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Problem

Methane gas ( $\text{CH}_4$ ) at 400 K and 1 atm enters a combustion chamber, where it is mixed with air entering at 500 K and 1 atm. The products of combustion exit at 1700 K and 1 atm. The molar analysis of the products on a dry basis is 9.7%  $\text{CO}_2$ , 0.5%  $\text{CO}$ , 2.95%  $\text{O}_2$  and 86.85%  $\text{N}_2$ . For operation at steady state, determine:

- (a) The air–fuel ratio.
- (b) The percent theoretical air,
- (c) The rate of heat transfer from the combustion chamber in kJ per kmol of fuel.

Neglect kinetic and potential energy effects. The average value for the specific heat of methane between 298 and 400 K is 38 kJ/kmol K. Assume the water in the product is in the vapor form.