For the reaction, CO(g) + 2H2 (g)= CH3 OH (g) derive an expression for the equilibrium constant, Kp in terms of the extent of reaction, € and the total pressure pt, if initially 2 mol of CO and 3 mol of H2 are mixed.

Solution. The general expression for the equilibrium constant is written as: $K_p=\frac{p_{CH_3OH}}{p_{H_2}^2 \times p_{CO}}$.

We have a degree of reaction €. Then reacted: 2€ moles CO, 4€ moles H_2, and formed: 2€ moles CH_3OH. Then the equilibrium quantities of substances:

- for CO: (2-2€) moles;
- for H_2: (3-4€) moles;
- for CH_3OH: 2€ moles.

We have a total pressure pt, then partial pressures:

-for CO: $p_{CO}=\frac{2-2€}{2-2€+3-4€+2€}pt=\frac{2-2€}{5-4€}pt$;

-for H_2: $p_{H2}=\frac{3-4€}{5-4€}pt$;

-for CH_3OH: $p_{CH3OH}=\frac{2€}{5-4€}pt$.

Then the expression of the equilibrium constant takes the form:

$K_P=\frac{€(5-4€)^2}{(1-€)(3-4€)^2 pt^2}$.

Answer: $K_P=\frac{€(5-4€)^2}{(1-€)(3-4€)^2 pt^2}$.