# How Stirling engines work

## Questions

- Can the heat supplied be converted completely into work?
  Which law of thermodynamics is relevant to this question?
- How is the Carnot cyclic process related to the Stirling engine?
- How does the Stirling engine differ from the steam engine, and the Otto and diesel engines?
- What advantages does a Stirling engine offer?

## Solutions

- According to the second law of thermodynamics, only a portion of heat can be converted into mechanical work. Part of the heat is always “lost” in the form of unused waste heat via the cooling unit. What percentage of the heat is lost depends on the difference between the hot ($T_2$) and cold ($T_1$) working point of the engine. This can be expressed via the thermal efficiency:

$$\eta_{\text{ideal}} = 1 - \frac{T_1}{T_2} < 1.$$

- Similar to the Carnot cyclic process, the Stirling engine is a typical heat engine and can be represented as a cyclic process in the p-V diagram.
- In the case of the steam engine, fuel is burned separately in a steam generator and the working medium (usually water) is fed to the working cylinder as hot steam. With internal combustion engines, the fuel is burned in the working cylinder by means of explosion.
- In the Stirling engine, the working medium (air or other gas) enclosed in the operating cylinder is heated from the outside by the combustion gases of the fuel, or else heat is delivered from other sources (geothermal, sun). Thanks to its simple, almost wear-free design, the Stirling engine has advantages in terms of costs and service life for power plants with small and medium power outputs.