

Case name: HyRoE project F

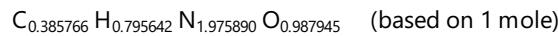
Description: F=8

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:



α : 0.8448571 (oxidizer excess coefficient)

O/F: 8.0000000

O/F₀: 9.4690572 (stoichiometric)

rho: 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 × 10 ⁻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

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 Optimu m expansio n	Specific impulse, s Optimu m expansio n	Thrust, kN Sea level	Specific impulse, N·s/kg Optimu m expansio n	Specific impulse, s Optimu m expansio n	Thrust, kN Vacuum
0.1000	0.1912	0.9814	1409.071 7	143.6853	0.2694	2448.175 1	249.6444	0.4681	2639.855 5	269.1903	0.5048
0.1900	0.3633	1.8755	1786.667 5	182.1894	0.6491	2457.211 5	250.5658	0.8927	2646.410 0	269.8587	0.9614
0.1907	0.3647	1.8828	1788.724 3	182.3991	0.6523	2457.262 1	250.5710	0.8961	2646.446 7	269.8625	0.9651
0.2800	0.5354	2.7730	2065.587 3	210.6313	1.1059	2462.128 0	251.0672	1.3182	2649.978 0	270.2226	1.4188
0.3700	0.7075	3.6727	2210.133 3	225.3709	1.5636	2465.430 6	251.4040	1.7442	2652.375 6	270.4670	1.8765
0.4600	0.8796	4.5739	2298.436 3	234.3753	2.0216	2467.879 3	251.6537	2.1706	2654.153 9	270.6484	2.3345
0.5500	1.0516	5.4763	2358.042 2	240.4534	2.4798	2469.804 7	251.8500	2.5974	2655.552 3	270.7910	2.7927
0.6400	1.2237	6.3796	2401.022 5	244.8362	2.9382	2471.379 0	252.0105	3.0243	2656.696 0	270.9076	3.2511
0.7300	1.3958	7.2838	2433.505 1	248.1485	3.3967	2472.702 7	252.1455	3.4514	2657.657 8	271.0057	3.7096
0.8200	1.5679	8.1886	2458.932 7	250.7414	3.8554	2473.839 5	252.2614	3.8787	2658.483 9	271.0899	4.1683
0.9100	1.7400	9.0940	2479.389 3	252.8273	4.3141	2474.831 9	252.3626	4.3062	2659.205 2	271.1635	4.6270
1.0000	1.9121	10.0000	2496.210 3	254.5426	4.7730	2475.709 7	252.4521	4.7338	2659.843 2	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

	opt exp	2475.7097	2475.7097	N·s/kg
	vacuum	2659.8432	2659.8432	N·s/kg
Mass flow rate	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