# 16.522 Space Propulsion
# Homework #4

**Handed: 2/26/04**
**Due: 3/4/04**

**Problem 1**

In class, we found that an electrically preheated hydrazine thruster limited to a 2000K temperature yielded a specific impulse or 334s. As an alternative, consider the use of Ammonia ($NH_3$): the advantage is the lighter decomposition gas mixture ($2NH_3 \rightarrow N_2+3H_2$), the disadvantage is the negative enthalpy of liquid ammonia (-11.0 kcal/mol). Assuming $\gamma$=1.33 and $\frac{A_e}{A_t} = 50$, calculate the specific impulse for the same top temperature, and the thrust obtainable for a power of 864w (compare to 0.693N for hydrazine).

**Problem 2**

The DSCS-III satellite has an initial mass of 1043 kg. Assuming the amount of hydrazine needed for the 10 yr. Mission is 30% over that needed for NSSK alone, dimension and estimate the mass of the fuel tank, with the following assumptions:

| | |
|---|---|
| NSSK fuel: | 135.5 kg |
| Materials: | Titanium, $\rho = 4.42 g/cm^3$, $\sigma_{allowable} = 6.9 \times 108$ N/m$^2$, Minimum gauge = 0.3mm, Hemispherical elastomer diaphragm, 2mm thick, $\rho = 900$ kg/m$^3$ |
| Reinforcements: | -10cm wide equatorial band (covering weld), double thickness<br>-2 10 cm diameter discs around fill and discharge holes (double thickness),an elastomer mounting "bead", 2 mm thick, 2cm wide, reinforcing diaphragm attachment. |
| Structural Attachments: | 2% of supported mass |

Pressurization is by Nitrogen gas, and the blowdown ratio ($P_{max}/P_{min}$) is 4.5
Temperature is assumed to remain at 290K.

Select $P_{MAX}$ = 400 psia.

**Reference**: Spacecraft Propulsion, by Ch. D. Brown, AIAA Education Series, 1996.