 3 points on tube surface (tubes resting on Datum A plane)
Datum B: line from 2 points on tube surface (tubes slide up against Datum B)
Datum C: point at center of tooling marks on the same tube

Design



Cam handle secures spacing between Flow Tubes

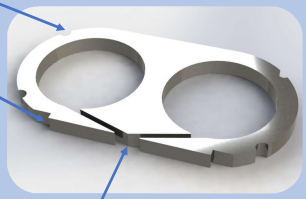
Spacer maintains proper spacing between tubes

Ridge defines Datum A at apex

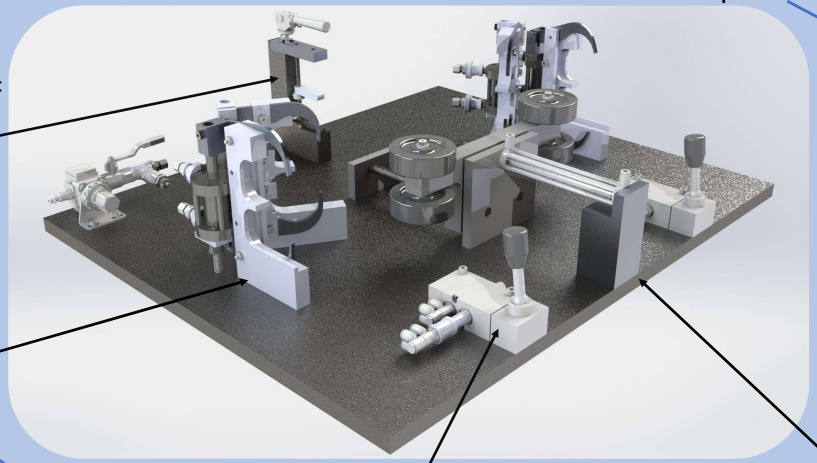
Apex Spacer Subassembly

Exterior hinges aid in Brace Bar conformity at flow tube interface

Brace Bar Geometry Redesign

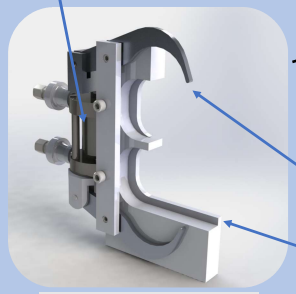


Notch interfaces with chopstick



Intersecting gaps allow for one tac weld

Pneumatic actuator clamps Brace Bar



"Chopsticks" clamp down on Brace Bar

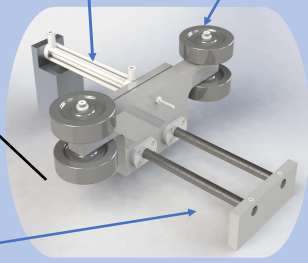
Elevated ridge defines Datums A & B

Clamping Subassembly

Pneumatic actuator controls

Wheels define Datum C

Pneumatic actuator



Linear track constrains snow plow motion

"Snow Plow" Subassembly

Results

Design for Assembly (DFA) Assessment

	Overall Assembly Steps	Number of Loose Tools	Number of Reorientations
Pre-redesign	22	8	3
Redesign	10	1	1

Reducing DFA Metrics

- Eliminates needs for vice grips and crescent wrench
- Operator can insert tubes into jig in same orientation as assembled
- One slot on brace bars reduces number of tac welds
- Simultaneous clamping of brace bars and pushing of snow plow

Conclusions

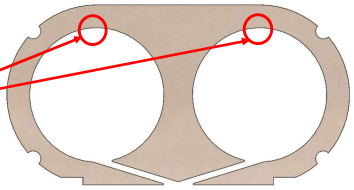
Impact

- Reduces steps required to assemble Flow Meter Subassembly
- Simplifies assembly process to allow for less training
- Improves Brace Bar conformity at Flow Tube interface
- Achieves specified tolerances of assembly drawing

Future Improvements

- Current assembly weighs ~100lbs
- Further simplify jig to improve ergonomics
- Conduct higher level analyses on what materials can be lighter
- Further analyze placement of brace bar hinges/add tool to open brace bars
- Provide housing for pneumatic tubing

Adding internal hinges will allow for easier brace bar handling



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