



## Air Density and Temperature Changes in a Capstone Microturbine Cycle

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<https://infinityturbine.com/capstone-microturbine-cycle-air-density-vs-temp-changes.html>

Explore how air density, temperature, and pressure change from inlet to exhaust in a Capstone Microturbine. Understand each stage of the Brayton cycle and its impact on efficiency.



This webpage QR code

**PDF Version of the webpage (maximum 10 pages)**

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### Introduction

The Capstone Microturbine operates on a simple Brayton cycle: air is compressed, mixed with fuel and burned, and the hot gas expands through a turbine to produce power. Each stage in this process dramatically changes the air's pressure, temperature, and density. This article analyzes those changes using approximate thermodynamic conditions for a typical Capstone C65 or C200 microturbine, starting with an outside air temperature of 60°F (15°C).

### 1. Ambient Inlet Conditions

Temperature: 15°C (288 K)  
 Pressure: 1 atm (14.7 psi or 101 kPa)  
 Density: ~1.225 kg/m<sup>3</sup>

At the inlet, the air is drawn through a filter and enters the compressor at atmospheric conditions. The air is relatively cool and dense, which helps improve the turbine's mass flow rate and power output.

### 2. End of Compressor Section

The compressor in a Capstone microturbine typically operates with a pressure ratio of 3.5:1 to 4:1.

Assuming an outlet pressure of about 4 atm (~400 kPa or 58 psi) and an adiabatic efficiency of around 80%, the air experiences significant compression heating.

Pressure: ~4 atm (400 kPa or 58 psi)  
 Temperature: ~300°C (573 K)  
 Density: ~2.4–2.8 kg/m<sup>3</sup>

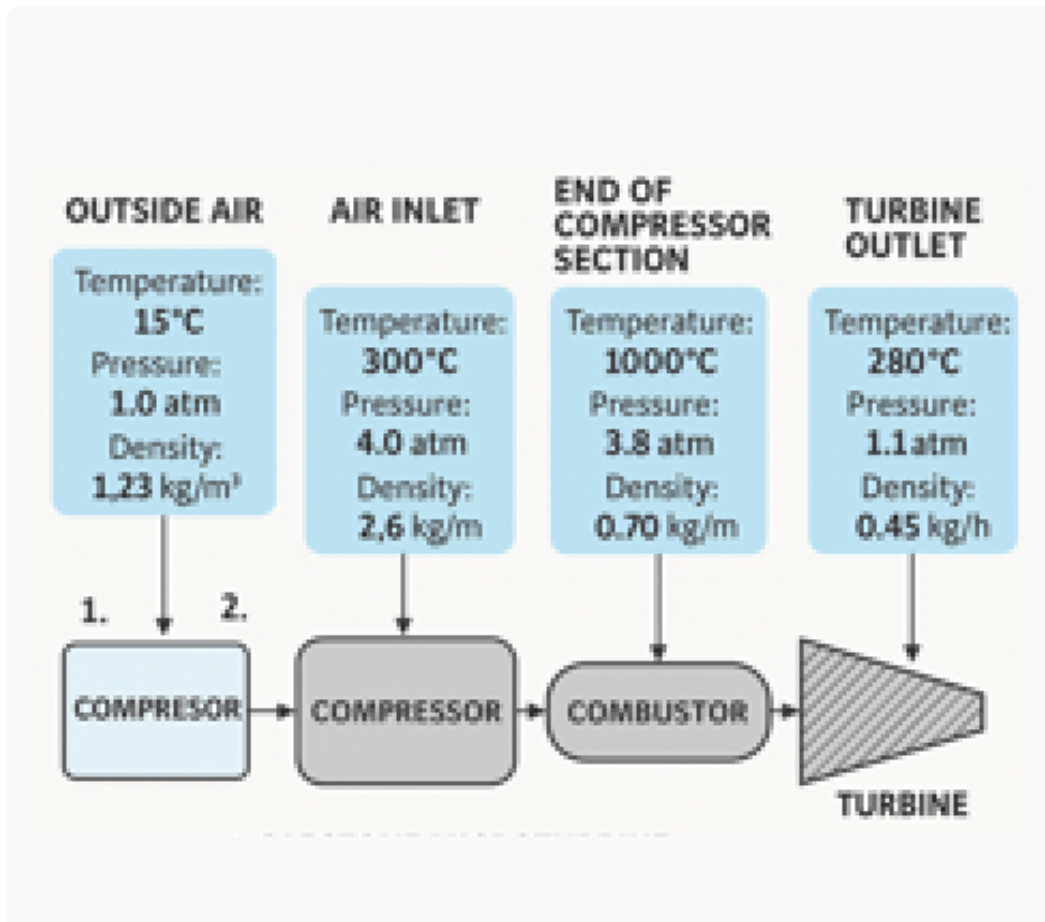
Effect: The air becomes much hotter and about twice as dense as at inlet, but because of the large temperature rise, it does not become as dense as a simple pressure ratio would suggest. The high energy content in this compressed air is essential for efficient combustion.

### 3. Combustion Section

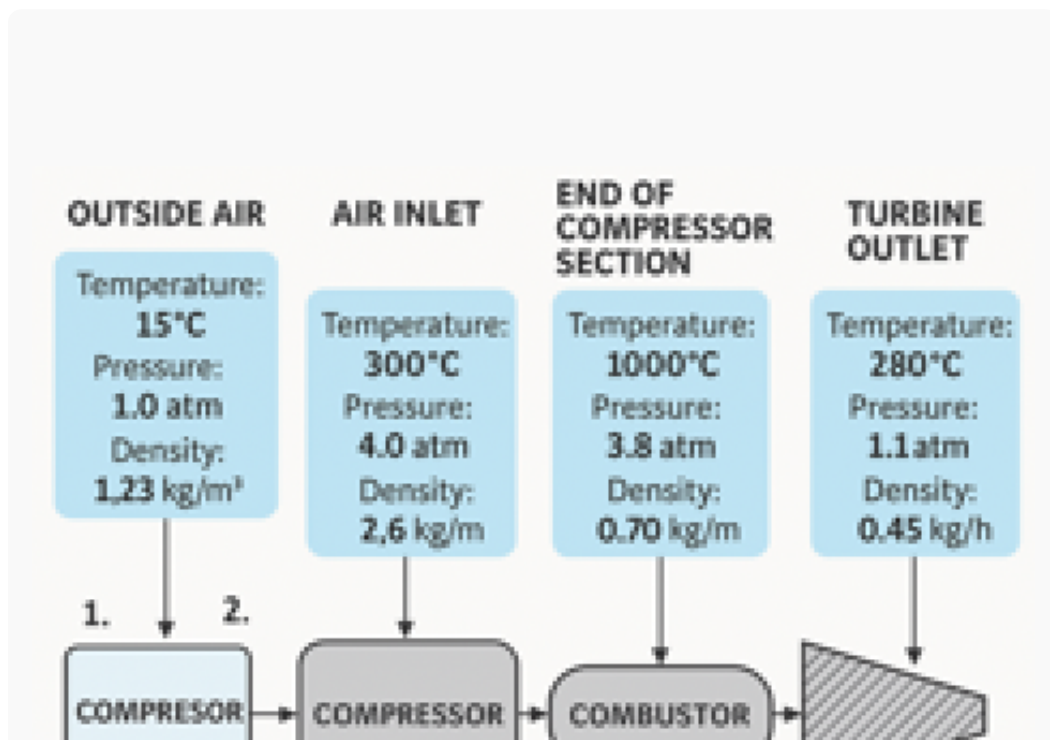
In the combustion chamber, fuel (typically natural gas or biogas) is mixed with the compressed air and burned under nearly constant pressure. The Capstone turbine uses lean premixed combustion for low emissions.

Pressure: ~3.8–4.0 atm (slight drop from compressor discharge)  
 Temperature: ~950–1000°C (1223–1273 K)  
 Density: ~0.6–0.8 kg/m<sup>3</sup>

Effect: The density drops dramatically because the temperature rises to nearly 1000°C, even though pressure stays roughly constant. The hot gases expand rapidly, increasing volume and velocity, which drives the turbine.









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