**Le Chatelier’s Principle** : A system in equilibrium partially opposes any change.

**Qn**. Equation for the production of sulfur trioxide is

 2SO2(g) + O2(g) ⇄ 2SO3(g) Δ*H* = - ve kJ mol-1

###  Explain the impact on the – value of *K*

* position of equilibrium
* amount of SO2
* concentration of SO2 of
1. an increase in temperature
2. a decrease in pressure
3. addition of excess oxygen gas
4. addition of an inert gas
5. the addition of a catalyst to an equilibrium mixture

**Discussion**

Le Chatelier’s Principle : A system in equilibrium partially opposes any change.

If the yield is low, change the conditions to improve it.

The usual variables are

**1**. **Temperature**

 Temperature is the only variable that leads to a change in the numerical value of *K*.

|  |  |  |
| --- | --- | --- |
| Endothermic reaction ΔH = +ve |  T↑, K↑ |  T ↓, K↓ |
| Exothermic reaction ΔH = - ve  |  T↑, K ↓ |  T↓, K↑ |

 2SO2(g) + O2(g) ⇄ 2SO3(g) Δ*H* = - ve kJ mol-1

 This is an **exothermic reaction**. T**emperature** of the reactor is **increased**, the value of ***K* will**

 **drop. Therefore**

* back reaction favoured, amount of SO2 increased and concentration of SO2 increased

**2. Pressure (Volume)**

 2SO2(g) + O2(g) ⇄ 2SO3(g)

 3 molecules 2 molecule

 **Pressure decrease** = volume increase. System opposes the decrease in pressure by moving in the

 **reverse direction** – every **2 product** molecules reacting produces **3 reactant** molecules. Therefore

* back reaction favoured, ***K* unchanged** as temperature constant, amount of SO2 increases.
* **Care**: despite the back reaction the [SO2] is less than before the volume increase.

**3**. **Concentration**

 2SO2(g) + O2(g) ⇄ 2SO3(g)

 **Extra O2** gas is injected into an equilibrium mixture.

 The system opposes this by moving in the **forward direction** to use up some of the O2.Therefore

* **forward reaction** is favoured, *K* is **unchanged** as temperature constant, the amount and concentration of SO2 **decrease**.

**4**. **Addition of an inert gas**. An inert gas does not change the volume of the reactor or the amounts of any

 chemicals. Therefore the system has nothing to oppose so **no change** occurs. Don’t be fooled by the

 fact that the total pressure has increased.

**5**. **Addition of catalyst**. Catalysts work for either the forward or back direction. They do not affect the

 final yield, just the reaction rate.

 A catalyst will **not change the concentrations** of a system at equilibrium.

 If the system is **not** at equilibrium, the **catalyst will help it reach equilibrium faster**.

###### CARE

The reaction between nitrogen tetroxide and ditrogen dioxide is

 N2O4(g) 2NO2(g)

 colourless brown

An equilibrium mixture will be brown in colour due to the NO2 present.

The volume of an equilibrium mixture is halved, what will happen to the intensity of the brown colour?

original intensity volume decrease final intensity

Many students suggest the brown intensity will decrease as

the system favours the reverse reaction trying to reduce the

number of particles present. However, this is ignoring the fact

that the initial change in volume increased the brown intensity

significantly.

The final intensity is greater than the original intensity.