Turbojet Design Point: Specific Thrust, SFC and Nozzle Area

Specific thrust, fuel/air ratio, SFC, air and fuel flow and nozzle area of a simple turbojet at a flight Mach number, choked or unchoked nozzle.

Input parameters

Unit system: SI

Parameter	Value	Unit
Ambient pressure (ISA 10,000 m: 0.2650 bar)	1.0132	bar
Ambient temperature (ISA 10,000 m: 223.15 K)	15.000	°C
Flight Mach number	0	
Compressor pressure ratio	12.000	
Turbine inlet temperature	1,126.8	°C
Intake isentropic efficiency	93.000	%
Compressor isentropic efficiency	86.000	%
Turbine isentropic efficiency	89.000	%
Propelling nozzle efficiency	95.000	%
Mechanical efficiency	99.000	%
Combustion efficiency	99.000	%
Combustion pressure loss	5.0000	%
Air specific heat	1.0050	kJ/(kg·K)
Air ratio of specific heats	1.4000	
Gas specific heat	1.1480	kJ/(kg·K)
Gas ratio of specific heats	1.3333	
Gas constant (air and gas)	0.28700	kJ/(kg·K)
Fuel net calorific value	43,100	kJ/kg
Fuel H/C atom ratio (kerosene about 1.92, methane 4)	1.9200	
Thrust required	20.000	kN

Calculated results

Parameter	Value	Unit
Flight speed	0	m/s
Intake stagnation temperature	288.15	K
Intake stagnation pressure	1.0132	bar
Compressor delivery temperature	634.58	K
Compressor delivery pressure	12.159	bar
Turbine exit (jet pipe) temperature	1,093.7	K
Turbine exit pressure	3.7362	bar
Nozzle pressure ratio	3.6874	
Critical pressure ratio	1.9191	
Nozzle choked (1 = yes, 0 = no)	1.0000	
Jet velocity	598.93	m/s

Parameter	Value	Unit
Specific thrust	814.35	N·s/kg
Fuel/air ratio	0.022006	
Specific fuel consumption	0.097283	kg/(N·h)
Air flow for the thrust	24.560	kg/s
Fuel flow	1,945.7	kg/h
Nozzle exit area	0.056666	m²

Notes for this case

- The nozzle is choked: the jet leaves at sonic speed above ambient pressure, and the pressure thrust $A_5(p_c - p_a)$ is added to the momentum thrust.
- Fuel flow neglected in the momentum balance (as in the textbook); fuel/air ratio from an enthalpy balance with NIST Shomate data for a CH_y fuel.

Formula and method

$$T_{01} = T_a + \frac{C_a^2}{2c_p}, \quad \frac{p_{01}}{p_a} = \left(1 + \eta_i \frac{C_a^2}{2c_p T_a}\right)^{\gamma/(\gamma-1)}, \quad \frac{p_{04}}{p_c} = \left[1 - \frac{1}{\eta_j}\frac{\gamma-1}{\gamma+1}\right]^{-\gamma/(\gamma-1)}$$

$$F_s = (C_5 - C_a) + \frac{A_5}{\dot{m}}(p_5 - p_a), \quad SFC = \frac{f}{F_s}$$

Variables

p_a	Ambient pressure (ISA 10,000 m: 0.2650 bar)	Pa
T_a	Ambient temperature (ISA 10,000 m: 223.15 K)	K
M	Flight Mach number	-
r_c	Compressor pressure ratio	-
T_{03}	Turbine inlet temperature	K
η_i	Intake isentropic efficiency	-
η_c	Compressor isentropic efficiency	-
η_t	Turbine isentropic efficiency	-
η_j	Propelling nozzle efficiency	-
η_m	Mechanical efficiency	-
η_b	Combustion efficiency	-
$\Delta p_b/p_{02}$	Combustion pressure loss	-
c_{pa}	Air specific heat	J/(kg·K)
γ_a	Air ratio of specific heats	-
c_{pg}	Gas specific heat	J/(kg·K)
γ_g	Gas ratio of specific heats	-
R	Gas constant (air and gas)	J/(kg·K)
Q_{net}	Fuel net calorific value	J/kg
y	Fuel H/C atom ratio (kerosene about 1.92, methane 4)	-
F	Thrust required	N
C_a	Flight speed	m/s
T_{01}	Intake stagnation temperature	K
p_{01}	Intake stagnation pressure	Pa

T_{02}	Compressor delivery temperature	K
p_{02}	Compressor delivery pressure	Pa
T_{04}	Turbine exit (jet pipe) temperature	K
p_{04}	Turbine exit pressure	Pa
p_{04}/p_a	Nozzle pressure ratio	-
p_{04}/p_c	Critical pressure ratio	-
choked	Nozzle choked (1 = yes, 0 = no)	-
C_5	Jet velocity	m/s
F_s	Specific thrust	m/s
f	Fuel/air ratio	-
SFC	Specific fuel consumption	kg/(N·s)
$\dot{m}$	Air flow for the thrust	kg/s
$\dot{m}_f$	Fuel flow	kg/s
A_5	Nozzle exit area	m²

Method and standards

Textbook turbojet design-point calculation with a convergent nozzle.

Assumptions and limits

- Convergent nozzle; constant c_p and γ; fuel flow neglected in the momentum balance.

Report details

Report reference	FCC-M07F-14CT (the same inputs always give the same reference)
Generated	23 November 2026, 17:43 UTC
Calculator	Turbojet Design Point: Specific Thrust, SFC and Nozzle Area
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/gas-turbines-combined-cycle/turbojet-design-point

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.