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Industrial applications of nano Cu-Chromite catalyzer

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Abstract
Nano Cu-Chromite catalyzer is a high usage catalyzer in chemical reactions. This catalyzer has many applications in oxidation, hydrogenation, dehydrogenation, alkylation, alcohol decomposition, useful reactions in petroleum include: reforming. Recyclable is one of advantages of this catalyzer. This catalyzer produces by sol-gel, co-precipitating, deposition in vacuum and ceramic methods. This paper explores applications of this catalyzer in various industries.

Keywords: Nano Cu-Chromite, hydrogen producing, nano catalyzer

Introduction
Cu-Chromite is an important catalyzer in chemical reactions that has wide application in synthesis of organic chemistry processes. Uses in many reactions such as: hydrogenation, dehydrogenation, hydrogenolysis, oxidation, alkylation, cycloaddition, as catalyzer for omission of excess organic material from water, producing volatile organic compounds, producing H2 in green processes and reforming reactions. Cu-Chromite also uses in transformation alcohols through omitting Sulfur on chemical water division thermal cycle, producing H2 from methanol, alcohol synthesis through converting CO to CO_2 in thermal decomposition of biomass in producing pharmaceutical materials in odorant chemical material industries and synthesis species of odors, desulfuration, producing electrodes, sensors and semiconductors, producing thermal stable masterbatches. It has done too much research projects in producing and application of this catalyzer, also there are too much handbooks and inventions about this subject. So another several studies on innovation preparing methods and exploitation usage on Cu-Chromite catalyzer. Nonetheless, it's continue different and alternative studies on new methods of producing and presenting now. Table 1 shows the general properties of Cu-Chromite.

Table 1: General properties of Cu-Chromite

Chemical formula	Cu2Cr2O4
Scientific number	01101-01-9
Molecular weight	163.54
Boiling temperature	Unknown
Smelting temperature	Unknown
Solution in water	Low
Physical state	Solid
Ignition point temperature	Unknown
Appearance form	Black powder
Density	1.38gr.cm-3

1- Applications of Cu-Chromite catalyzer 1-1-Hydrogenation
Catalytic hydrogenation is the most useful method for reducing chemical compounds and has showed that it has much applications in organic chemical synthesis and industrial processes. Cu- Chromite is an appropriate industrial catalyzer because it's ability in selectivity hydrogenation Aliphatic and Aromatic compounds. This catalyzer is used in vapor phase (for hydrogenation of nitro Benzene and nitro Toluene to related Amines) and liquid phase (for hydrogenation of Carbonyl groups in Ketones, Aldehydes and Esters to related Amines).

For the first time, Cu- Chromite catalyzer is used by Adkins and his cooperators for hydrogenation of organic compounds [1]. They used this catalyzer for hydrogenation of twenty one organic compound in 120-150oc and 100-150 atm. Among this compounds, sixteen compounds were hydrogenated successfully. Cu-Chromite catalyzer is used for reduction of Furfural (C4H3O-CHO) to Furfuryl alcohol (C4H3O-CH2OH), Butane Aldehyde to 1-Butanol, reduction the limitation of conjugated systems and the reduction of Carbonyl groups and the non-conjugated fatty acids. Selective hydrogenation of polyunsaturated organic compound has been successful in industry and laboratory processes.

1-2- Edible oils hydrogenation

Edible oils hydrogenation is an important industrial process for usages in producing butter, frying oils. Vegetate edible oils is mixture of saturated fatty acids, fatty acids with one unsaturated link and polyunsaturated fatty acids. This links is easily broken with oxygen and cause smelly oil. This oils is hydrogenated for producing fat and low melting point oils.

$$Cu2Cr2O4$$

$$\text{Edible oil} + H2 \rightarrow \text{Margarine}$$

In addition to the hydrogenation reaction of Trans fatty acid isomers may also be produced. Trans isomers harmful to human health and thus reduce or eliminate Trans fatty acids unwanted side reactions in the hydrogenation to be done. Cu-Chromite catalyst very high selectivity for the hydrogenation of vegetable oils demonstrated minor's choice. In connection with the catalytic properties of the catalyst parameters such as temperature, hydrogen pressure, hydrogen flow, the catalyst concentration and reaction method used most is done. A leading property Cu-Chromite for hydrogenation, is their high selectivity while a stronger catalysts such as Nickel and saturation are very much front and very low nutrient products also find their Cu-Chromite but low quality of trophic values [2].

1-3-Hydrogenation of Aromatic compounds

Cu-Chromite hydrogenation catalysts for Polyethylene and Polyamide Ethers links under high pressure and high temperature, but is a strong catalyst for the reduction of Aromatic compounds are rarely used. In general, Cu-Chromite catalysts for the hydrogenation of unsaturated compounds containing groups are used. But also has application in the hydrogenation of Aromatic compounds such as hydrogenation of Nitrobenzene to Aniline. Phenanthrene and Anthracene products with this catalyst has two more hydrogen reduced. Selective hydrogenation of Aromatic Nitro groups are reduced to Aromatic Amines is very important for a response [3].

$$Cu2Cr2O4$$

$$C6H5NO2 + 3H2 \rightarrow C6H5NH2 + 2H2O$$

1-4-Alcohols hydrogenation

Cu-Chromite catalyzer is able to hydrogenate of species of Aliphatic and Aromatic alcohols. The reaction below is an example of this process in 36oc and 300atm.

$$Cu2Cr2O4$$

$$RCH2OH + HN(CH3)2 + H2 \rightarrow RCH2N(CH3)2 + H2O$$

1-5-Aldehydes hydrogenation

Cu-Chromite catalyzer is a so useful catalyzer for Aldehydes hydrogenation in 125- 150oc.Hydrogentaion of Benz aldehyde is done by below reaction in 1800c without hydrolyze to benzyl alcohol:

$$Cu2Cr2O4$$

$$C6H5CHO + H2 \rightarrow C6H5CH2OH$$

Vapor phase hydrogenation of furfural in the presence of Cu-Chromite catalyst is perhaps the best way to prepare Furfuryl alcohol that is a very important matter in polymer industries, this compound is widely used to produce synthetic fibers, chemical detergents and resins. It is also used as a solvent for Furan resins, pigments, varnishes and rocket fuels. Pramotana and colleagues observed that Cu-Chromite can be used as an active phase hydrogenation of Furfural to Furfuryl alcohol [5].

1-6-Kethones hydrogenation

Cu-Chromite also is useful for hydrogenation of Ketones to related alcohols. The most part is for Acetone hydrogenation that leads to produce Iso-Propanol in 300-3500c.

$$Cu2Cr2O4$$

$$CH3COCH3 + H2 \rightarrow C3H7OH$$

Keng and his colleagues hydrogenated Methyl 2-Dkanvat for synthesis of 1-Dodecanol in presence of Cu-Chromite [6].The used catalyzer produced by ceramic and co-precipitating methods and promoted by co-precipitating. The most efficiency in hydrogenation reaction reached55%.1-Dodecanol is a fatty alcohol that able to absorb the flower odors. This alcohol is used in lubricating oils and pharmaceutics industries.

1-7-Dehydrogenation of Alcohols

Dehydrogenation of Alcohols to Aldehydes or related Ketones is an important industrial reaction. This reaction done by Cu-Chromite because of high selectivity property for producing no- hydrogen products. Catalytic dehydrogenation of Alcohols have key role in industries specially pharmaceutics industries. General reaction is below:

$$Cu2Cr2O4$$

$$R1 - CHOH - R2 \rightarrow R1 - CO - R2 + H2$$

Dehydrogenation of Methanol to Formaldehyde or Methyl Formate acts with Cu-Chromite below [7].

$$Cu2Cr2O4$$

$$CH3OH \rightarrow HCOH + H2$$

$$Cu2Cr2O4$$

$$HCOH + CH3OH \rightarrow HCOOCH3 + 2H2$$

Such as dehydrogenation of first type of Alcohols that leads to producing Aldehydes, dehydrogenation of Methanol in presence of Cu-Chromite converts to Methyl Formate. This compounds uses as pesticide also primary material for producing Fumaric acid, Acetic Acid, N, N- Dimethyl Formamide, HCN, Methyl Cellulose, CO. Dehydrogenation

of Ethanol in presence of Cu-Chromite has high selective power (up to95%).

$$Cu2Cr2O4$$

$$C2H5OH \rightarrow CH3CHO + H2$$

Produced Acetaldehyde is an important intermediate substance for producing some of chemical industrial materials such as no water-Acetic Acid, Ethyl Acetate,1,3-Botyl Glycol, Vinyl Acetate, Odors, Anylyn. This substance also uses as starter of synthesis of Phenol, some of polymers, dense Aldehyde products. Cu-Chromite is a high selective catalyzer for dehydrogenation of Iso- Propanol to Acetone [8].

$$Cu2Cr2O4$$

$$\text{Iso} - \text{propanol: } C3H7OH \rightarrow CH3COCH3 + H2$$

Acetone is a great solvent for several compounds such as: resins, waxes, oils and lots of Organic compounds. Using dehydrogenation for reaching Butyr Aldehyde from 1-Botanol is so interesting. Because of this reaction hasn't any adverse reactions and pure Hydrogen is just the byproduct of the reaction.

$$Cu2Cr2O4$$

$$C4H9OH \rightarrow C3H4CHO + H2$$

According to Rao's research, 90% of Cu, 8% of Cr and 2% of improved C in silica, is the best catalyzer for dehydrogenation of 1-Botanol with high efficiency and selectivity [9]. Cu-ZnO-Cr2O3/SiO2 catalyzer that produces with saturation have good selectivity and efficiency for dehydrogenation of 2-Botanol to 2-Botanon. Butyr Aldehyde uses in Organic synthesis, especially for resin and rubber industries also for food flavoring. Iso-Butyl-Aldehyde is an anti- Oxidant, uses in rubber industries, also uses for Amino acid and making perfumes, flavoring, and additives to gasoline.

1-8-Converting Glycerol to Propylene Glycol

Glycerol is a byproduct of bio-diesel industry. Glycerol produces from esterification process of vegetable oil too much. Produces 1kg raw Glycerol per 9kg of bio-diesel, so most of catalytic processes of converting Glycerol reported processes such as: oxidation, dehydrogenation, esterification [10]. Among this methods, hydrogenolysis of Propylene-Glycerol is a useful method for increasing the advantages of bio-diesel vegetable. Propylene Glycerol is an important substance for producing Poly-Ester (PS) resins, food industries, plastic industries and pharmaceutics industries, an Organic solvent for extraction, also as humidity absorber for tobacco. Cu-Chromite uses for converting Glycerol to Propylene-Glycerol with selectivity of 85% in200oc and 1.4MPa, also Cu-Chromite catalyzer has clear catalytic and selectivity for converting Glycerol with converting rate of 51% and selectivity of 96% to 1,2-Propanol in 4.1MPa of pressure of Hydrogen and 2100c.Cu-Chromite catalyzer shows high converting rate with low Cu to Cr ratio that is different with that explained for Cu-Chromite. Chiau and his colleagues reported dehydrogenation of Glycerol in presence of Cu-Chromite for producing Acetol [11]. Produced Acetol hydrogenizes easily for converting to Propyl-Glycerol. So for converting Glycerol to Propyl-Glycerol, Acetol is an intermediate compound. In this process, first Glycerol dehydrogenize to Acetol and then Acetol converts to Propylene-Glycerol. Kim and his colleagues produced Cu-Chromite catalyzer by method of saturating and coprecipitating and uses this catalyzer for valuating converting of Glycerol to Propylene-Glycerol [12]. The used catalyzer for valuating was consist of Cu-Oxide and Cr-Oxide. The catalyzer was produced from coprecipitating consist of just one phase (CuCr2O4).

1-9-Oxidation Reactions

Ethyl-Benzene oxidation can be done by Cu-Chromite catalyzer [13]. Ethyl-Benzene is useful in production of valuable products that produces from petrochemical industry of Xylene vapor. Ethyl-Benzene oxidation is important for producing Aromatic Ketones and Estophenon. This compound is one of perfume additives also uses as intermediate in pharmaceutics, resins, alcohols and Tear gas.Figure1 shows the Ethyl-Benzene oxidation.

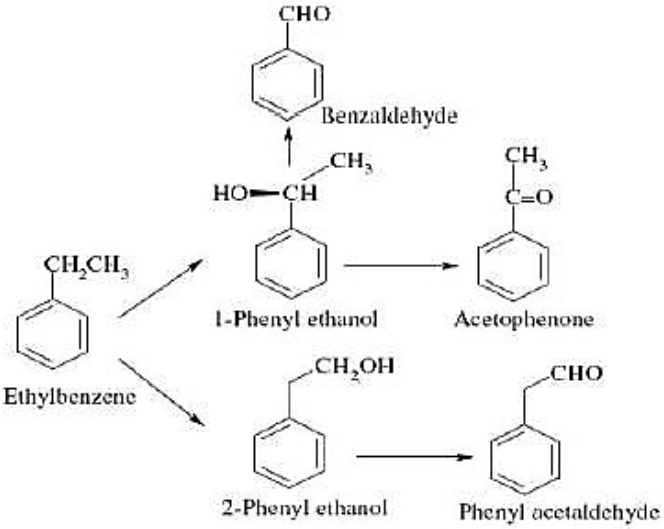


Fig 1: Etyl-Benzen oxidation

1-10-Alkylation

Alkylation is one of most important reactions in petroleum chemistry that Cu-Chromite catalyzer can able to participate [14].

$$CuCr2O4$$

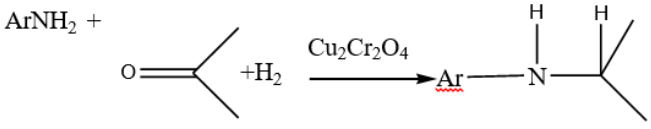
$$C6H6 + CH36COCCH3 + H2 \rightarrow C6H5CH\,(CH3)2 + H2O$$

1-11-N-Alkylation

N-Alkylation is one of reactions that acts with this catalyzer. According to production of derivations of Amines is noteworthy. Among one of reactions that acts this process, N-Alkylation and reduction reactions that done by this catalyzer simultaneous [15]. Among this reactions:

$$CU2Cr2O4$$

$$CH3CH2NH2 + 2CH3OH + H2 \rightarrow CH3CH2NH2 + 2CH3OH$$



1-12-Cycloaddition reactions

Heterocyclic compounds include of Hydrogen, is important for pharmaceutics. In last half century it has attended to synthesis of this compounds. Bai and his colleagues reported improved Cu-Chromite catalyst on Alumina for cycloadding intermolecular production of Pyrazin [17]. Also they used Cu-Chromite catalyzer for Amining of Ethanol-Amin to Ethylene-diamine and mixture of cyclic products such as Pyrazin. It's specified that increasing water cause, increasing selectivity of catalyst for production of loop products [18].

1-13-Hydrogen produce

Hydrogen uses much in petrochemical and chemical-materials industries. Synthesis of Ammoniac uses 40% of total of world production of hydrogen. Also Hydrogen uses for hydrogenation of oils and fats for producing butter from vegetable oils in food industries. So it uses for producing Methanol and Hydrochloric acid (HCL), it uses too as operation for reduction of metal in mine stones. Since Hydrogen is lightest gas, uses for fill up balloons that uses for research in earth atmosphere. Hydrogen has the highest combustion energy relation to its weight. This property introduced Hydrogen as a proper fuel for one-step or multi-step reactors. It says a lot about hydrogen is that too much of it due to pollution and lack of future fuel source. When Hydrogen burns, produces water and energy. Using Hydrogen as fuel cause reduction need of petroleum productions and increase natural fuel resources. Hydrogen is not found in the Free State, but it can also be used in combination with other materials such as oxygen in water or alcohol, hydrocarbons, etc. For producing Hydrogen should use energy so Hydrogen isn't a source of energy but energy needs for producing that [19].

1-13-1Producing Hydrogen from hydrolysis

Photo electrochemical processes was considered in semiconductors in last two decades. There are lots of research for new materials for photochemical processes in usage of Cu-Chromite for solar energy. Producing Hydrogen studied according to powder Cu-Chromite in water that includes reducing electrolyte (SO_2, S_2, S_2O_2). This reaction isn't sensitive in acidity and can absorb lot of solar energy [20]. figure 3 shows the schematic of Hydrogen photochemical production

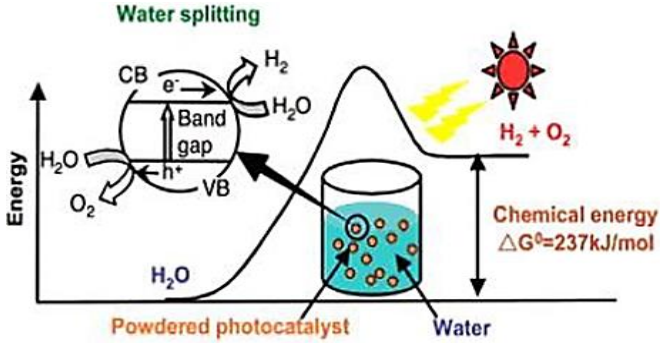


Fig 3: Schematic of Hydrogen photochemical production

1-14-Desulfuration of hot gases of coal

World energy demand is requisite of economical development. Using common energies, such as: coal and new sources, should improve performance of energy producing technologies. In Coal gasification process in about 95% of sulfur content coal to Hydrogen Sulfide, the reduced 5000ppm output gas in the process should reduce to 150ppm.The efficiency is related to removing Hydrogen-Sulfide without cooling coal gases. This process shows the importance of Desulfurizing in high temperature and can done by absorbents such as metal oxides that convert to stable Sulfurs. Cu-Cr-O oxides studied as Sulfur absorbent in gassing in high temperature. $CuO\text{-}Cr_2O_3$ absorbent can reduce Hydrogen-Sulfide lower than 5-10 ppm in 650-850 °C in gassing coal process [21].

Conclusion

Nowadays Nano technology brings new revolution in developed countries for us and this cause innovation for processes. Materials technology makes productions, cheaper, parts and systems, more intelligence, multi- compatible with environment, more persistent and costume products. Cu-Chromite catalyzer can solve lots of problems of today country industries according to its properties and applications. So it's proper to transform Nano technology aspect from theoretical to applicative.

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