Team 08: Vacuum Bleeder

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Objective:

- Develop a semi-automated vacuum bleeder for off-road racing shocks.
- Reduce mess, oil waste, and operator dependency in the current manual process.
- Improve fill consistency by cycling between vacuum and pressurized oil injection using a PLC/HMI - Controlled tabletop machine.

Background:

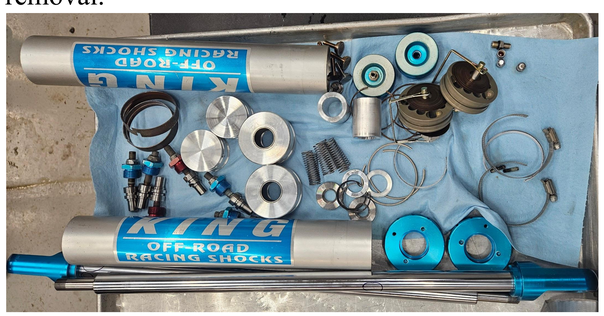
- Lenger Racing currently bleeds shocks using a manual vacuum-and-fill process guided heavily by operator experience.
- The process is time-consuming, inconsistent, and more difficult for complex shocks with trapped air pockets.

Specifications:

- Budget target: under $5,000
- Power: standard 120 VAC
- Shock compatibility: 8–22” in length, 2–4.5” in bore
- Oil volume range: 0.1–1.5 gal
- Tank capacity: 1.5–3 gal target
- Injection pressure: up to 170 psi
- Cycle time target: 3–30 min
- Under 350 lbs

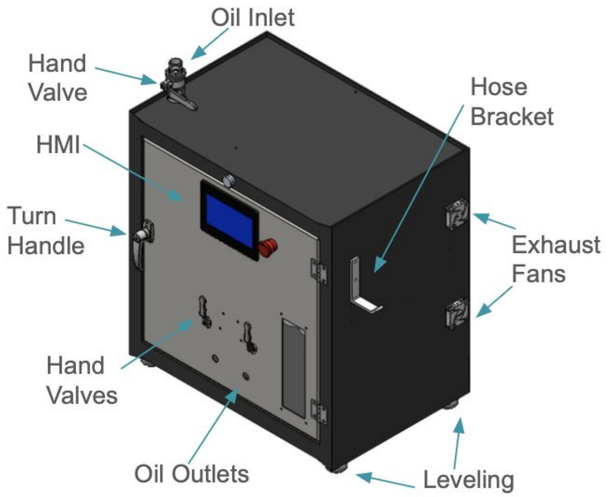
Use Case:

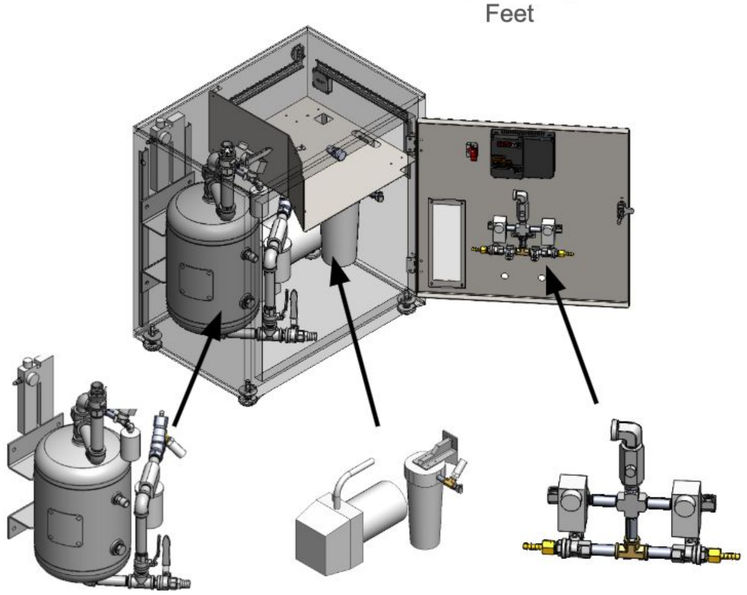
- Operator mounts one or two compatible shocks and selects setup on the HMI.
- Machine pulls vacuum, injects oil, then repeats the cycle as needed.
- Operator watches a semi-clear hose for remaining air and confirms when bleeding is complete.
- System then safely returns the shock to atmospheric pressure for removal.



Design Approach:

- Built around four subsystems: injection, vacuum, relief, and controls.
- Injection system uses a pressurized ASME-certified tank to deliver oil into the shock.
- Vacuum system removes trapped air and uses a catch reservoir to protect the pump from oil ingestion.
- Relief path safely depressurize the tank and shocks during end-of-cycle, fault, E-stop, or power loss.
- Horner X7A PLC/HMI serves as the main controller and operator interface
- Sensors include injection pressure, vacuum pressure, flow rate meter, and fluid level switch.





Results:

- Successfully assembled and integrated the injection, vacuum, and control subsystems into a single automated machine.
- Tested the system using a 2.0 in. diameter shock with an 8 in. stroke length, successfully completing the vacuum and oil injection cycles.
- The 2.0 in. diameter shock completed the bleeding process in an average time of approximately 11 minutes.
- Tested the system using a 3.5 in. diameter shock with an 18 in. demonstrating compatibility with larger off-road shocks.
- The 3.5 in. diameter shock completed the process in an average time of approximately 21 minutes.
- Both shock sizes were completed within the specified cycle-time target of 3-30 minutes, demonstrating compatibility with different shock sizes.

Notable Challenges:

- Shock geometry varies significantly, making universal fixturing difficult.
- Packaging plumbing, electrical components, and maintenance access into a compact enclosure required multiple design tradeoffs.
- Leaking fitting were a major issue during assembly and testing, requiring multiple connections to be resealed and repositioned.
- Check valve location had to be revised during testing to prevent air backflow into the shock.