A NOVEL STEAM CONDENSER WITH LOOP THERMOSYPHONS AND FILM-FORMING AGENTS FOR IMPROVED HEAT TRANSFER EFFICIENCY AND DURABILITY

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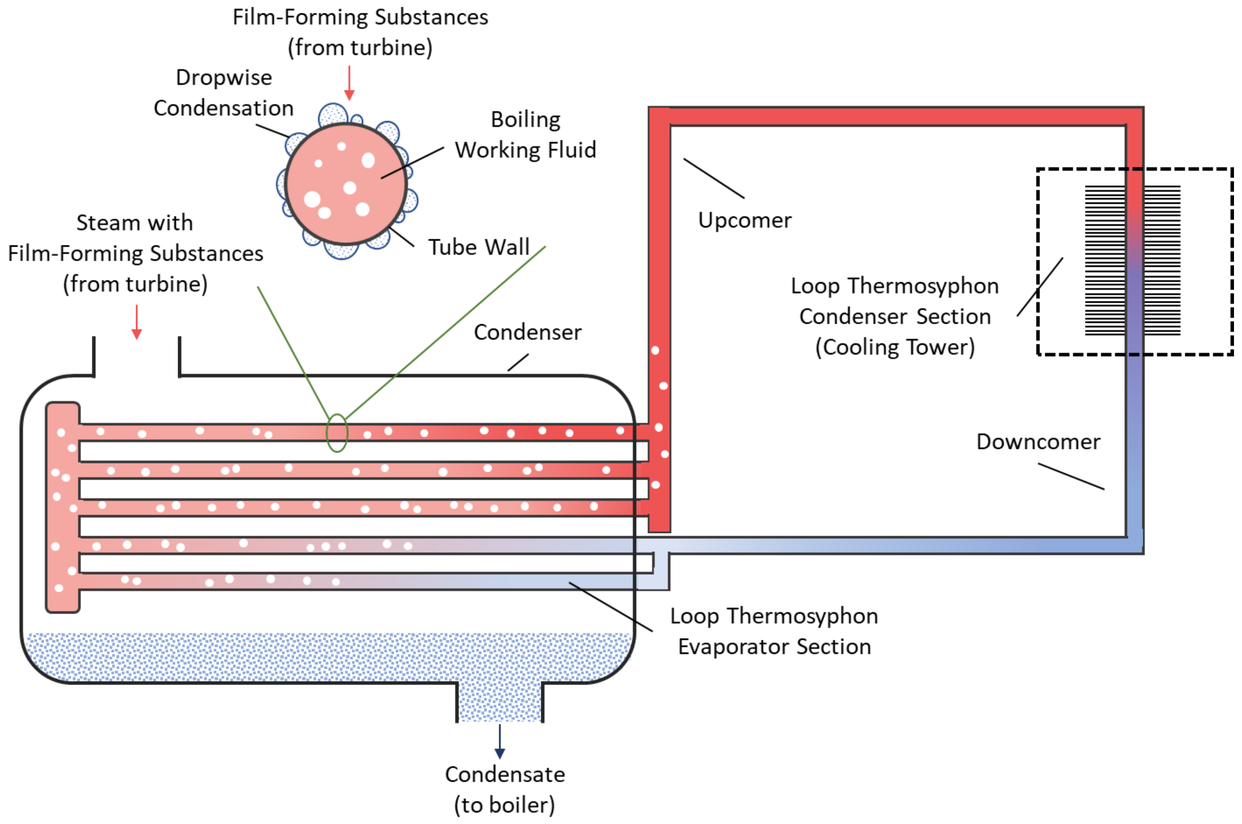
INTRODUCTION

<u>Goal</u>

- Develop robust film-forming amine coatings applied to steam surface condensers to enhance performance and efficiency for coal-fired power plants
- Replace pumped cooling water systems with passive loop thermosyphons to reduce energy use, limit operations and maintenance issues, and promote high thermal performance
- Apply long-term coating solution on steel and copper tubing to promote enhanced dropwise condensation

<u>Research Areas</u>

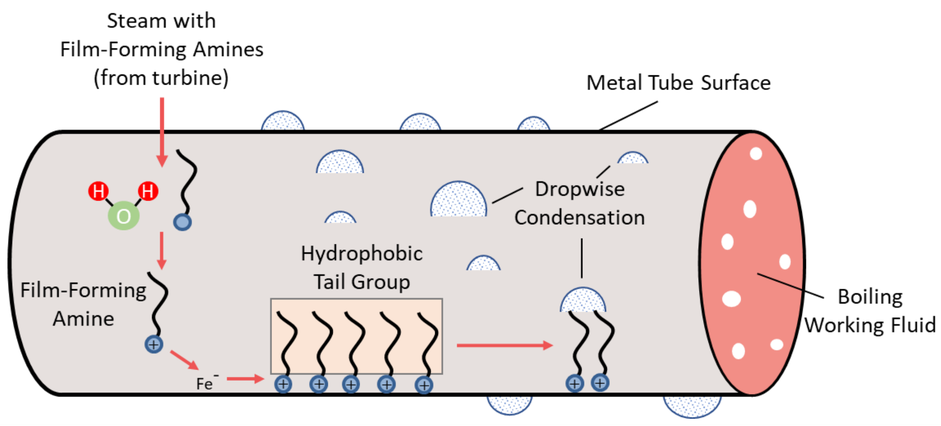
- Dropwise condensation enhancement using polyamines
- Corrosion mitigation of condenser surfaces
- Scalability of loop thermosyphon
- Thermal performance of passive two-phase loop thermosyphons with a closed circuit cooling tower



NEED

<u>Power Plant Efficiency Improvements</u>

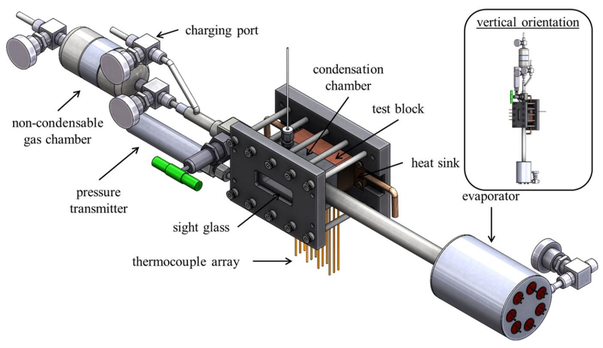
- Develop cost-effective, reliable technologies to improve the overall efficiency of new and existing coal-fired power plants
- Water management through reduction in freshwater use
- Hydrophobic coatings applied to condenser surfaces can sustain enhanced dropwise condensation behavior

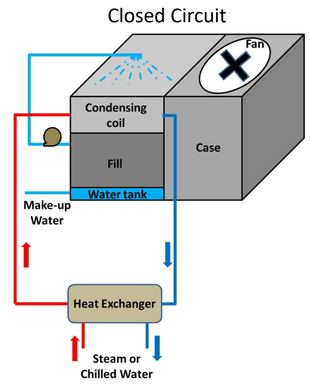


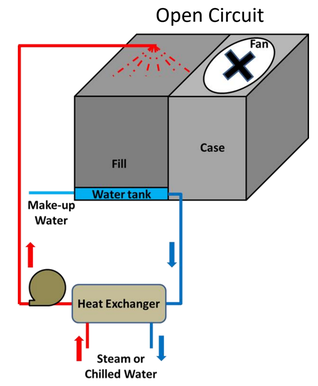
APPROACH

<u>Test Setup & Design</u>

- Use a flat plate condenser test apparatus for performance evaluations
- Design and fabricate tall loop thermosyphons and evaluate the impact of the height on start up & transient conditions
- Compare the thermal performance between a pumped cooling water loop with an open circuit cooling tower and loop thermosyphon with a closed circuit cooling tower



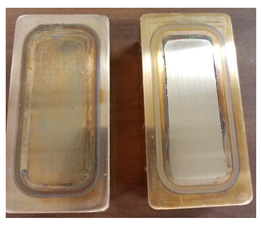


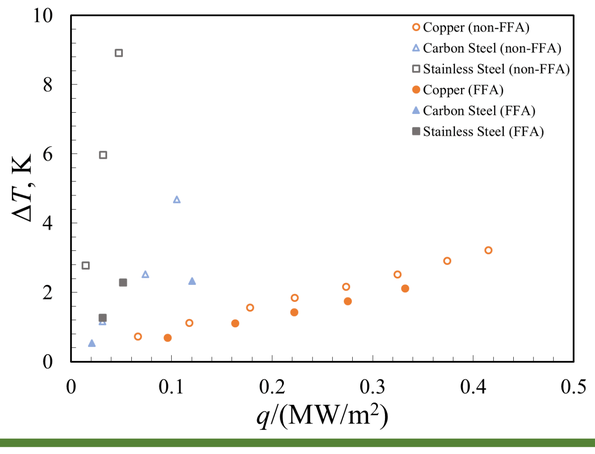


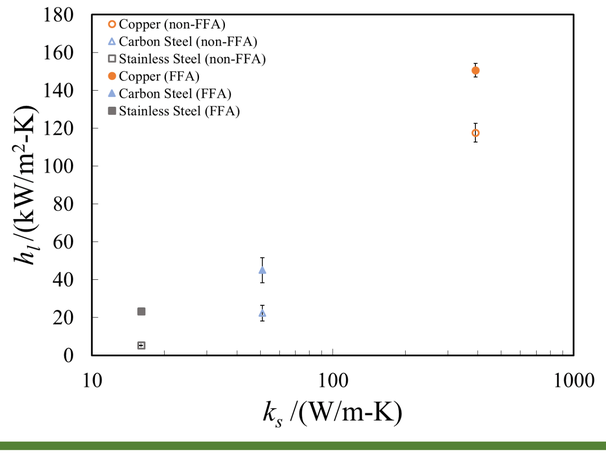
RESULTS

<u>Initial Findings</u>

- Copper is protected from oxidation and maintains high thermal performance (h = 160 kW/m^2-K)
- Carbon and stainless steel currently only have short term performance benefits







BENEFITS/FUTURE WORK

- Determined how to apply FFA coatings in a deoxygenated atmosphere to prevent surface corrosion & pitting
- Initial dropwise condensation thermal performance results suggest potential for 2-16x improvement
- Need to determine how to apply a robust FFA coating on carbon and stainless steel, possibly by using another phase of the material

- The scalability and impact of height on loop thermosyphons is being evaluated to adapt to power plant cooling systems
- The integration between loop thermosyphons and commercially available closed circuit cooling towers will be conducted for thermal performance testing

Project No. DE-FE0031657

2019 Crosscutting Annual Review Meeting
Pittsburgh April 10th, 2019, Pennsylvania