Case name: HyRoE project F

Description: F=8

Thu Dec 4 11:22:59 2025

Table 1. Propellant Specification

Component	Temperature, K	Pressure, MPa	Enthalpy, kJ/mol	Enthalpy, kJ/kg	Mass fraction
C32H66(a)	298.1	0.1013	-967.8000	-2146.534	0.1111111
N2O(L),298.15K	298.1	0.1013	65.1000	1479.115	0.8888889
Total			52.6482	1076.259	

Propellant exploded formula:

$C_{0.385766}\ H_{0.795642}\ N_{1.975890}\ O_{0.987945}$ (based on 1 mole)

$C_{9.306232}\ H_{19.194103}\ N_{47.666443}\ O_{23.833222}$ (by mass %)

α: 0.8448571 (oxidizer excess coefficient)

O/F: 8.0000000

O/F_0: 9.4690572 (stoichiometric)

rho: kg/m^3

Table 2. Combustion Properties

Parameter	Injector	Nozzle inlet	Nozzle throat	Nozzle exit	Unit
Pressure	5.0000	4.9186	2.8459	0.1238	MPa
Temperature	3284.2759	3280.5046	3084.0654	1908.9882	K
Enthalpy	28671.6653	28448.9589	14199.0722	-51423.7614	J/mol
	1076.2565	1067.7829	527.3904	-1862.4941	kJ/kg
Entropy	258.4433	258.5386	261.2580	267.9235	J/(mol·K)
	9.7013	9.7038	9.7038	9.7038	kJ/(kg·K)
Internal energy	1364.6455	1173.2951	-11443.3034	-67295.9901	J/mol
	51.2251	44.0376	-425.0340	-2437.3632	kJ/kg
Specific heat (p=const)	3.6859	3.6862	3.4248	1.5619	kJ/(kg·K)
Specific heat (V=const)	3.1484	3.1490	2.9350	1.2597	kJ/(kg·K)
Gamma	1.1707	1.1706	1.1669	1.2399	
Isentropic exponent	1.1522	1.1521	1.1526	1.2399	
Gas constant	0.3121	0.3121	0.3088	0.3011	kJ/(kg·K)
Molecular weight	26.6402	26.6430	26.9233	27.6102	
Density	4.8779	4.8045	2.9880	0.2153	kg/m^3
Sonic velocity	1086.7374	1086.0208	1047.7271	844.2471	m/s
Mach number	0.0000	0.1199	1.0000	2.8716	
Area ratio	5.0000	5.0000	1.0000	6.0000	A/At
Mass flux	625.4532	625.4532	3130.6511	521.9659	kg/(m^2·s)
Viscosity	0.9948	0.9940	0.9531	0.6859 x10^{-4}	kg/(m·s)
Conductivity, frozen	0.2371	0.2368	0.2242	0.1468	W/(m·K)
Specific heat (p=const), frozen	1.6164	1.6163	1.6100	1.5297	kJ/(kg·K)
Prandtl number, frozen	0.6783	0.6784	0.6843	0.7149	
Conductivity, effective	0.6954	0.6948	0.5945	0.1522	W/(m·K)
Specific heat (p=const), effective	3.6859	3.6863	3.4248	1.5519	kJ/(kg·K)
Prandtl number, effective	0.5273	0.5273	0.5491	0.6993	

Table 3. Combustion Products

Product	Injector mass fraction	Injector mole fraction	Nozzle inlet mass fraction	Nozzle inlet mole fraction	Nozzle throat mass fraction	Nozzle throat mole fraction	Nozzle exit mass fraction	Nozzle exit mole fraction
CO	0.1209847	0.1150669	0.1208648	0.1149651	0.1101763	0.1059007	0.0779374	0.0768241
CO2	0.1569582	0.0950106	0.1571467	0.0951349	0.1739463	0.1064128	0.2246058	0.1409097
COOH	0.0000054	0.0000032	0.0000053	0.0000032	0.0000028	0.0000017		
H	0.0003068	0.0081076	0.0003061	0.0080920	0.0002215	0.0059162	0.0000045	0.0001222
H2	0.0020138	0.0266129	0.0020119	0.0265896	0.0018042	0.0240960	0.0018664	0.0255629
H2O	0.1179219	0.1743765	0.1179686	0.1744641	0.1226410	0.1832820	0.1297601	0.1988687
H2O2	0.0000040	0.0000032	0.0000040	0.0000031	0.0000021	0.0000016		
HCN	0.0000002	0.0000002	0.0000002	0.0000002				
HCO	0.0000030	0.0000027	0.0000029	0.0000027	0.0000013	0.0000012		
HCOOH	0.0000007	0.0000004	0.0000006	0.0000004	0.0000004	0.0000002		
HNCO	0.0000006	0.0000004	0.0000006	0.0000004	0.0000003	0.0000002		
HNO	0.0000078	0.0000067	0.0000077	0.0000066	0.0000036	0.0000031		
HNO2	0.0000021	0.0000012	0.0000021	0.0000012	0.0000010	0.0000005		
HO2	0.0000306	0.0000247	0.0000302	0.0000244	0.0000152	0.0000124		
N	0.0000040	0.0000077	0.0000040	0.0000076	0.0000017	0.0000032		
N2	0.5596108	0.5321754	0.5596409	0.5322607	0.5615905	0.5397332	0.5657572	0.5576101
N2O	0.0000065	0.0000039	0.0000064	0.0000039	0.0000033	0.0000020		
NCO	0.0000002	0.0000001	0.0000002	0.0000001				
NH	0.0000016	0.0000028	0.0000016	0.0000028	0.0000006	0.0000011		
NH2	0.0000007	0.0000012	0.0000007	0.0000012	0.0000003	0.0000005		
NH3	0.0000006	0.0000009	0.0000006	0.0000009	0.0000003	0.0000005		
NO	0.0131363	0.0116626	0.0130725	0.0116073	0.0089180	0.0080017	0.0000115	0.0000106
NO2	0.0000150	0.0000087	0.0000149	0.0000086	0.0000074	0.0000043		
O	0.0023292	0.0038783	0.0023206	0.0038643	0.0014021	0.0023594	0.0000002	0.0000003
O2	0.0118704	0.0098825	0.0118449	0.0098623	0.0083912	0.0070602	0.0000011	0.0000010
OH	0.0147847	0.0231585	0.0147409	0.0230924	0.0108684	0.0172050	0.0000557	0.0000904
Gaseous fraction:	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
Condensed fraction:	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

Table 4. Ideal Performance

Parameter	Sea level	Optimum expansion	Vacuum	Units
Characteristic velocity		1584.1517		m/s
Effective exhaust velocity	2467.3578	2424.3558	2661.4797	m/s
Specific impulse (by mass)	2467.3578	2424.3558	2661.4797	N·s/kg
Specific impulse (by weight)	251.6005	247.2155	271.3954	s
Thrust coefficient	1.5575	1.5304	1.6801	
Thrust	5.2091	5.1183	5.6189	kN
Altitude	0.0000	0.0000		km
Ambient pressure	1.0000	1.2215	0.0000	atm

Table 5. Estimated Delivered Performance

Parameter	Sea level	Optimum expansion	Vacuum	Units
Characteristic velocity		1551.6271		m/s
Effective exhaust velocity	2414.7106	2372.5915	2604.8469	m/s
Specific impulse (by mass)	2414.7106	2372.5915	2604.8469	N·s/kg

Parameter	Sea level	Optimum expansion	Vacuum	Units
Specific impulse (by weight)	246.2320	241.9370	265.6205	s
Thrust coefficient	1.5562	1.5291	1.6788	
Thrust	5.0979	5.0090	5.4994	kN
Altitude	0.0000	0.0000		km
Ambient pressure	1.0000	1.2215	0.0000	atm

Table 6. Altitude Performance

Altitude, km	Pressure, atm	Specific impulse, N·s/kg	Specific impulse, s	Thrust coefficient	Thrust, kN
0.0000	1.0000	2414.5299	246.2135	1.5561	5.0976

Table 7. Throttled Performance (delivered)

Throttle value	Mass flow rate, kg/s	Pressure, MPa	Specific impulse, N·s/kg Sea level	Specific impulse, s Sea level	Thrust, kN Sea level	Specific impulse, N·s/kg Optimum expansion	Specific impulse, s Optimum expansion	Thrust, kN Optimum expansion	Specific impulse, N·s/kg Vacuum	Specific impulse, s Vacuum	Thrust, kN Vacuum
1.0000	2.1112	5.0000	2414.7106	246.2320	5.0979	2372.5915	241.9370	5.0090	2604.8469	265.6205	5.4994

Table 8. Chamber Size

Combustion chamber size			Nozzle size		
Dc	64.85	mm	Type	TIC nozzle	
Dt	29.00	mm	Rn	7.25	mm
Lcyl	212.54	mm	Tn	20.00	deg
Lc	300.00	mm	Te	6.60	deg
L*	1346.23	mm	De	71.04	mm
R1	29.00	mm	Le	84.62	mm
R2	187.74	mm	Le/Dt	2.92	
b	20.00	deg	Le/Lc15	107.86	%
Ac/At	5.00		Ae/At	6.00	

Parameter		Engine	Chamber	
Thrust	sea level	5.0979	5.0979	kN
	opt exp	5.0090	5.0090	kN
	vacuum	5.4994	5.4994	kN
Specific Impulse	sea level	2414.7106	2414.7106	N·s/kg
	opt exp	2372.5915	2372.5915	N·s/kg
	vacuun	2604.8469	2604.8469	N·s/kg
Mass flow rate	total	2.1112	2.1112	kg/s
	oxidizer	1.8766	1.8766	kg/s
	fuel	0.2346	0.2346	kg/s
Number of chambers		1		

Table 10. Thermal Analysis