

TYPES CATALYST



NANIK DWI NURHAYATI, S.Si, M.Si

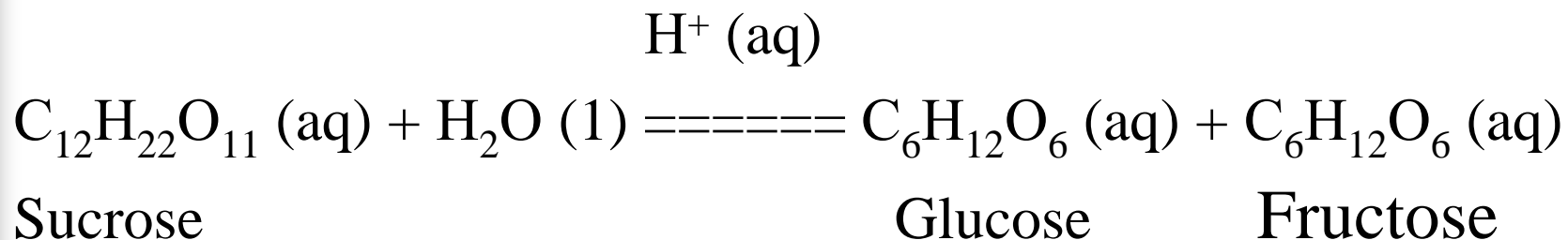
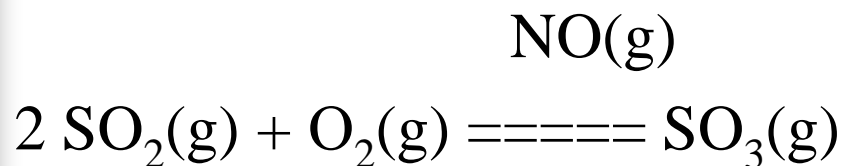
Chemical Education Study Program
Teacher Training and Educational Studies
Sebelas Maret University (UNS)

Website: <http://nanikdn.staff.uns.ac.id>,
email: nanikdn@uns.ac.id



1. *Homogeneous catalysts.*

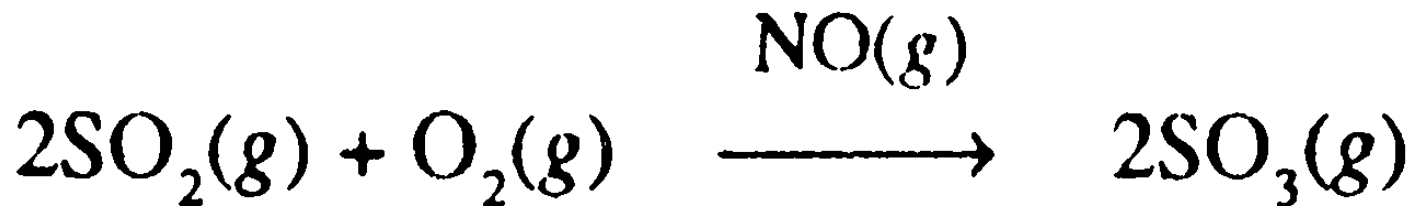
If the catalyst is present in the same phase as the reactants, it is called a homogeneous catalyst and this type of catalysis is called homogeneous catalysis.



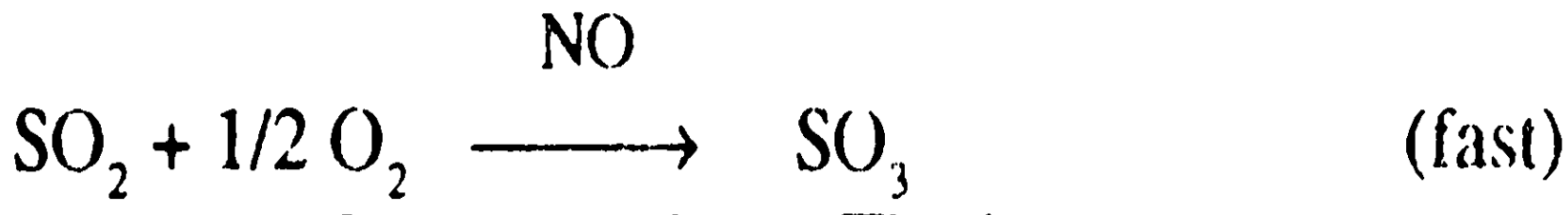
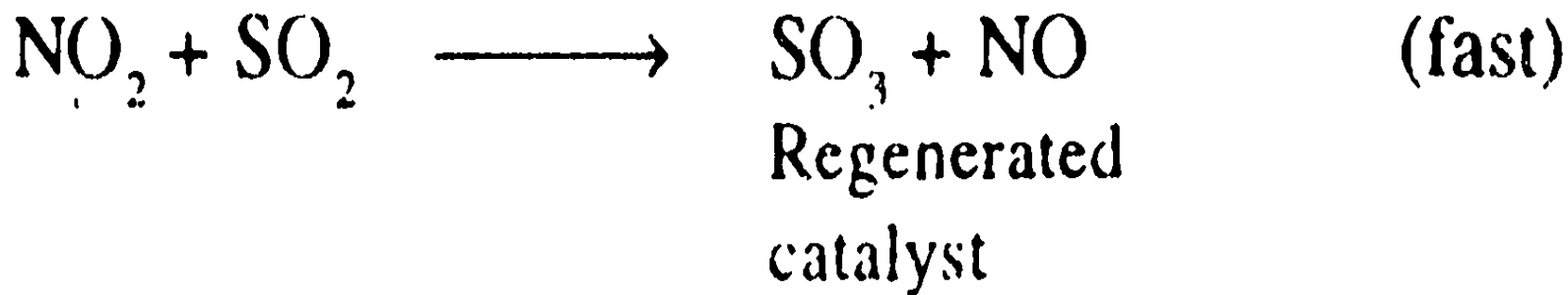
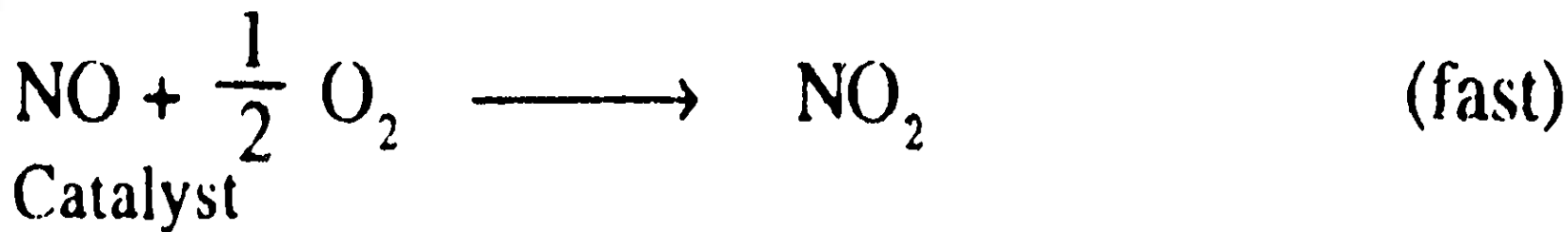
Mechanism of Catalytic reactions

The catalyst combines with one of the reactants to form an *intermediate*. Intermediate compound being unstable combines with the other reactant to form product.

For example, the combination of SO₂ and O₂ to form SO₃ is a slow process. However, in the presence of NO (catalyst), the reaction becomes fast.



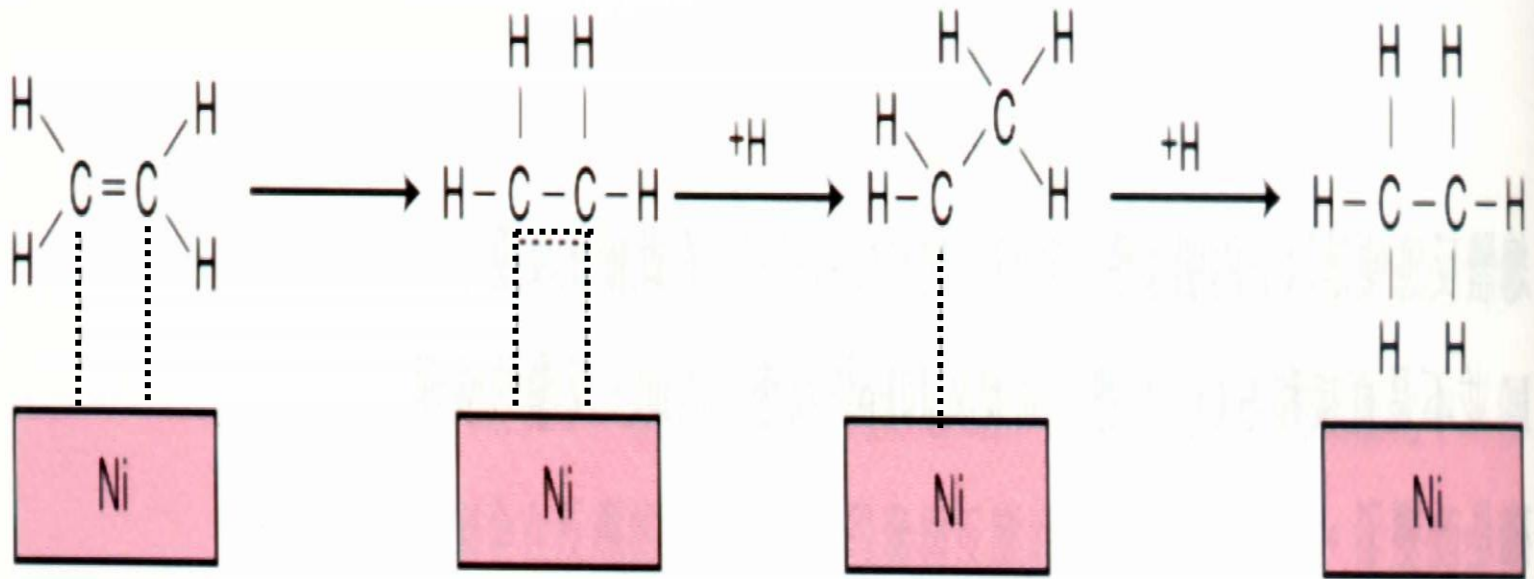
It is believed that in this reaction nitric oxide combines with one of the reactants to form intermediate compound (NO₂). This intermediate (NO₂) combines readily with SO₂ to form SO₃ and the catalyst NO is regenerated in the last step.



Types of Catalyst

2. Heterogeneous Catalyst

- catalyst with different phase as the reactant
- usually solid state
e.g. decomposition of H_2O_2 with MnO_2 as catalyst
e.g. hydrogenation of ethene (Ni as catalyst)



Types of catalysis

Positive

Negative

Autocatalysis

Homogeneous

Heterogeneous

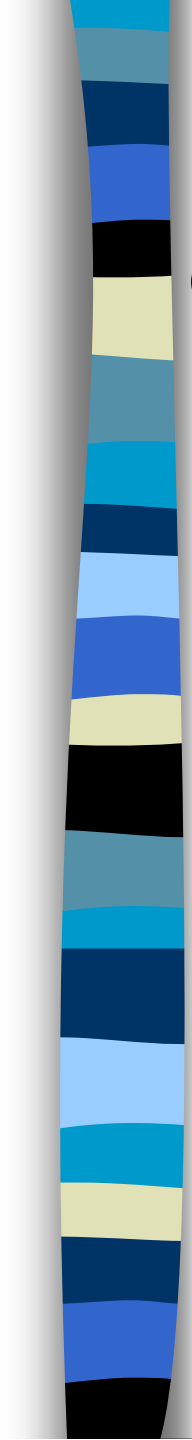
Enzyme

Acid-base specific

Acid-base unspecific

Characteristics of catalysts.

- 1. Activity.** The ability of a catalyst to increase the rate of a chemical reaction is called activity. A catalyst may accelerate a reaction to as high as 10^{10} times.
- 2. Selectivity.** Ability of the catalyst to direct a reaction to give a particular product.
- 3. Small quantity.** Only small quantity is needed for a reaction.
- 4. Specific.** One catalyst is needed for specific reaction only.
- 5.** Physical properties may change during a reaction but it *does not take part in the reaction.*
- 6.** Catalyst doesn't influence on the general **stoichiometric coefficients.**
- 7.** Catalysts decrease **activation energy** thus increase the chemical rate.
- 8.** Catalysts don't influence on the **equilibrium constant.** They only reduce time of reaching the equilibrium and increase the rate of forward and back reaction.



Components of a Typical Catalyst

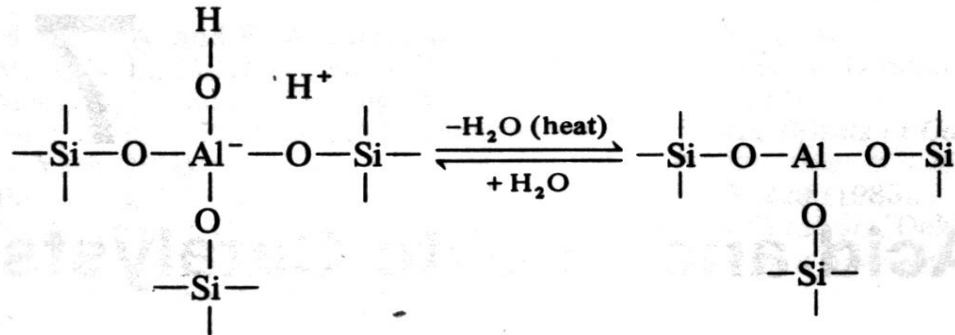
- A. Active phase - metal that provides active sites where the chemical reaction takes place
- B. Support or Carrier - high surface area oxide which disperses and stabilizes the active phase
(adds efficiency, physical strength, sometimes selectivity)
- C. Promoter(s) - additive which improves catalyst properties, e.g. activity, selectivity, catalyst life



Active Catalytic Phases and Reactions They Typically Catalyze

Active Phase	Elements/Compounds	Reactions Catalyzed
metals	Fe, Co, Ni, Cu, Ru, Pt, Pd, Ir, Rh, Au	hydrogenation, steam reforming, HC reforming, dehydrogenation, ammonia synthesis, Fischer-Tropsch synthesis
oxides	oxides of V, Mn, Fe, Cu, Mo, W, Al, Si, Sn, Pb, B	complete and partial oxidation of hydrocarbons and CO, acid-catalyzed reactions (e.g. cracking, isomerization, alkylation), methanol synthesis
sulfides	sulfides of Co, Mo, W, Ni	hydrotreating (hydrodesulfurization, hydrodenitrogenation, hydrodemetallation), hydrogenation
carbides	carbides of Fe, Mo, W	hydrogenation, FT synthesis

Acid Catalyst (Zeolite)

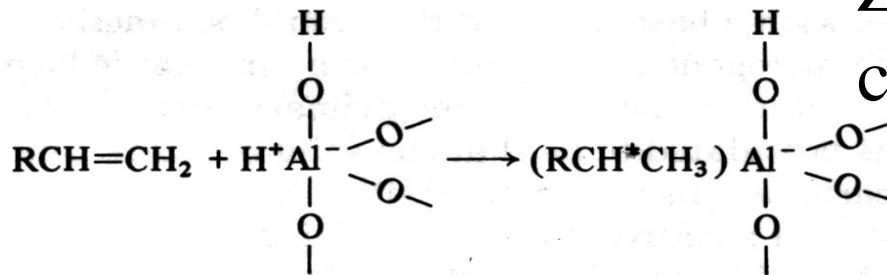


Brönsted acid

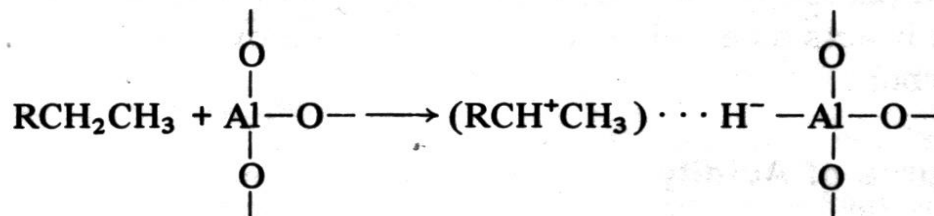
Lewis acid

Properties catalyst solid

Zeolite silika-alumina is catalyst

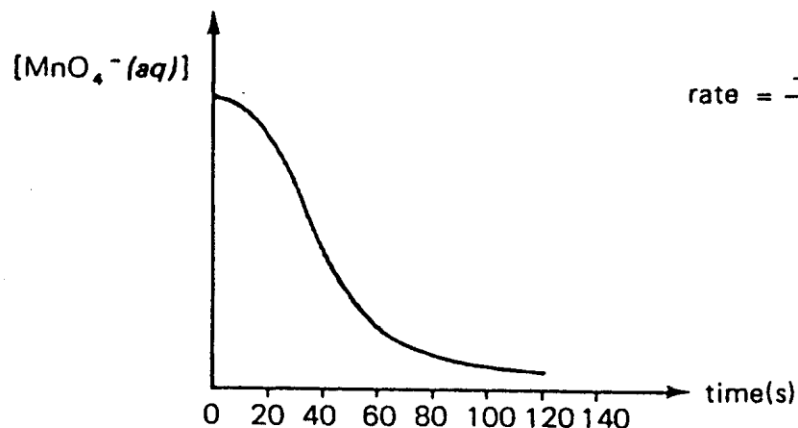


and

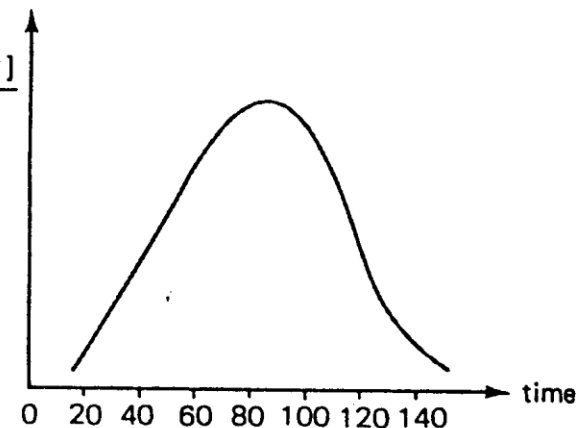


3. Autocatalysis

- the product in the reaction be the catalyst of the reaction
- this product is called **autocatalyst**
- e.g. $2\text{MnO}_4^- + 16\text{H}^+ + 5\text{C}_2\text{O}_4^{2-} \rightleftharpoons 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 10\text{CO}_2$



$$\text{rate} = \frac{-d[\text{MnO}_4^-]}{dt}$$



A scenic view of a rocky cliffside with lush green trees and a waterfall in the background. The text "Thanks for attention" is overlaid in a large, bold, purple font with a white outline, slanted upwards from left to right.

Thanks for attention