Thermal Investigation of sUAS Motors Under Varying Power Conditions

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Introduction

- Unmanned aerial systems (UAS) are growing in popularity and size

- Common uses:
  - Filming
  - Farming
  - Deliveries
  - Inspections

- Future uses:
  - Military cargo
  - Air taxis
Objective

• Investigate the relationship between motor size, power, and temperature

• Test methods of self-cooling to mitigate temperature spike

• Figure out what happens if a
• motor (or controller) gets too hot
Methodology

• KSU’s eVTOL Propulsion Test Stand
  • Rcbenchmark Series 1780 Thrust Stand and Dynamometer

• Measurable Variables:
  • Throttle setting
  • Thrust
  • Torque
  • Rotational speed
  • Temperature
General Motor Operation

1. Motor Started
2. Heat Up
3. Equilibrium Temperature
4. Power Cutoff
5. Temperature Spike
6. Max Temperature
7. Cool Down
Heating & Cooling Slope Equations

- 3 motors (4 tests each)
- Heating slope very consistent
- Cooling slope similar for each motor
Self-Cooling

• Motor heated to 135°F
  • Uncooled- Motor shut off
  • Cooled- Throttle reduced to 20% until 100°F

• Reduced temperature spike by ~55°F

• Self-cooling took ~3 minutes
Thermal Runaway

- Motor temperature increases rapidly after shut down
- Occurs at higher throttle settings
- Temperature can change 45°F in ~35 seconds
Custom Motor Head

• KDE Direct 7215XF motor continuously exhibited thermal runaway

• Design a new head to increase airflow and decrease thermal runaway

• Cut short due to university shut down
Conclusion

• There is a relationship between motor size, power and temperature

• Running a motor at low throttle settings before shut-down can be effective in self-cooling

• Fire and smoke make for interesting lab experiments