Case name: HyRoE project F

Description: F=8

Wed Nov 26 20:58:24 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),184.67K	184.7	0.1013	61.0240	1386.506	0.8888889
Total			48.6213	993.940	

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	10.0000	9.8365	5.6765	0.1188	MPa
Temperature	3320.8072	3316.8790	3106.0094	1619.4037	K
Enthalpy	26663.2520	26436.6561	11942.9333	-63717.9372	J/mol
	993.9375	985.3944	440.9521	-2307.5270	kJ/kg
Entropy	253.7933	253.8862	256.3080	261.3109	J/(mol·K)
	9.4608	9.4633	9.4633	9.4633	kJ/(kg·K)
Internal energy	-947.5061	-1141.4415	-13881.8951	-77182.4239	J/mol
	-35.3206	-42.5459	-512.5417	-2795.1395	kJ/kg
Specific heat (p=const)	3.3386	3.3384	3.0571	1.5175	kJ/(kg·K)
Specific heat (V=const)	2.8456	2.8456	2.6099	1.2163	kJ/(kg·K)
Gamma	1.1733	1.1732	1.1713	1.2476	
Isentropic exponent	1.1577	1.1576	1.1599	1.2476	
Gas constant	0.3099	0.3099	0.3070	0.3011	kJ/(kg·K)
Molecular weight	26.8259	26.8285	27.0844	27.6131	
Density	9.7157	9.5691	5.9533	0.2437	kg/m^3
Sonic velocity	1091.5920	1090.8656	1051.6512	779.9717	m/s
Mach number	0.0000	0.1198	1.0000	3.2945	
Area ratio	5.0000	5.0000	1.0000	10.0000	A/At
Mass flux	1250.8165	1250.8165	6260.8458	626.2847	$kg/(m^2 \cdot s)$
Viscosity	1.0036	1.0027	0.9588	0.6125×10^{-4}	kg/(m·s)
Conductivity, frozen	0.2387	0.2385	0.2252	0.1267	W/(m·K)
Specific heat (p=const), frozen	1.6189	1.6188	1.6120	1.4918	kJ/(kg·K)
Prandtl number, frozen	0.6806	0.6807	0.6862	0.7212	
Conductivity, effective	0.6057	0.6051	0.5099	0.1272	W/(m·K)
Specific heat (p=const), effective	3.3387	3.3384	3.0571	1.4931	kJ/(kg·K)
Prandtl number, effective	0.5531	0.5532	0.5749	0.7191	

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	0.1151752	0.1103051	0.1150600	0.1102055	0.1048373	0.1013720	0.0726495	0.0716193
CO2	0.1660799	0.1012330	0.1662613	0.1013534	0.1823321	0.1122105	0.2329142	0.1461376
COOH	0.0000084	0.0000050	0.0000082	0.0000049	0.0000042	0.0000025		
H	0.0002273	0.0060489	0.0002268	0.0060364	0.0001601	0.0043022	0.0000004	0.0000107
H2	0.0018491	0.0246069	0.0018474	0.0245864	0.0016666	0.0223910	0.0022469	0.0307779
H2O	0.1212864	0.1806020	0.1213279	0.1806814	0.1254937	0.1886679	0.1264241	0.1937766
H2O2	0.0000054	0.0000043	0.0000053	0.0000042	0.0000026	0.0000020		
HCHO,formaldehy	0.0000001	0.0000001	0.0000001	0.0000001				
HCN	0.0000003	0.0000003	0.0000003	0.0000003	0.0000001	0.0000001		
HCO	0.0000041	0.0000038	0.0000040	0.0000037	0.0000018	0.0000017		
HCOOH	0.0000013	0.0000008	0.0000013	0.0000007	0.0000007	0.0000004		
HNCO	0.0000011	0.0000007	0.0000011	0.0000007	0.0000005	0.0000003		
HNO	0.0000098	0.0000084	0.0000096	0.0000083	0.0000043	0.0000037		
HNO2	0.0000030	0.0000017	0.0000030	0.0000017	0.0000013	0.0000007		
HO2	0.0000319	0.0000259	0.0000315	0.0000256	0.0000145	0.0000119		
N	0.0000035	0.0000066	0.0000034	0.0000065	0.0000014	0.0000026		
N2	0.5601804	0.5364305	0.5602096	0.5365109	0.5621726	0.5435266	0.5657625	0.5576743
N2O	0.0000084	0.0000051	0.0000082	0.0000050	0.0000040	0.0000025		
NCO	0.0000002	0.0000001	0.0000002	0.0000001				
NH	0.0000017	0.0000031	0.0000017	0.0000031	0.0000007	0.0000012		
NH2	0.0000011	0.0000018	0.0000010	0.0000017	0.0000005	0.0000008		
NH3	0.0000010	0.0000016	0.0000010	0.0000016	0.0000006	0.0000009	0.0000001	0.0000002
NO	0.0119091	0.0106469	0.0118473	0.0105926	0.0076689	0.0069221	0.0000002	0.0000002
NO2	0.0000165	0.0000096	0.0000163	0.0000095	0.0000074	0.0000044		
O	0.0015903	0.0026664	0.0015837	0.0026556	0.0008906	0.0015076		
O2	0.0090604	0.0075957	0.0090361	0.0075760	0.0058962	0.0049906		
OH	0.0125439	0.0197855	0.0125034	0.0197236	0.0088372	0.0140733	0.0000020	0.0000033
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		1584.2150		m/s
Effective exhaust velocity	2597.5911	2569.6165	2759.3785	m/s
Specific impulse (by mass)	2597.5911	2569.6165	2759.3785	N·s/kg
Specific impulse (by weight)	264.8806	262.0280	281.3783	s
Thrust coefficient	1.6397	1.6220	1.7418	
Thrust	5.1800	5.1242	5.5026	kN
Altitude	0.0000	0.0000		km
Ambient pressure	1.0000	1.1729	0.0000	atm

Table 5. Estimated Delivered Performance

Parameter	Sea level	Optimum expansion	Vacuum	Units
Characteristic velocity		1570.2767		m/s

Parameter	Sea level	Optimum expansion	Vacuum	Units
Effective exhaust velocity	2558.1784	2530.4500	2718.5424	m/s
Specific impulse (by mass)	2558.1784	2530.4500	2718.5424	N·s/kg
Specific impulse (by weight)	260.8616	258.0341	277.2142	s
Thrust coefficient	1.6291	1.6115	1.7313	
Thrust	5.1014	5.0461	5.4212	kN
Altitude	0.0000	0.0000		km
Ambient pressure	1.0000	1.1729	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	2545.6290	259.5819	1.6291	5.0764

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	1.9941	10.0000	2558.1784	260.8616	5.1014	2530.4500	258.0341	5.0461	2718.5424	277.2142	5.4212
1.2000	2.3930	12.0142	2586.1024	263.7091	6.1885	2532.0633	258.1986	6.0592	2719.7153	277.3338	6.5082
1.4000	2.7918	14.0302	2606.1684	265.7552	7.2759	2533.4098	258.3359	7.0728	2720.6943	277.4336	7.5956
1.6000	3.1906	16.0477	2621.3038	267.2986	8.3636	2534.5413	258.4513	8.0868	2721.5172	277.5175	8.6834
1.8000	3.5895	18.0663	2633.1365	268.5052	9.4515	2535.5014	258.5492	9.1011	2722.2155	277.5887	9.7713
2.0000	3.9883	20.0859	2642.6507	269.4754	10.5397	2536.3354	258.6342	10.1156	2722.8221	277.6506	10.8594
2.2000	4.3871	22.1064	2650.4730	270.2730	11.6279	2537.0698	258.7091	11.1304	2723.3563	277.7051	11.9477
2.4000	4.7859	24.1278	2657.0222	270.9409	12.7164	2537.7238	258.7758	12.1454	2723.8322	277.7536	13.0361
2.6000	5.1848	26.1498	2662.5890	271.5085	13.8049	2538.3118	258.8358	13.1606	2724.2600	277.7972	14.1247
2.8000	5.5836	28.1724	2667.3816	271.9972	14.8936	2538.8447	258.8901	14.1759	2724.6477	277.8367	15.2134
3.0000	5.9824	30.1956	2671.5529	272.4226	15.9824	2539.3308	258.9397	15.1914	2725.0015	277.8728	16.3021

Table 8. Chamber Size

Combustion chamber size			Nozzle size		
Dc	44.72	mm	Type	TIC nozzle	
Dt	20.00	mm	Rn	3.98	mm

Lcyl	246.65	mm	Tn	24.08	deg
Lc	300.00	mm	Te	9.79	deg
L*	1403.40	mm	De	63.25	mm
R1	15.00	mm	Le	70.00	mm
R2	94.98	mm	Le/Dt	3.50	
b	20.00	deg	Le/Lc15	86.74	%
Ac/At	5.00		Ae/At	10.00	

Parameter		**Engine**	**Chamber**	
Thrust	sea level	5.1014	5.1014	kN
	opt exp	5.0461	5.0461	kN
	vacuum	5.4212	5.4212	kN
Specific Impulse	sea level	2558.1784	2558.1784	N·s/kg
	opt exp	2530.4500	2530.4500	N·s/kg
	vacuun	2718.5424	2718.5424	N·s/kg
Mass flow rate	total	1.9941	1.9941	kg/s
	oxidizer	1.7726	1.7726	kg/s
	fuel	0.2216	0.2216	kg/s
Number of chambers		1		

Table 10. Thermal Analysis