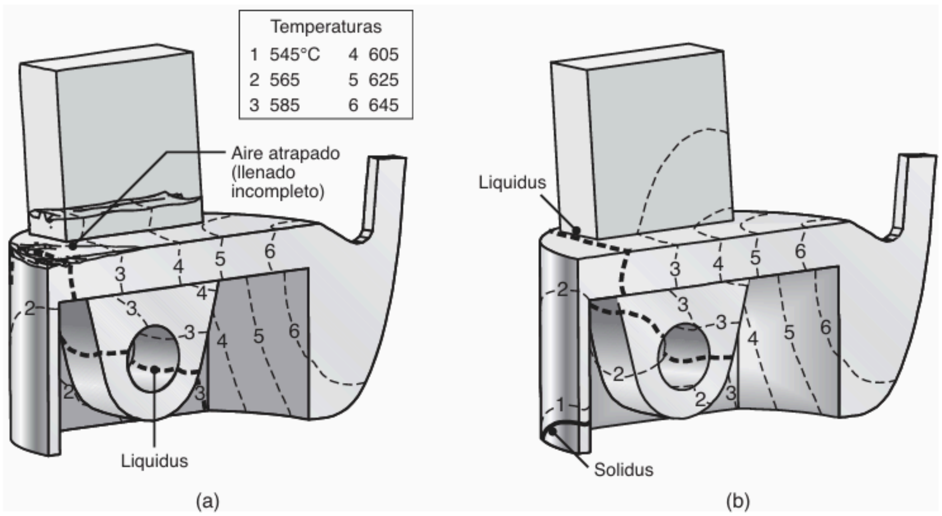
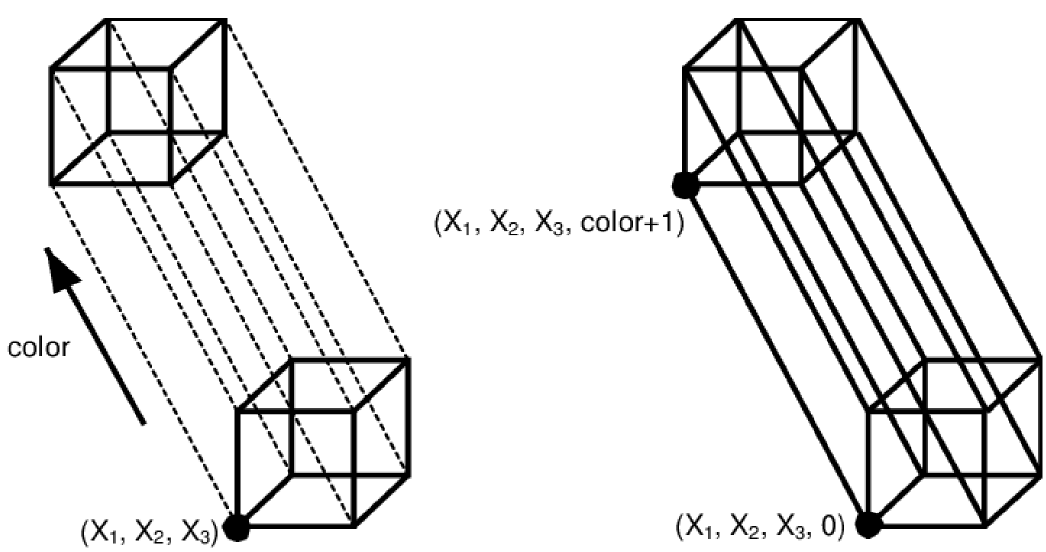
Composites_propellants(I)



Composite structures Material and manufacturing process improvements, for composites in particular, generally increase specific strength and stiffness, while improved thermal stability for items such as optical benches is being achieved with carbon-carbon and ceramic materials. Carbon fibres derived from mesophase pitch give improved conductivity and modulus over standard carbon fibres derived from polyacrylonitrile (PAN), but they have lower compressive strength. This is good for optical benches but can be a problem at joints in highly loaded primary structures. Introducing carbon nanotubes into composite resins and adhesives or growing them onto the sides of carbon fibres improves thermal and electrical conductivity, strength and stiffness. Draping, weaving and stitching of fibres are being used to generate complex shapes which can be complemented by resin transfer moulding or a resin injection process. By integrating systems into composite structures, we may approach the concept of the intelligent structure. Already optical fibres can be embedded into a carbon fibre matrix allowing signals to pass along skins.



Points:

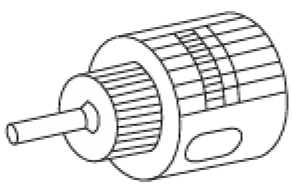
• mechanical including kapton and aluminium laminates,

• physical techniques including shape memory materials and solvent evaporation which suffers from out-gassing problems,

• chemical, thermal and/or UV curing,

• cas catalysed polymers.

For small spacecraft for low Earth orbit constellations or small-scale, single experiments, the designer is required not only to produce an efficient structure to maximize payload but also to respond to the ever-increasing commercial pressure of schedule and cost. Moulded, single component structures that can be stacked for multiple launches are an attractive proposition. The possibility of large numbers of spacecraft for the proposed global constellations.



The ACS designer will need to know the required time-history of the rotational motion, the angular rate ω which is required of the spacecraft, and of any parts of it that can move independently on bearings. The angular momentum Hc and the torque T needed to produce it may then be calculated from the Newtonian law $dHc/dt = T$ where Hc is the angular momentum referred to the centre-of-mass C, detailed in equations.

EXTERNAL TORQUES

Source:
Aerodynamic
Magnetic
Gravity gradient
Solar radiation
Thrust misalignment

INTERNAL TORQUES

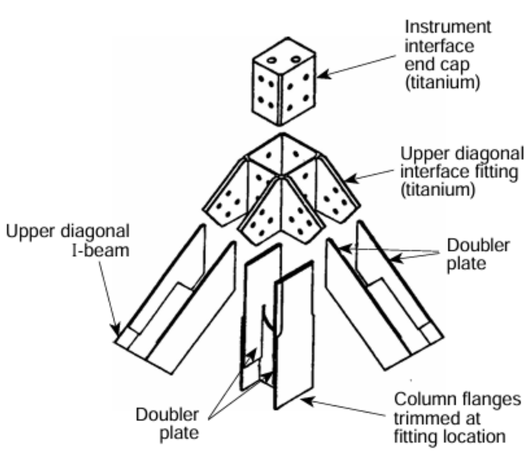
Source:
Mechanisms
Fuel movement
Astronaut movement

Flexible appendages
General mass movement

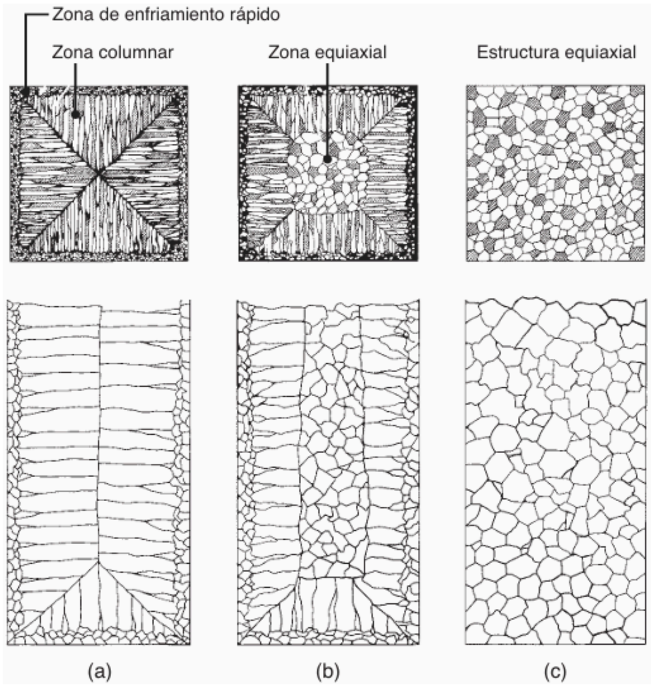
HEIGHT RANGE OVER WHICH IT IS POTENTIALLY DOMINANT

Aerodynamic: <about 500km
Magnetic: 500–35000km
Gravity gradient: 500–35000km
Solar radiation: >700km
Thrust misalignment: all heights

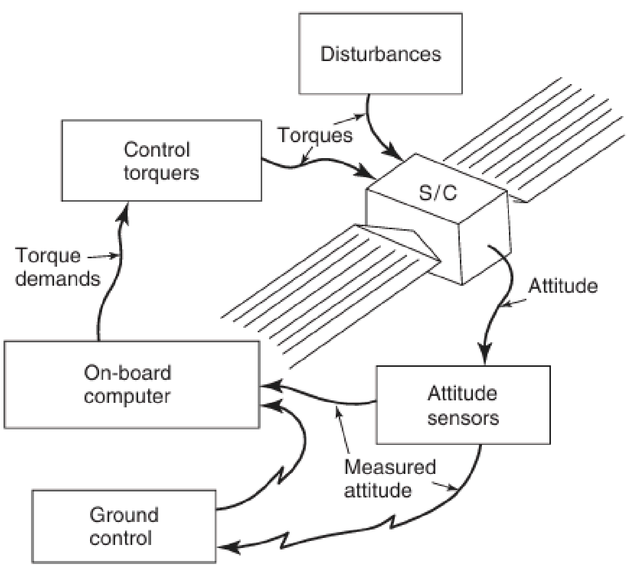
Propellants are often tailored to and classified by specific applications, such as space launch booster propellants or tactical missile propellants, each having specific chemical ingredients, different burning rates, different physical properties, and different performance. Table 12–1 shows four rocket motor applications (each with somewhat different propellants), plus several gas generator applications and an artillery shell application. Propellants for rocket motors produce hot (over 2400 K) gases and are used for thrust, but gas generator propellants operate with lower-temperature combustion gases (800 to 1200 K in order to use uncooled hardware) and are used to produce power, not thrust. 2. Double-base (DB)* propellants form a homogeneous propellant grain, usually a nitrocellulose (NC)*—a solid ingredient that absorbs liquid nitroglycerine (NG), plus minor percentages of additives. The major ingredients are highly energetic materials and they contain both fuel and oxidizer. Both extruded double-base (EDB) and cast double-base (CDB) propellants have found extensive applications, mostly in small tactical missiles of older design. By adding crystalline nitramines (HMX or RDX)* Both performance and density can be improved; these are sometimes called cast-modified double-base propellants. Adding an elastomeric binder (rubber-like, such as crosslinked polybutadiene) further improves the physical properties and allows more nitramine and thus increasing performance slightly. The resulting propellant is called elastomeric-modified cast double-base (EMCDB). These four classes of double-base propellants have nearly smokeless exhausts. Adding some solid ammonium perchlorate (AP) and aluminum (Al) increases the density and the specific impulse slightly, but exhaust gases become smoky—such propellant is called composite-modified double-base propellant or CMDB.



The Dynamics: The dynamic equations for this spacecraft, treated as a rigid body, are covered in Section 3.4.1 of Chapter 3, using principal axes for the analysis. With small angular velocities the responses about these axes are largely uncoupled and may be approximated by $I_{xx} \dot{\omega}_x = T_x$, $I_{yy} \dot{\omega}_y = T_y$, $I_{zz} \dot{\omega}_z = T_z$



Composite propellants form a heterogeneous propellant grain between oxidizer crystals and powdered fuel(usually aluminum)held together in a matrix of synthetic rubber (or plastic) binder, such as polybutadiene (HTPB).* Composite propellants are cast from a mix of solid (AP crystals, Al powder) and liquid (HTPB, PPG)* ingredients. The propellant is hardened by crosslinking or curing the liquid binder polymer with a small amount of curing agent, and curing it in an oven, where it becomes solid. In the past four decades composites have been the most commonly used class of propellant.



Flights at high speeds (Supersonic aerodynamics)

The speed of sound or sonic velocity is the speed of propagation when the air changes
Its pressure or the particles in the air flow change their pressure level and speed when they collide with a wing. The speed of propagation is very fast and it is not about flying faster than sound, but about the speed of propagation in the air and the fact that the pressure is disturbed. There is disturbance of the pressure effect when flying at high speeds.

The speed of an object compared to the speed of sound, or the speed at which small pulses of pressure are transmitted in the airflow around the aircraft wing, is important to parameterize, or write a parameter of, the supersonic airflow.

Variables: Given the important variables or indices of the speed of sound, adiabatic coefficient, constants and Temperature:

- “a” is the speed of sound.
- “γ\gamma” is the adiabatic coefficient (for air, γ=1.4\gamma = 1.4γ=1.4).
- “R” is the ideal gas constant (for air, R=287 J/(kg) R = 287 {J/(kg·K)} “R=287J/(kg)”
- “T” is the absolute temperature in Kelvin.

Height	Temperature	speed of sound	MPH Kts

```
% Parameters
gamma = 1.4;         % Adiabatic coefficient for air
R = 287;             % Ideal gas constant for air in J/(kg·K)
T = 300;             % Temperature in Kelvin (example: 300K)

% Calculate the speed of sound
a = sqrt(gamma * R * T);

% Show the result
fprintf('The speed of sound is %.2f m/s\n', a);
```

a = squareRoot % R T

Code Explanation

1. **Parameter Definition**: The values of γ\gammaγ, R and T are defined. In this example, T has been set to 300 K, which is a typical temperature for air at sea level.
2. **Calculation of the Speed of Sound**: The formula a=γRTa = \sqrt{\gamma R T}a=γRT is used to calculate the speed of sound.

3. **Show the result**: The result is printed using `fprintf`.

Aircraft flaps in approximate calculations:

Stall speed with flaps fully extended and retracted is calculated and displayed, and will also plot the relationship between lift coefficient and stall speed. You can run this code in a Python environment to get the results and visualization. On the other hand, variables are a way to synthesize calculations with programming languages and processes at an automatic or automated level of variables where the aerodynamic variables are:

1. W is the weight of the aircraft.
2. Weigh the density of the air.
3. Vstall is the stall speed.
4. S is the reference area.