16.512, Rocket Propulsion
Prof. Manuel Martinez-Sanchez
Lecture 19: Liquid Propellants

Propellant Selection

Read Sutton, Ch. 7

Fuels

	Hydrazine	LH	MMH	RP-1	UDMH
	N_2H_4	H_2	N_2H_3-CH_3	$CH_{1.97}$	N_2H_2-$(CH_3)_2$
m.p. (K)	274.5	14.0	220.7	225	216
b.p. (K)	386.7	20.4	360.6	460-540	336
Sp. ht $\left(\frac{\text{Kcal}}{\text{Kg K}}\right)$	0.80	1.75	0.7	0.45	0.65
ρ (g/cm^3)	1.0	0.071	0.86	0.6-0.8	0.6-0.8
ΔH_f @ 25^{0}C (Kcal/mol)	+12.0 (ℓ)	-2.4 (@20K)	+12 .7 (ℓ)	-5.9 (ℓ)	+12.7 (ℓ)
	Unstable	Cryogenic	Unstable		Unstable

Oxidizers

	NA	NTO	LOX	
	Nitric Acid	Nitrogen Tetroxide	Liquid Oxygen	Hydrogen Peroxide
	HNO_3	N_2O_4	O_2	H_2O_2
m.p. (K)	231.6	261.7	54.4	272.8
b.p. (K)	355.7	294.3	90.0	423.5
Sp. ht $\left(\frac{\text{Kcal}}{\text{Kg K}}\right)$	0.4-0.16	0.37	0.4	
ρ (g/cm^3)	1.5	1.37	1.1-1.2	1.46
ΔH_f @ 25^{0}C (Kcal/mol)	-41.4	0	$\frac{-15.7}{4.18} \simeq -3.8 \frac{\text{Kcal}}{\text{mol}}$ (@90K)	-44.8 (ℓ)
	Corrosive	Toxic	Reactive, Cyrogenic	Unstable

Desirable: Low m.p., high ρ, c, b.p. (for high ΔH in cooling)
Stability (negative ΔH_f)
Low vapor pressure (high b.p.)
Hypergolicity
Non-toxicity
Storability
Non-corrosive

Examples of use:

Hydrazine	LH	MMH	RP-1	UDMH
Monoprops.	J-2	Space biprops	Atlas	Titan II (50% N_2H_4)
	SSME	Shuttle OMS	Thor	Lunar Lander
	Vulcain (Ariant)		Delta (St.1)	Proton?
	J7 (Japan)		Titan I	
	RL-10 (Centans)		Saturn	
	RS-68(EELV) Delta IV		RD-170	
			RD-180	
			Fastrac (X-34)	
			RS-76	

NA	NTO		L_{ox}	H_2O_2
	Titan II		Atlas	X-15
	Shuttle OMS		Jupiter	
	Space biprops	With RP-1	RD-170	
	Proton?		RD-180	
			Delta (St.1)	
			Fastrac(X 34)	
			RS-76	
			SSME	
		With LH	Vulcain	
			RS-68	
			RL-10	

NA	NTO	L_{ox}	H_2O_2
	Titan II	Atlas	X-15
	Shuttle OMS	Jupiter	
	Space biprops With	RD-170	
	Proton? RP-1	RD-180	
		Delta (St.1)	
		Fastrac(X 34)	
		RS-76	
		SSME	
	With LH	Vulcain	
		RS-68	
		RL-10	