P.I. Professor Dunn-Rankin
Project Scientist: Dr. Chien
Team Members: Candy Hernandez, Fahd AlBalawi, Michelle Tanaka, Christopher Vuong

Combustion: Hot Air Balloon Burner Engineering

UCI Samueli School of Engineering

Project Goals

The primary goal of this project is to research and design a functional adjustable testing method for finding the combustion efficiency and emissions of an MK-32 burner used in hot air balloons. This study investigates a single 3.2 MW propane burner and how efficiency varies with different flame burst times.

Background

The MK-32 burner supplied by UltraMagic Ballooning has a maximum power output of 3.2 MW at a nominal pressure of 6 bar. The burner provided flame is 5-7 m tall. Liquid propane is heated within the burner's coils with a pilot flame before main flame ignition. Heat addition from the burner is provided in combustion bursts, with overall heat addition provided by: *burner burst time x burner burst frequency x burner thermal efficiency*

Project Significance

- Optimizing the control of the balloon flight will depend on the relationship between the burner operating mode and its efficiency.
- Reduce fuel costs for hot air balloon operators
- Quantifies emissions for improvement of air quality from operation
  - NOx forms smog and acid rain
  - CO is harmful for human health, reduces the amount of oxygen delivered to organs.

Results

- As seen in Figure 2, efficiencies are directly related to burst time. The 15, 10, 5, and 1 second burst peak efficiencies were 71.2%, 72.8%, 78.6%, and 81.2%, respectively.

- NO_x emissions are reduced with shorter flame burst times. Peak NO_x emissions for 15, 10, 5, and 1 second bursts were observed to be 23.5,16.3, 10.7, and 3.4 ppm, respectively.

Figure 1. Winter Quarter Costs

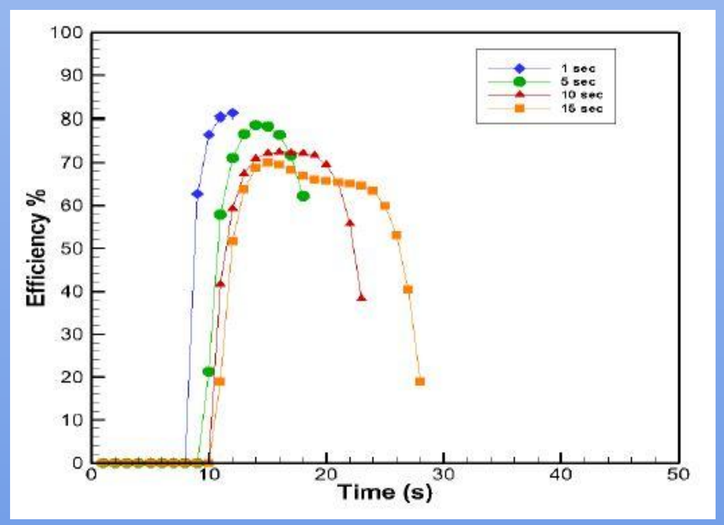

Figure 2. Efficiency comparison with burst time

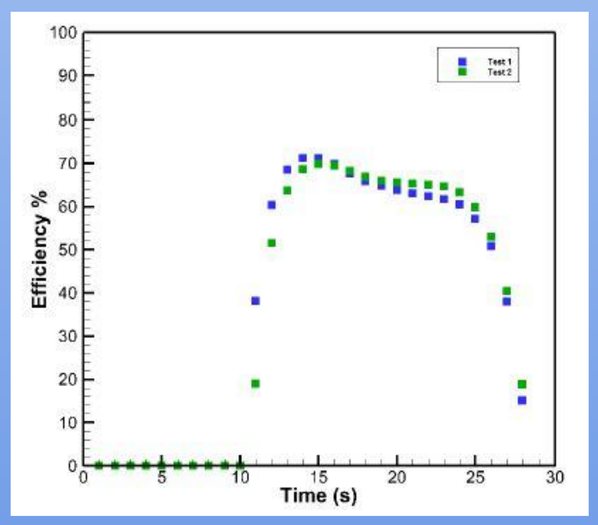

Figure 3. Efficiency for 15 second burn time

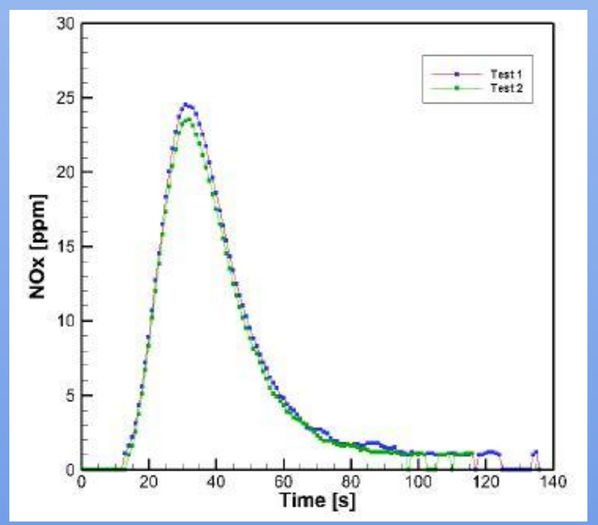

Figure 4. NOx emissions for 15 second burn time

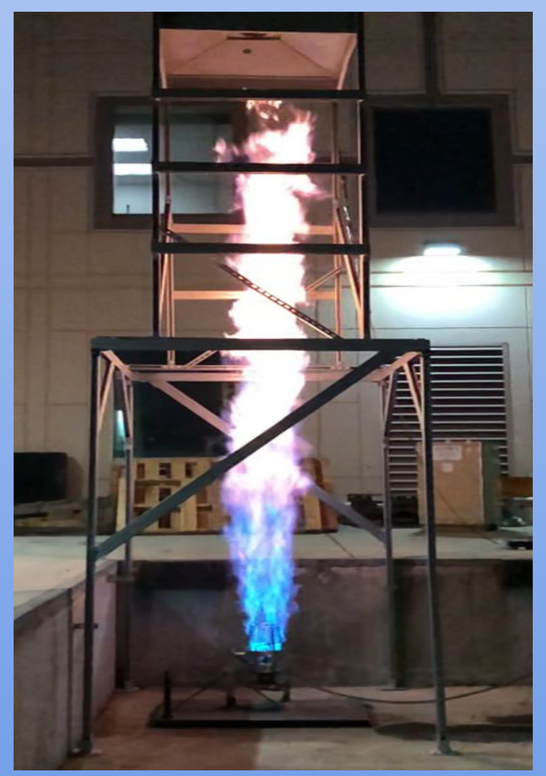

Figure 5. MK-32 burner flame