Small -Scale Rocket Engine for Testing (SRT)

KFUPM Design Expo

Team 48

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1. Definition

- Revolutionize space testing with our small rocket engine—a reliable, cost-efficient, and high-pressure powerhouse. Ideal for short-range flights and scientific experiments, our innovative design breaks new ground in rocketry.
- Develop and provide a cost-effective and durable small rocket engine for aerospace testing, addressing the current shortage in the Saudi aerospace industry. Enable researchers and engineers to accelerate innovation and advance aerospace technology

Constraints

Governmental and Public Regulations	Testing limitations
Temperature	Less than 1600 K
Time limitations	Less than 16 weeks
Budget	6000 SAR

Targeted Specifications

Weight of the rocket	Less	5 kg
Combustion Chamber Diameter	Exactly	5.08 cm
Thrust	Around	250 N
Velocity	Above	140 m/s
Targeted Height	Above	20 m
Nozzle Diameter	Exactly	1.52 cm
Burn time	Less	5 sec

2. Propellant

- The standard formulation of KNSB propellant is **65% potassium nitrate** (KN) which serves as the oxidizer and **35% Sorbitol** (SB) which serves as the fuel and binder.

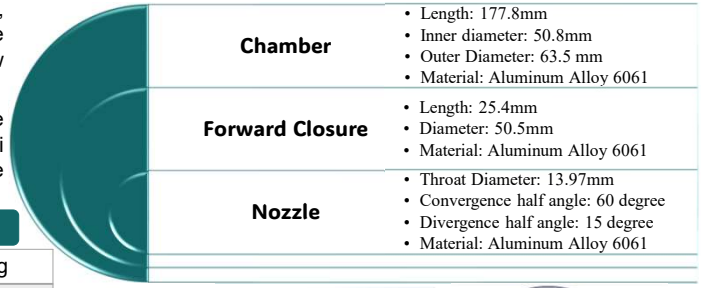
Chemical reaction:

$$3.2129\ KNO_3 + 0.9607\ C_6H_{14}O_6 \rightarrow 1.7953\ CO_2 + 2.3898\ CO + 4.6368\ H_2O + 2.0585\ H_2 + 1.6066\ N_2 + 0.0545\ KOH + 1.5792\ K_2CO_3$$

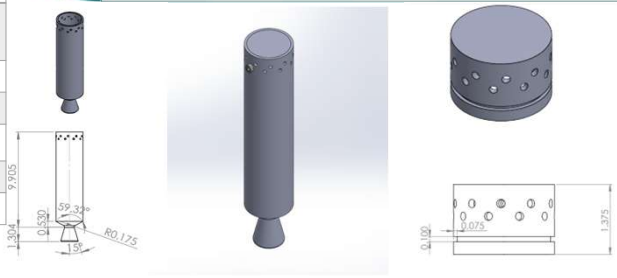
Mass Balance → **Energy Balance** → **Heat Transfer**

Properties		Unite
Density	1750	kg / m³
Cp_{mix}	69.471	J/mol-K
AFT (Adiabatic flam temperature)	1600	K
MW_{eff}	39.867	g/mol

3. Inner Design



Chamber	• Length: 177.8mm • Inner diameter: 50.8mm • Outer Diameter: 63.5 mm • Material: Aluminum Alloy 6061
Forward Closure	• Length: 25.4mm • Diameter: 50.5mm • Material: Aluminum Alloy 6061
Nozzle	• Throat Diameter: 13.97mm • Convergence half angle: 60 degree • Divergence half angle: 15 degree • Material: Aluminum Alloy 6061



4. Outer design

Nose cone
Dimeter 5.20 cm
Length 10.2 cm

Body Tube
Dimeter 5.20 cm
Length 29.9 cm

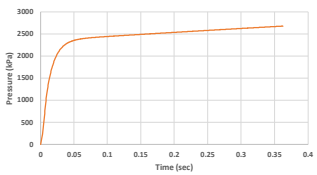
Fins
Hight 8 cm
Sweep angle 17.2 degree

Total length 45.2 cm

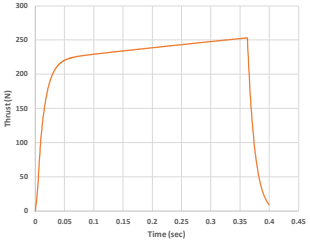
5. Validation

- The maximum Thrust generated by the engine is 253 N in less than 0.4 sec.
- Calculating the control limits showed that we are 95% confident that thrust generated will exceed 229.6 N.
- The maximum Pressure generated by the engine is 2680 kPa.
- The Combustion Chamber Diameter and Nozzle Diameter were 2 in and 0.6 in respectively.
- The velocity exceeds 143.1 m/s
- The rocket weight is 4.8 Kg.

Pressure over Time



Thrust Over Time



6. Safety

The Ignition System
- Remote activation system located 10m from launch site minimizes risk during ignition

The Propellant
- The specific composition has lower sensitivity to impacts or friction than the other propellant

The Forward Closure
- Designed with an overpressure safety mechanism of bolts that yield before chamber rupture Acts as a barrier of last defense in the unlikely event of a pressure build-up inside the chamber

7. Conclusion

The Small-Scale Rocket for Testing (SRT) is a reliable and economical tool developed for testing initiatives and research in the Saudi Arabian aerospace industry. The project began by identifying the needs of key customers. The focus was on the rocket's size and economic feasibility. The goal was to achieve targeted specifications. Safety considerations were addressed through component inheritance and fuel production.