Wood Stove with Forced Convection for Rich Quench Lean Combustion

David A. McClinton and Ajay K. Agrawal
The University of Alabama

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Wood Stoves

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- Are common in First and Third world countries
- They produce harmful emissions like Soot and Carbon monoxide
- They have poor thermal and combustor efficiencies
- After treatment systems are being devolved to solve the emission issues

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Wood Stove Standard Operation

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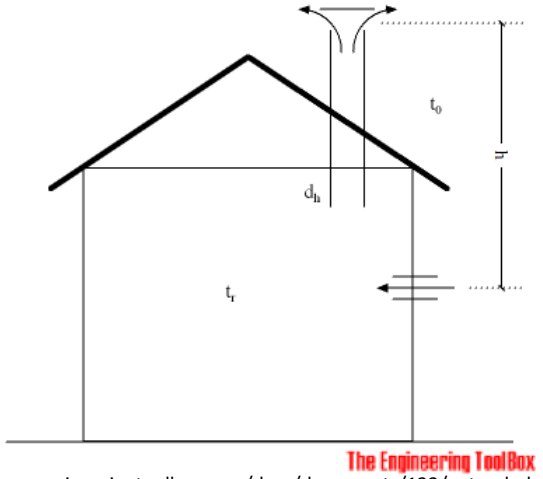
- Wood is loaded in through a door
- Natural draft drives the combustion air
- Heat must be in the chimney and causes poor thermal efficiency
- Limited control of heat output



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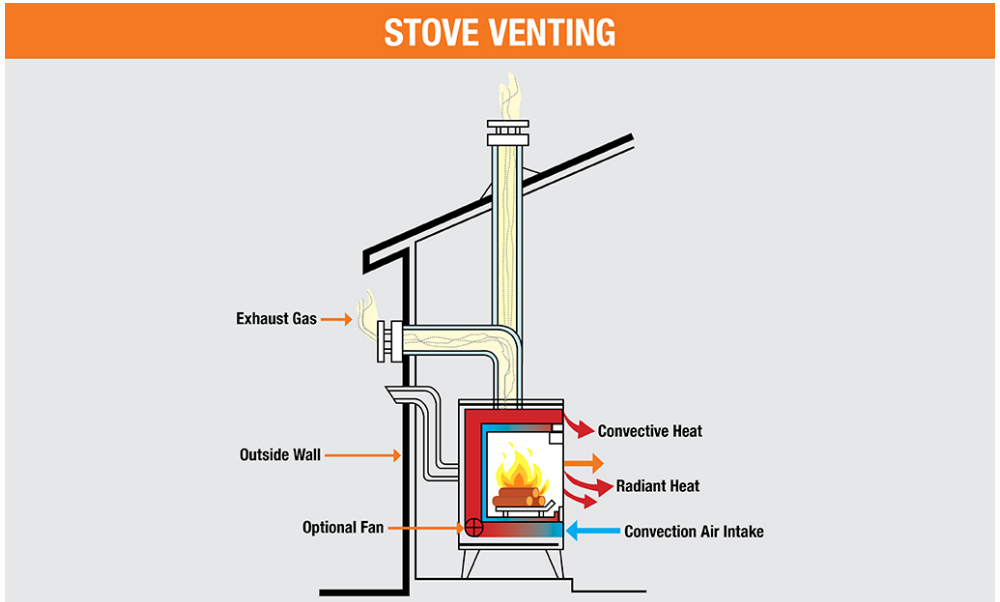

https://contentgrid.homedepot-static.com/hdus/en_US/DTCCOMNEW/Articles/best-wood-stoves-for-your-home-section-1-A.jpg

Emission Comparison

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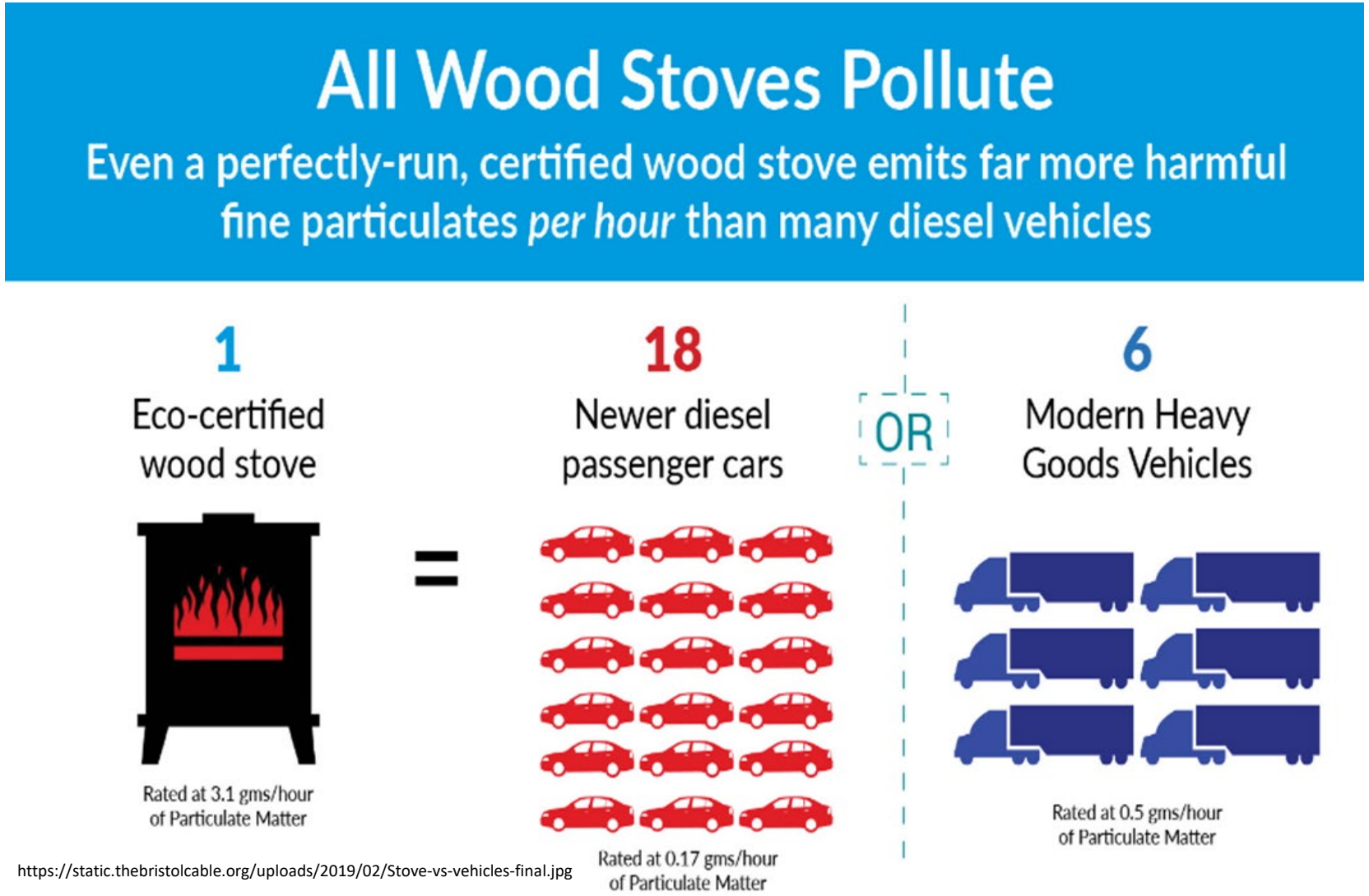

https://static.thebristolcable.org/uploads/2019/02/Stove-vs-vehicles-final.jpg

Objective

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- Develop wood combustion methodology to reduce emissions
- Incorporate forced draft system to have control of gasification air
- Provide a clean combustion wood combustor for more efficient heat transfer system

Rich Quench Lean (RQL)

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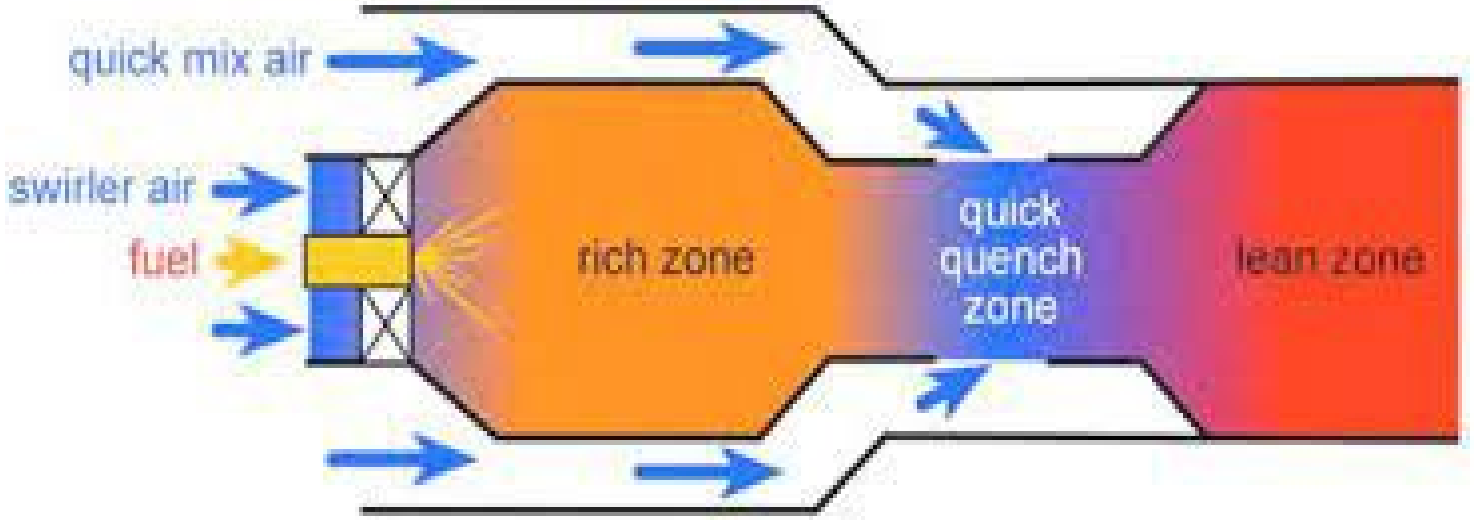
- RQL is commonly used in the aviation gas turbine industry to reduce emissions for liquid fuels



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Combustor and Full system Diagram

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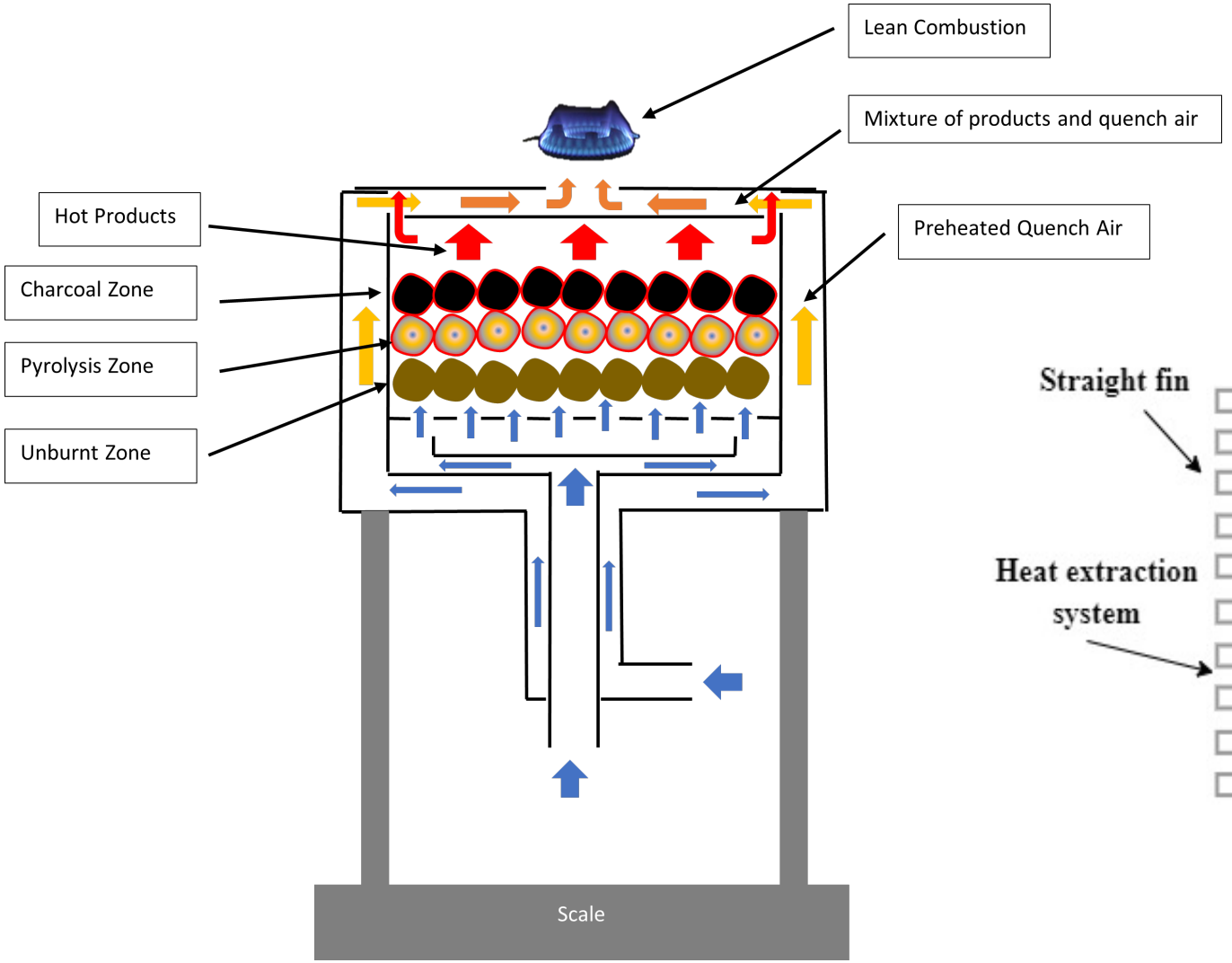

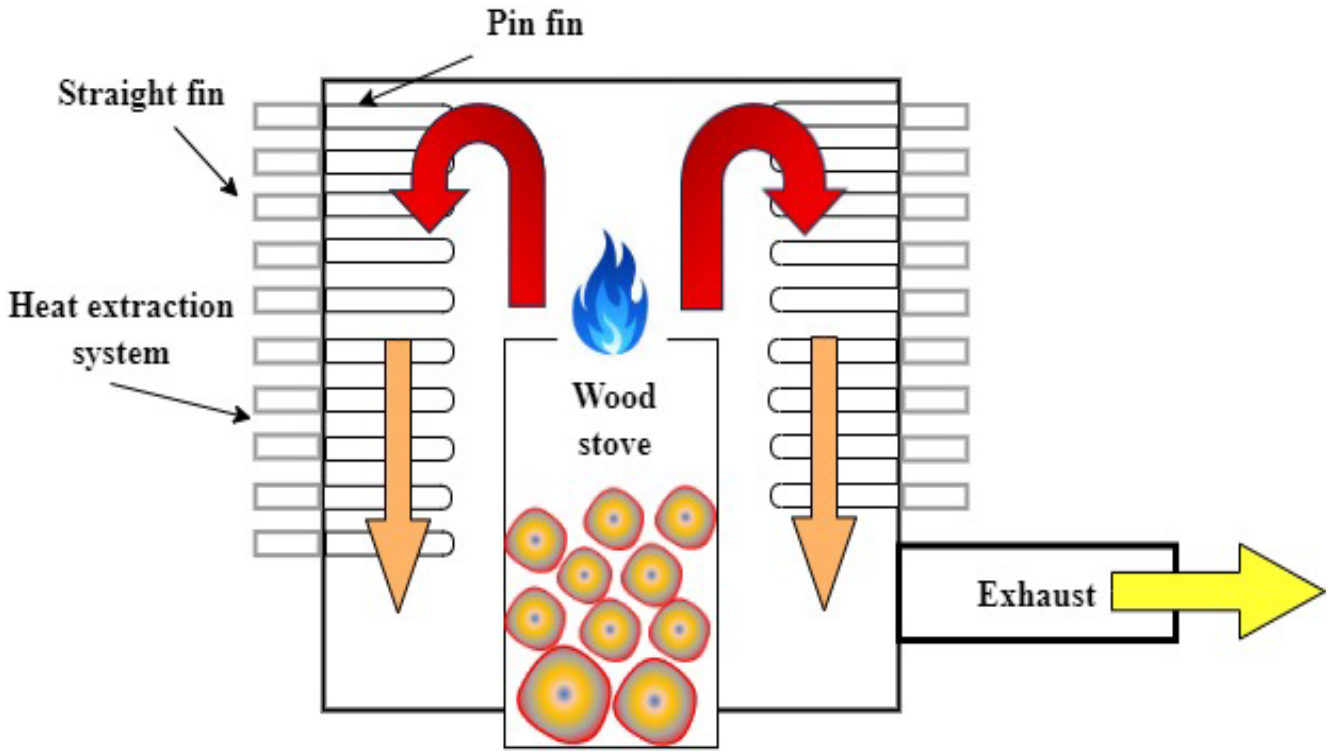

Experimental Setup

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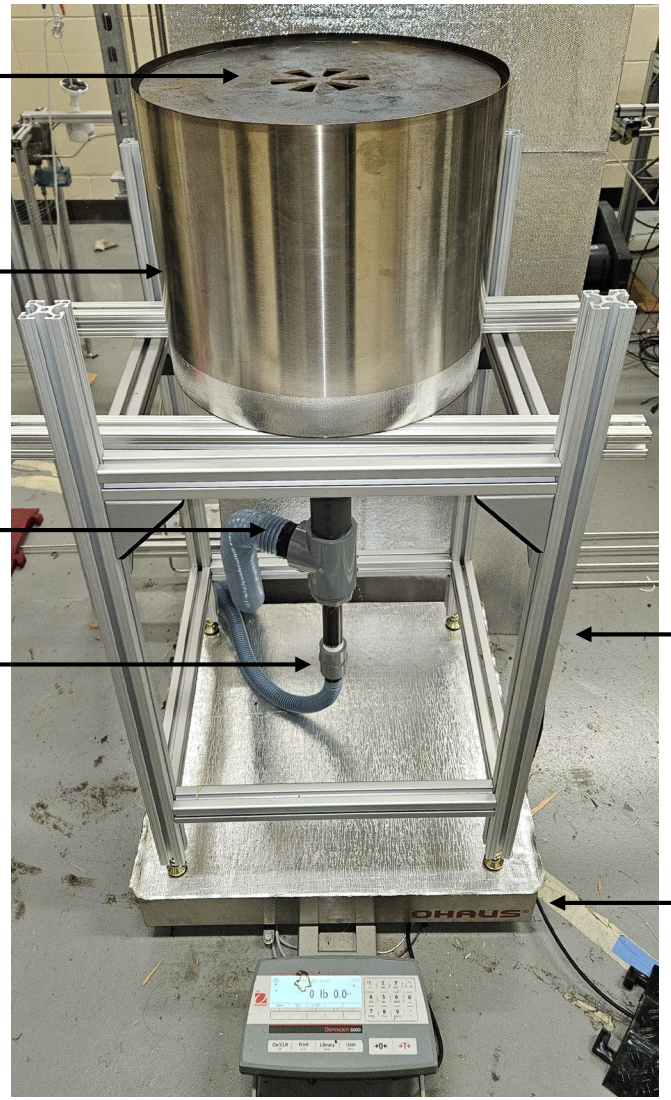
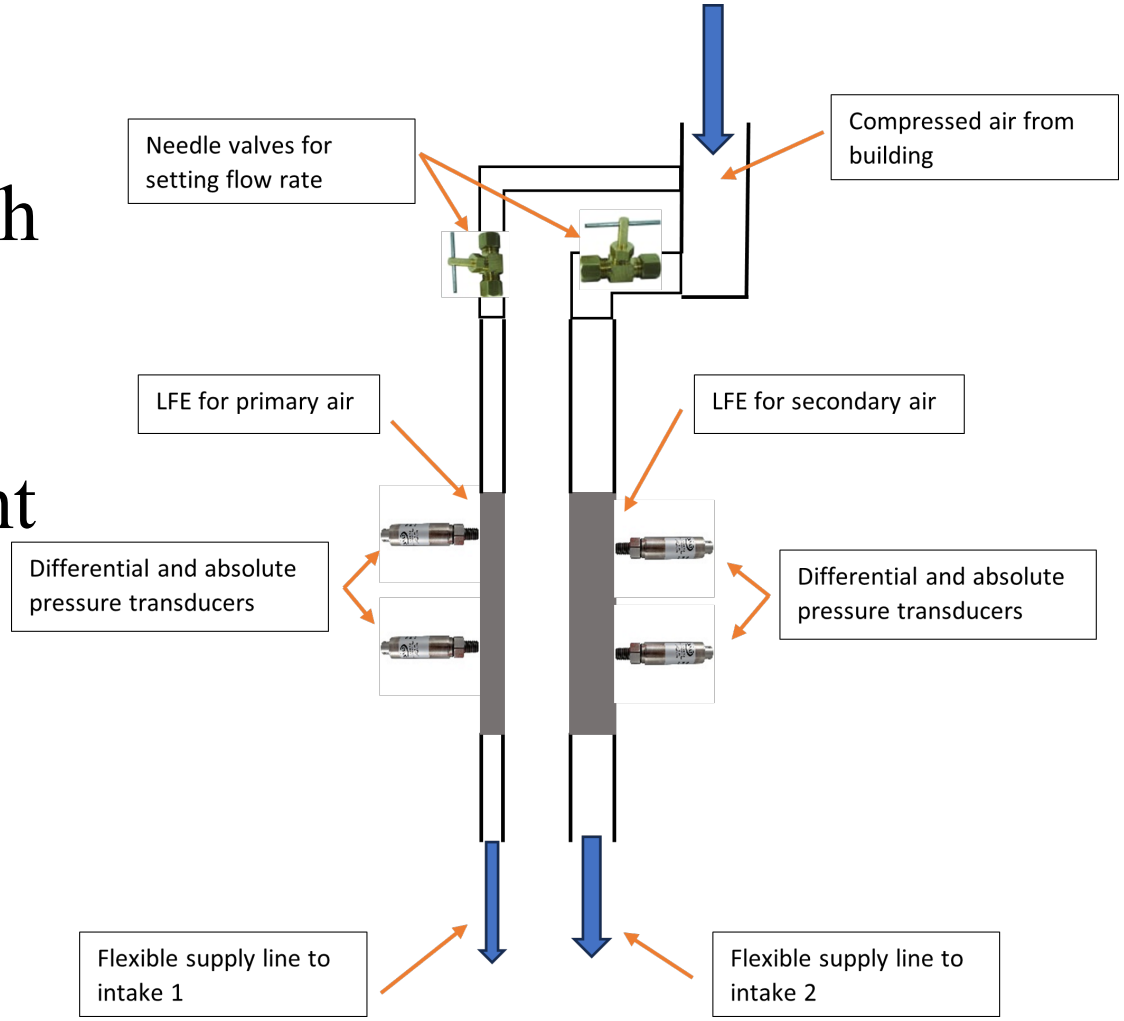


Forced Draft Measurement

- Compressed building air
- Laminar Flow Element (LFE) for each chamber
- Instrumentation on each LFE
- Flexible hoses for scale measurement



Measurement Capabilities

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- LFEs for volumetric flow rate (SLPM)
- Scale for burn rate (g/min)
- Thermocouples for product gas and quench air temperatures (°C)
- Visual imaging for flame characteristics
- Species concentration for product gas coming soon…

Baseline Gasification Chamber Testing

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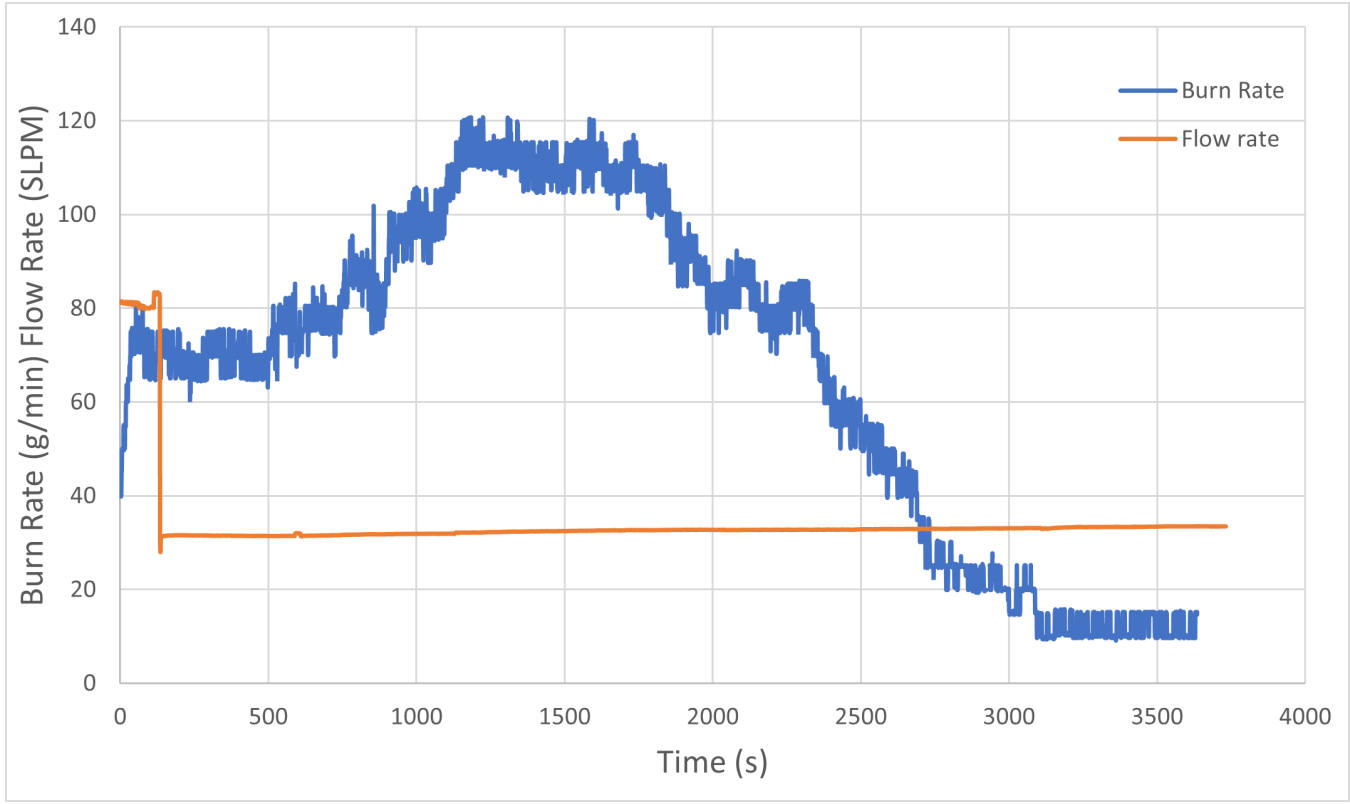
- Test was to determine the affects of natural draft on the gasification chamber



Gasification Chamber Testing with Hardware

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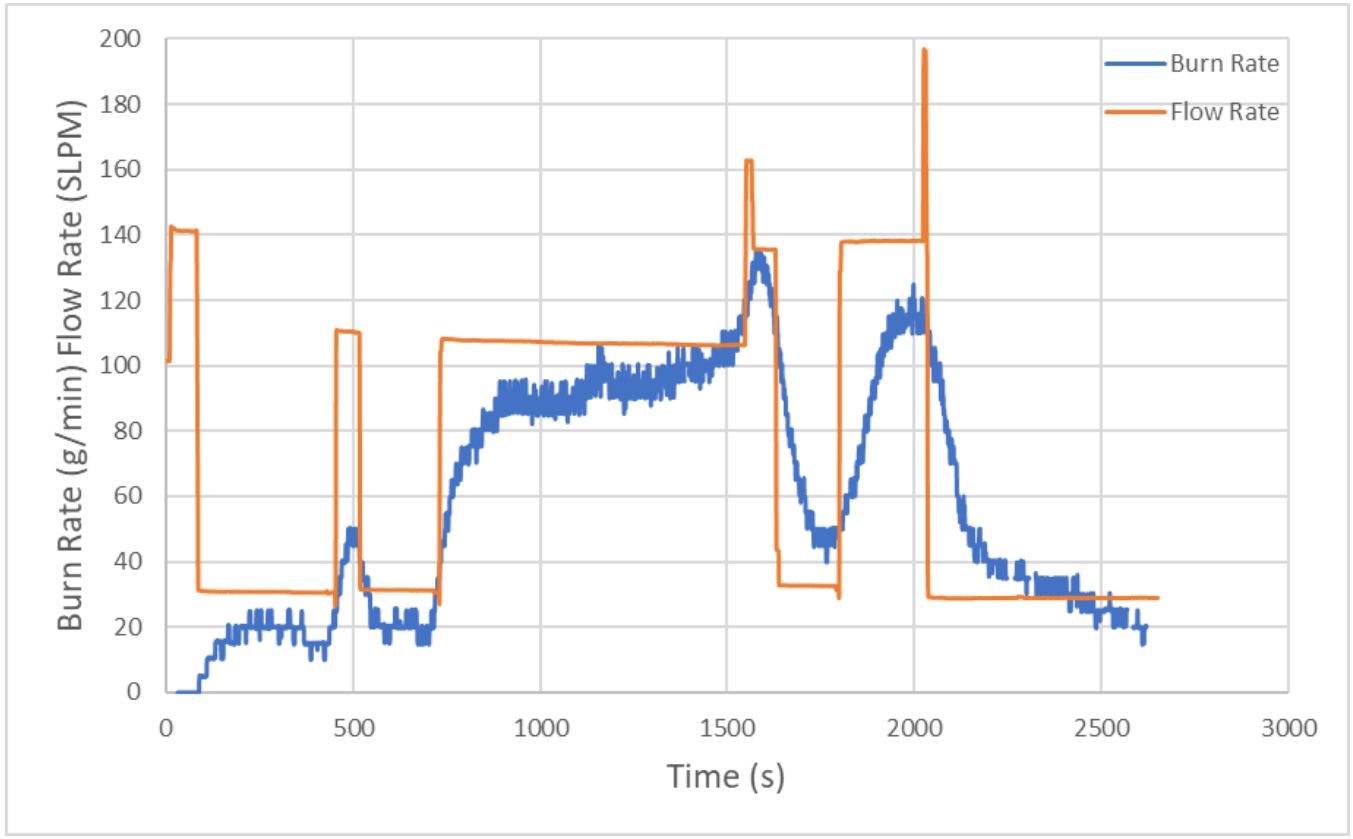
- Test was to determine the affects of forced draft on the gasification chamber



Secondary Combustion

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- Large jet flame produced
- Pre-mix combustion
- Can control how much quench and product gases are provided
- Mostly blue flame
- Stable at these flow rates

Conclusions

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- Forced draft allows control of burn rate
- Gasification air flow rate is important for quality of product gas
- Mixing quench air and product gases is an important parameter for achieving secondary combustion
- Stabilizer plate configuration is important for flame size, number of flames produced, and stabilization

Going Forward

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- Have the ability to determine species and concertation of gasified wood
- Multiple iterations of flame stabilizer plate
- Determine turn down ratio
- Integrate clean combustion wood combustor into a high efficiency heat transfer system

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