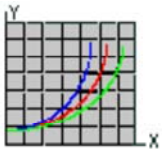
Richard Nakka's *Experimental Rocketry* Web Site



Solid Rocket Motor Theory -- Basic Assumptions

Basic Assumptions

The various physical and chemical processes that occur in an actual rocket motor during operation are highly complex. These processes include the complex chemical reactions that occur during combustion; the manner in which "consumption" of the propellant grain occurs during burning; the behaviour of the flow of exhaust gases as they form at the burning surface, travel through the chamber, and exit through the nozzle; the interaction between the exhaust gases and condensed particles (smoke).
The theoretical analysis of a solid rocket motor necessitates certain simplifications, that is, the assumption is of an *ideal rocket motor.* An ideal rocket motor assumes the following:

- The propellant combustion is complete and does not vary from that assumed by the combustion equation.
- The combustion products obey the *perfect gas law.*
- There is no friction impeding the flow of exhaust products.
- The combustion and flow in the motor and nozzle is *adiabatic*, that is, no heat loss occurs to the surroundings.
- Unless noted otherwise, *steady-state* conditions exist during operation of the motor. This means that the conditions or processes that occur do not change with time (for a given geometric conditions) during burning.
- Expansion of the working fluid (exhaust products) occurs in a uniform manner without shock or discontinuites.
- Flow through the nozzle is one-dimensional and non-rotational.
- The flow velocity, pressure, and density is uniform across any cross-section normal to the nozzle axis.
- Chemical equilibrium is established in the combustion chamber and does not shift during flow through the nozzle. This is known as "frozen equilibrium" conditions.
- Burning of the propellant grain always progresses *normal* (perpendicular) to the burning surface, and occurs in a uniform manner over the entire surface area exposed to combustion.

Any further assumptions that may be required are stated as necessary in the following analyses.
Although it seems like a lot of simplifying assumptions must be made, in fact, these are all reasonable and can be expected to reflect the actual behaviour of the rocket motor fairly closely.

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