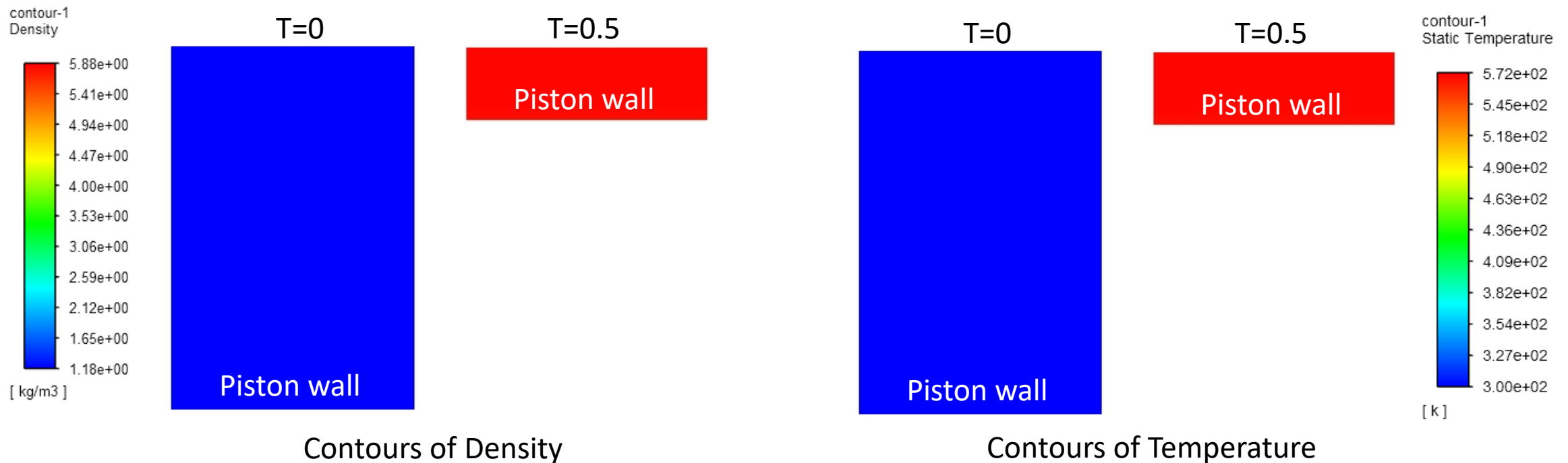


Isentropic Compression in a Piston-Cylinder Assembly

Results

- The compression ratio we prescribed for our simulation using the dynamic mesh approach is 5: 1.
- The density and temperature contours after the piston reached the Top Dead Center (TDC) are shown here.



- In compressible flows, unlike incompressible, the density of the fluid can vary. For most gases, this variation of density is dependent on the pressure and temperature of the fluid and can be obtained from the ideal-gas law.

Results

- Based on the volume-averaged density values at the beginning of the simulation (piston at BDC) and at the end of simulation (piston at TDC), the computed compression ratio exhibits an almost identical match with the prescribed ratio.

$$\frac{\rho_{TDC}}{\rho_{BDC}} = 4.999, \text{ where } \rho_{BDC} = 1.17665, \rho_{TDC} = 5.88210$$

- For an isentropic process, the density and temperature at two different states are related according to the following formula

$$\frac{T_2}{T_1} = \left(\frac{\rho_2}{\rho_1} \right)^{\gamma-1}$$

where γ is the ratio of specific heats and is equal to 1.4

- From the compression ratio (5: 1) and the initial temperature (300 K), the theoretical estimate for the final temperature of the fluid is 571.096 K.
- From the simulations, the volume-averaged temperature value when the piston is at TDC is calculated as 570.142 K, indicating an excellent match with the theoretical predictions.

Appendix

Isentropic Compression in a Piston-Cylinder Assembly



/ Setup Changes

- Modifications from the default Ansys Fluent 2020 R1 settings are outlined here.
 - **Inviscid Model:** In this problem, there is no explicit movement of fluid into and out of the system. The fluid is just compressed in a bounded enclosure, and therefore the viscous effects will be negligible and can be ignored.
 - **Transient Simulation:** As the piston moves, the fluid properties continue to change. Therefore, the problem is inherently transient in nature. Furthermore, in order to use the dynamic meshing approach to facilitate piston motion, it is mandatory to perform a transient simulation.
 - **Input of Transient Table File:** There are multiple ways of prescribing the piston motion. For this problem, the use of transient table file which contains information regarding the time variation of piston location is used.

 **Ansys**

