

Case name: HyRoE project F

Description: F=8

Wed Nov 26 23:26:55 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/F₀: 9.4690572 (stoichiometric)
 ρ : kg/m³

Table 2. Combustion Properties

Parameter	Injector	Nozzle inlet	Nozzle throat	Nozzle exit Unit
Pressure	10.0000	8.9908	5.4422	0.1140 MPa
Temperature	3320.8072	3294.8668	3103.3733	1620.0744 K
Enthalpy	26663.2520	25144.0183	11954.2223	-63689.7473 J/mol
	993.9375	936.6601	441.4730	-2306.5066 kJ/kg
Entropy	253.7933	254.3880	256.6026	261.6729 J/(mol·K)
	9.4608	9.4764	9.4764	9.4764 kJ/(kg·K)
Internal energy	-947.5061	-2251.0594	-13848.6884	-77159.8107 J/mol
	-35.3206	-83.8560	-511.4362	-2794.3212 kJ/kg
Specific heat (p=const)	3.3386	3.3349	3.0737	1.5176 kJ/(kg·K)
Specific heat (V=const)	2.8456	2.8439	2.6247	1.2164 kJ/(kg·K)
Gamma	1.1733	1.1727	1.1711	1.2476
Isentropic exponent	1.1577	1.1574	1.1595	1.2476
Gas constant	0.3099	0.3097	0.3071	0.3011 kJ/(kg·K)
Molecular weight	26.8259	26.8443	27.0780	27.6131
Density	9.7157	8.8100	5.7111	0.2337 kg/m ³
Sonic velocity	1091.5920	1086.7841	1051.1494	780.1274 m/s
Mach number	0.0000	0.3114	1.0000	3.2933
Area ratio	2.0000	2.0000	1.0000	10.0000 A/At
Mass flux	2981.8146	2981.8146	6003.1991	600.5132 kg/(m ² ·s)
Viscosity	1.0036	0.9981	0.9582	0.6127 x10 ⁻⁴ kg/(m·s)
Conductivity, frozen	0.2387	0.2371	0.2251	0.1268 W/(m·K)
Specific heat (p=const), frozen	1.6189	1.6180	1.6118	1.4919 kJ/(kg·K)
Prandtl number, frozen	0.6806	0.6811	0.6862	0.7212
Conductivity, effective	0.6057	0.6011	0.5134	0.1272 W/(m·K)
Specific heat (p=const), effective	3.3387	3.3350	3.0737	1.4933 kJ/(kg·K)
Prandtl number, effective	0.5531	0.5538	0.5737	0.7193

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	0.1143744	0.1096136	0.1050413	0.1015453	0.0726650	0.0716346
CO2	0.1660799	0.1012330	0.1673399	0.1020712	0.1820119	0.1119871	0.2328897	0.1461222
COOH	0.0000084	0.0000050	0.0000076	0.0000045	0.0000041	0.0000025		
H	0.0002273	0.0060489	0.0002236	0.0059559	0.0001626	0.0043678	0.0000004	0.0000110
H2	0.0018491	0.0246069	0.0018369	0.0244608	0.0016723	0.0224629	0.0022458	0.0307624
H2O	0.1212864	0.1806020	0.1215798	0.1811634	0.1253774	0.1884485	0.1264341	0.1937918
H2O2	0.0000054	0.0000043	0.0000049	0.0000039	0.0000025	0.0000020		
HCHO,form aldehy	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	0.0000037	0.0000034	0.0000018	0.0000017		
HCOOH	0.0000013	0.0000008	0.0000012	0.0000007	0.0000007	0.0000004		
HNCO	0.0000011	0.0000007	0.0000010	0.0000006	0.0000005	0.0000003		
HNO	0.0000098	0.0000084	0.0000088	0.0000077	0.0000042	0.0000037		
HNO2	0.0000030	0.0000017	0.0000027	0.0000015	0.0000012	0.0000007		
HO2	0.0000319	0.0000259	0.0000294	0.0000239	0.0000145	0.0000119		
N	0.0000035	0.0000066	0.0000032	0.0000061	0.0000014	0.0000026		
N2	0.5601804	0.5364305	0.5603769	0.5369878	0.5621529	0.5433794	0.5657625	0.5576742
N2O	0.0000084	0.0000051	0.0000076	0.0000047	0.0000040	0.0000024		
NCO	0.0000002	0.0000001	0.0000002	0.0000001				
NH	0.0000017	0.0000031	0.0000016	0.0000028	0.0000007	0.0000012		
NH2	0.0000011	0.0000018	0.0000009	0.0000016	0.0000004	0.0000007		
NH3	0.0000010	0.0000016	0.0000009	0.0000014	0.0000005	0.0000009	0.0000001	0.0000002
NO	0.0119091	0.0106469	0.0114926	0.0102815	0.0077114	0.0069589	0.0000002	0.0000002
NO2	0.0000165	0.0000096	0.0000152	0.0000089	0.0000074	0.0000043		
O	0.0015903	0.0026664	0.0015427	0.0025885	0.0009097	0.0015396		
O2	0.0090604	0.0075957	0.0088818	0.0074510	0.0059978	0.0050754		
OH	0.0125439	0.0197855	0.0122619	0.0193540	0.0089186	0.0141995	0.0000021	0.0000034
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		1583.7846	m/s
Effective exhaust velocity	2590.3587	2569.2194	2759.0893 m/s
Specific impulse (by mass)	2590.3587	2569.2194	2759.0893 N-s/kg
Specific impulse (by weight)	264.1431	261.9875	281.3488 s
Thrust coefficient	1.6355	1.6222	1.7421
Thrust	4.9530	4.9126	5.2756 kN
Altitude	0.0000	0.0000	km
Ambient pressure	1.0000	1.1253	0.0000 atm

Table 5. Estimated Delivered Performance

Parameter	Sea level	Optimum expansion	Vacuum Units
Characteristic velocity		1535.9350	m/s

Parameter	Sea level	Optimum expansion	Vacuum Units
Effective exhaust velocity	2496.2103	2475.7097	2659.8432 m/s
Specific impulse (by mass)	2496.2103	2475.7097	2659.8432 N·s/kg
Specific impulse (by weight)	254.5426	252.4521	271.2285 s
Thrust coefficient	1.6252	1.6119	1.7317
Thrust	4.7730	4.7338	5.0858 kN
Altitude	0.0000	0.0000	km
Ambient pressure	1.0000	1.1253	0.0000 atm

Table 6. Altitude Performance

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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
0.1000	0.1912	0.9814	1409.0717	143.6853	0.2694	2448.1751	249.6444	0.4681	2639.8555	269.1903	0.5048
0.1900	0.3633	1.8755	1786.6675	182.1894	0.6491	2457.2115	250.5658	0.8927	2646.4100	269.8587	0.9614
0.1907	0.3647	1.8828	1788.7243	182.3991	0.6523	2457.2621	250.5710	0.8961	2646.4467	269.8625	0.9651
0.2800	0.5354	2.7730	2065.5873	210.6313	1.1059	2462.1280	251.0672	1.3182	2649.9780	270.2226	1.4188
0.3700	0.7075	3.6727	2210.1333	225.3709	1.5636	2465.4306	251.4040	1.7442	2652.3756	270.4670	1.8765
0.4600	0.8796	4.5739	2298.4363	234.3753	2.0216	2467.8793	251.6537	2.1706	2654.1539	270.6484	2.3345
0.5500	1.0516	5.4763	2358.0422	240.4534	2.4798	2469.8047	251.8500	2.5974	2655.5523	270.7910	2.7927
0.6400	1.2237	6.3796	2401.0225	244.8362	2.9382	2471.3790	252.0105	3.0243	2656.6960	270.9076	3.2511
0.7300	1.3958	7.2838	2433.5051	248.1485	3.3967	2472.7027	252.1455	3.4514	2657.6578	271.0057	3.7096
0.8200	1.5679	8.1886	2458.9327	250.7414	3.8554	2473.8395	252.2614	3.8787	2658.4839	271.0899	4.1683
0.9100	1.7400	9.0940	2479.3893	252.8273	4.3141	2474.8319	252.3626	4.3062	2659.2052	271.1635	4.6270
1.0000	1.9121	10.0000	2496.2103	254.5426	4.7730	2475.7097	252.4521	4.7338	2659.8432	271.2285	5.0858

Table 8. Chamber Size

Combustion chamber size				Nozzle size	
Dc	28.28	mm	Type	TIC nozzle	
Dt	20.00	mm	Rn	3.98	mm
Lcyl	481.24	mm	Tn	24.08	deg
Lc	500.00	mm	Te	9.79	deg
L*	990.69	mm	De	63.25	mm
R1	15.00	mm	Le	70.00	mm
R2	26.84	mm	Le/Dt	3.50	
b	20.00	deg	Le/Lc15	86.74	%
Ac/At	2.00		Ae/At	10.00	

Parameter	Engine		Chamber	
Thrust	sea level	4.7730	4.7730	kN
	opt exp	4.7338	4.7338	kN
	vacuum	5.0858	5.0858	kN
Specific Impulse	sea level	2496.2103	2496.2103	N·s/kg

Mass flow rate	opt exp	2475.7097	2475.7097	N·s/kg
	vacuun	2659.8432	2659.8432	N·s/kg
	total	1.9121	1.9121	kg/s
	oxidizer	1.6996	1.6996	kg/s
	fuel	0.2125	0.2125	kg/s
Number of chambers		1		

Table 10. Thermal Analysis