AUBURN UNIVERSITY
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COLLEGE OF ENGINEERING
AEROSPACE

AERO 4970/7970 **Rocket Propulsion I** **SET IX**

Solid Propellant Rocket Fundamentals

1. What is the ratio of the burning area to the nozzle area for a solid propellant motor with these characteristics?

Propellant specific gravity	1.71
Chamber pressure	14 MPa
Burning rate	38 mm/s
Temperature sensitivity σ_p	0.007 $(K)^{-1}$
Specific heat ratio	1.27
Chamber gas temperature	2,220 K
Molecular mass	23 kg/kmol
Burning rate exponent n	0.3

Answer: 159.165.

2. Plot the burning rate against chamber pressure for the motor in Problem 1 using $r = ap_1^n$ and chamber pressures between 11 and 20 MPa.

3. What would the area ratio A_b / A_t in Problem 1 be if the pressure got increased by 10%? You may rely on the curve obtained in Problem 2.
Answer: 170.

4. Design a simple rocket motor for the conditions given in Problems 1 and 2 for a thrust of 5,000 N and duration of 15 s. Determine principal dimensions and approximate weight.

5. A newly designed case-bonded rocket motor with a simple end-burning grain failed and exploded on its first test. The motor worked well for about 20% of its burn time, when the record showed a rapid rise in chamber pressure. It was well conditioned at room temperature before firing and the inspection records did not show any flaws or voids in the grain. Make a list of possible causes for this failure and suggestions on what to do in each case to avoid a repetition of the failure.

6. Derive the following equation:

$$\pi_K = \frac{1}{1-n}\sigma_p$$

Hint: First derive π_K by differentiating $r = ap_1^n$ with respect to the temperature.
Note: This relation does not fit all the experimental data fully because there are other variables besides n that have a mild influence.