34.18 $80°F$ **atmostpheric air enters a gas turbine cycle and is compressed at a 4:1 ratio. The fuel used has a heating value of** $10,000\frac{Btu}{lb}$ **and the air-to-fuel ratio is 80. What is the enthalpy of the air leaving the combustor?**

A. $320\frac{Btu}{lb}$

B. $2300\frac{Btu}{lb}$

C. $4150\frac{Btu}{lb}$

D. $10,200\frac{Btu}{lb}$

Use the Brayton Cycle diagram for a standard gas turbine cycle with no regeneration and no heat recovery. State 1 is fully defined. Use Air at Low Pressure tables to obtain the enthalpy and relative pressure at State 1.

$$P_1 = 14.7psia$$

$$T_1 = 80°F$$

$$h_1 = 129\frac{Btu}{lb}$$

$$p_{r,1} = 1.386$$

Determine the enthalpy at State 2 by setting up a proportion between the compression ratio, which is given, and the ratio of the relative pressures. Use the relative pressure at State 2 to obtain the enthalpy from the Air at Low Pressure tables.

$$\frac{p_{r,2}}{p_{r,1}} = \frac{p_2}{p_1}$$

$$p_{r,2} = 4p_{r,1} = 4\,(1.386) = 5.544$$

$$h_2 \approx 192\frac{Btu}{lb}$$

Calculate the heat flux added in the combustor from State 2 to State 3 and add this quantity to h_2 to specific h_3. The heating value is given *per pound of fuel* and there is 80 times less fuel than air by mass due to the air-to-fuel ratio.

$$\dot{q}_{23} = \frac{HHV}{A/F} = \frac{10,000\frac{Btu}{lb_{fuel}}}{80\frac{lb_{air}}{lb_{fuel}}} = 125\frac{Btu}{lb_{air}}$$

$$\dot{q}_{23} = h_3 - h_2$$

$$h_3 = h_2 + \dot{q}_{23} = 192\frac{Btu}{lb} + 125\frac{Btu}{lb} = 317\frac{Btu}{lb}$$

Answer A