# Engine name: LPE -3

Tue 13. Jan 18:07:43 2026

## Propellant Specification

| Component | Temperature (K) | Mass fraction | Mole fraction |
|---|---|---|---|
| RP-1 | 293.00 | 0.26 | 0.45 |
| O2(L) | 86.00 | 0.74 | 0.55 |
| | Total | 1.00 | 1.00 |

Exploded propellant formula: $O_{1.097} C_{0.451} H_{0.880}$

$$O/F = 2.784$$
$$O/F^0 = 3.406 \text{ (stoichiometric)}$$
$$\alpha_{ox} = 0.817 \text{ (oxidizer excess coefficient)}$$

## Table 1. Thermodynamic properties

| Parameter | Injector | Nozzle inlet | Nozzle throat | Nozzle exit | Unit |
|---|---|---|---|---|---|
| Pressure | 3.0000 | 2.9692 | 1.7296 | 0.0364 | MPa |
| Temperature | 3567.0178 | 3564.6476 | 3403.4467 | 2461.0488 | K |
| Enthalpy | -772.1112 | -778.5685 | -1430.8459 | -5136.3004 | kJ/kg |
| Entropy | 11.3792 | 11.3810 | 11.3810 | 11.3810 | kJ/(kg·K) |
| Internal energy | -2017.4873 | -2023.0257 | -2601.5706 | -5912.6561 | kJ/kg |
| Specific heat (p=const) | 7.6970 | 7.7024 | 7.6671 | 4.0383 | kJ/(kg·K) |
| Specific heat (V=const) | 6.4770 | 6.4820 | 6.5040 | 3.5476 | kJ/(kg·K) |
| Gamma | 1.1884 | 1.1883 | 1.1788 | 1.1383 | |
| Isentropic exponent | 1.1297 | 1.1296 | 1.1254 | 1.1273 | |
| Gas constant | 0.3491 | 0.3491 | 0.3440 | 0.3155 | kJ/(kg·K) |
| Molecular weight (M) | 23.8144 | 23.8161 | 24.1712 | 26.3569 | |
| Molecular weight (MW) | 0.02381 | 0.02382 | 0.02417 | 0.02636 | |
| Density | 2.4089 | 2.3859 | 1.4774 | 0.0468 | kg/m³ |
| Sonic velocity | 1186.1068 | 1185.6329 | 1147.8168 | 935.5280 | m/s |
| Velocity | 0.0000 | 113.6424 | 1147.8168 | 2954.3829 | m/s |
| Mach number | 0.0000 | 0.0958 | 1.0000 | 3.1580 | |
| Area ratio | 6.2500 | 6.2500 | 1.0000 | 12.2500 | |
| Mass flux | 271.1425 | 271.1425 | 1695.7579 | 138.3819 | kg/(m²·s) |
| Mass flux (relative) | 0.904e-04 | 0.913e-04 | | | kg/(N·s) |

## Table 2. Fractions of the combustion products

| Species | Injector mass fractions | Injector mole fractions | Nozzle inlet mass fractions | Nozzle inlet mole fractions | Nozzle throat mass fractions | Nozzle throat mole fractions | Nozzle exit mass fractions | Nozzle exit mole fractions |
|---|---|---|---|---|---|---|---|---|
| CO | 0.3410449 | 0.2899588 | 0.3409576 | 0.2899059 | 0.3274443 | 0.2825671 | 0.2391260 | 0.2250123 |
| CO2 | 0.2962620 | 0.1603131 | 0.2963995 | 0.1603993 | 0.3176515 | 0.1744630 | 0.4564444 | 0.2733604 |
| COOH | 0.0000212 | 0.0000112 | 0.0000210 | 0.0000111 | 0.0000127 | 0.0000068 | 0.0000002 | 0.0000001 |
| H | 0.0013850 | 0.0327227 | 0.0013848 | 0.0327209 | 0.0012156 | 0.0291522 | 0.0003193 | 0.0083500 |
| H2 | 0.0057712 | 0.0681771 | 0.0057703 | 0.0681717 | 0.0054963 | 0.0659030 | 0.0043294 | 0.0566057 |
| H2O | 0.2388507 | 0.3157366 | 0.2388903 | 0.3158122 | 0.2466031 | 0.3308692 | 0.2859766 | 0.4183923 |
| H2O2 | 0.0000167 | 0.0000117 | 0.0000166 | 0.0000116 | 0.0000104 | 0.0000074 | | |
| HCHO,formaldehy | 0.0000003 | 0.0000003 | 0.0000003 | 0.0000002 | 0.0000002 | 0.0000001 | | |

| Species | Injector mass fractions | Injector mole fractions | Nozzle inlet mass fractions | Nozzle inlet mole fractions | Nozzle throat mass fractions | Nozzle throat mole fractions | Nozzle exit mass fractions | Nozzle exit mole fractions |
|---|---|---|---|---|---|---|---|---|
| HCO | 0.0000162 | 0.0000133 | 0.0000160 | 0.0000131 | 0.0000090 | 0.0000075 | 0.0000001 | 0.0000001 |
| HCOOH | 0.0000021 | 0.0000011 | 0.0000020 | 0.0000011 | 0.0000012 | 0.0000006 | | |
| HO2 | 0.0001571 | 0.0001133 | 0.0001562 | 0.0001127 | 0.0001023 | 0.0000749 | 0.0000013 | 0.0000010 |
| O | 0.0134536 | 0.0200250 | 0.0134422 | 0.0200096 | 0.0109217 | 0.0165000 | 0.0007208 | 0.0011874 |
| O2 | 0.0477666 | 0.0355492 | 0.0477468 | 0.0355371 | 0.0423788 | 0.0320121 | 0.0043836 | 0.0036107 |
| O3 | 0.0000003 | 0.0000002 | 0.0000003 | 0.0000002 | | | | |
| OH | 0.0552522 | 0.0773664 | 0.0551959 | 0.0772933 | 0.0481527 | 0.0684358 | 0.0086981 | 0.0134798 |

**Table 3. Theoretical (ideal) performance**

| Parameter | Sea level | Optimum expansion | Vacuum | Unit |
|---|---|---|---|---|
| Characteristic velocity | | 1760.06 | | m/s |
| Effective exhaust velocity | 2484.95 | 2954.38 | 3217.16 | m/s |
| Specific impulse (by mass) | 2484.95 | 2954.38 | 3217.16 | N·s/kg |
| Specific impulse (by weight) | 253.39 | 301.26 | 328.06 | s |
| Thrust coefficient | 1.4119 | 1.6786 | 1.8279 | |

**Table 4. Estimated delivered performance**

| Parameter | Sea level | Optimum expansion | Vacuum | Unit |
|---|---|---|---|---|
| Characteristic velocity | | 1716.47 | | m/s |
| Effective exhaust velocity | 2321.69 | 2791.13 | 3053.91 | m/s |
| Specific impulse (by mass) | 2321.69 | 2791.13 | 3053.91 | N·s/kg |
| Specific impulse (by weight) | 236.75 | 284.62 | 311.41 | s |
| Thrust coefficient | 1.3526 | 1.6261 | 1.7792 | |

**Ambient condition for optimum expansion:** H=7.86 km, p=0.359 atm

**Table 5. Altitude performance**

| Altitude, km | Pressure, atm | Effective exhaust velocity, m/s | Specific impulse (by weight), s | Thrust coefficient |
|---|---|---|---|---|
| 0.000 | 1.00000 | 2484.951 | 253.394 | 1.4119 |