The importance of catalyst preparation.

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Abstract

Catalyst preparation is the most important step in the manufacture of catalysts. This is because the catalyst preparation stage is almost complex and contains many details that must be known and clear to the catalyst manufacture. Due to the large number of details in the preparation stage, these details undoubtedly affect the final properties of the catalyst, especially the selectivity and catalytic efficiency of the as prepared catalyst. Although the exact details of the preparation process vary, there are many preparation methods that produce the same catalysts but with characteristic properties associated with a particular preparation process. In this research, we will discuss the most important components of the catalyst as well as the most important methods of preparation and the characteristics and problems of these methods.

Keywords: Catalyst preparation, Catalytic activity, Selectivity, Components of catalyst, Classifications of catalysts

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Introduction

Catalyst technologies are a complex system. The complexity of catalyst systems is not only limited to materials or compositions and structures, but also includes simultaneous occurrence of mass transfer, heat transfer, chemical reaction and so on. It is common practice in the world of catalysts that heterogeneous catalysts are the most widely used and influential in both industrial and environmental applications [1-3]. Easy separation of heterogonous catalysts, handling and recycling of the catalyst or the possibility of continuous operation of the reactor are attractive features for previous applications. For all this, it is important for scientists of catalysts to be interested in studying the components of the catalyst to reach the final product. A heterogeneous catalyst is composed of several constituents such as support, promoter and active catalytic ingredients of metal or metal oxide etc. [1,4-7]. The aim of this investigation is discuss of these components.

Components of heterogeneous catalysts

The active species

The active species have a catalytic activity towards one or more catalytic reactions. These species are constituted of one or more compounds which either contribute each one with its own different functional properties, or interact between themselves creating synergistic effects at their interfaces.

Promoter

Promoter is small amount of additional material which insert in the catalyst composition, to improve the physical and chemical properties of catalyst. These materials can be classified in physical and chemical promoters. Physical promoter, it is element or compounds resulted in enhancement in the thermal stability and mechanical resistance of catalyst depending upon high melting point such as Al_2O_3, SiO_2, TiO_2 and MgO. In addition, chemical promoter, it is element or compound brought about modifications in the activity, selectivity and lifetime of the catalyst such as Li and K oxides.

Support

Support is the substance that forms the largest amount of the catalytic component. The activity of the support varies according to the nature of the catalytic reaction in which the catalyst is present. Alumina, active carbon, magnesia, silica, titiania, zirconia and zeolites are the important industrial supports

Catalyst Classification

Classification of the industrial catalysts can be done using various criteria:

1) Number of components of the catalytically material [8]. There are single and multi-components catalysts.

2) Chemical nature of the catalytically material [9-13]. There are four types can be summarized as follows:

(i) Redox catalysts. They are used for oxidation, hydrogenation, dehydrogenation and halogenation.

(ii) Acid – base catalysts. They are used for alkylation, hydration, dehydration, oligomerization, hydrogen transfer, and carking and isomerization reactions.

(iii) Poly-functional catalysts. They are a mixture of redox and acid – base catalysts which used for reforming, aromatization of paraffin reaction.

(iv) CO- transformation catalysts. They are used for CO-transformation reaction such as synthesis of methanol from CO and H_2 using Cu-Zn/Al_2O_3 catalyst.

3) Preparation procedure [14]. There are bulk and supported catalysts.

Heterogeneous Catalyst Preparation

The general steps for manufacture of a heterogeneous catalyst are as follows:

(1) Selection of the required ingredients (support, precursors of the active components and promoters and water or solvent).

(2) Mixing of them (by coprecipitation, deposition or impregnation).

(3) Drying.

(4) Mixing with binder, lubricant, forming agent.

(5) Shape formation.

(6) Calcination.

(7) Activation or reduction to the desired oxidation state.

However, the most common (traditional) methods followed up for catalyst preparation [15] are ceramic, precipitation or co-precipitation, impregnation, sol-gel, ion exchange, adsorption, and deposition–precipitation methods. In addition, there are new methods used for preparation of catalyst preparation such as plasma method, micro-emulsion, combustion and electro -spinning methods. Indeed, before we choose the method of preparation or even the catalyst, we have to answer a question and I think that it is the key question of the industrial or environmental process, which is the catalytic process that we want to be dragged by the catalyst? But what is the goal that we hope the catalyst will accomplish? In other words, what point do we want to reach by the catalyst? Here it will only be through the highest value for both the selectivity and catalytic efficiency. There are many factors that will control the selectivity and activity of the catalyst. The most important of these factors is the method of preparation of the catalyst, which includes other parameters.

In fact, each method of catalyst preparation has advantages and disadvantages and of course you will prefer the method that has the greatest advantages. As a result of scientific progress, the preference in the catalyst preparation methods will be to prepare the nanometric catalysts.

Since we have agreed that some parameters will control in the method of catalyst preparation and therefore will control in all the characteristics of the catalyst, we will address, for example, those parameters that affect the process of catalyst preparation by precipitation or co-precipitation method.

Parameters affecting the main properties of precipitated catalysts

The process parameters influence the quality of the final precipitates, and fine tuning of the parameters is necessary in order to produce the required material, are listed in this Table 1 [16,17].

Parameters	The properties affected by such parameters
pH	Phase
Anion	Morphology, textural properties
Solution composition	Phase, purity, precipitate composition
Aging	Purity, crystallinity, textural properties
Additives	Textural properties
Precipitating agent	Phase, homogeneity
Super saturation	Particle size, rate of precipitation
Solvent	Crystallinity, textural properties
Mixing consequence	precipitate composition, homogeneity
Temperature	Phase, textural properties

Table 1. *Fine tuning of the parameter in order to produce the required material.*

Conclusion

The main purpose of the catalyst preparation process is to obtain a catalyst with specific specifications to achieve a certain catalytic reaction leading to higher industrial or environmental productivity via high selectivity and activity of catalyst. The process of catalyst preparation is an important and dangerous factor in the classification of catalysts. The catalyst preparation process also contains very important parameters that essentially control in the various properties of catalyst such as precursors, composition, mixing consequence and so on. Therefore, these parameters have a great economic impact on the economic value of catalysts, which also affect industrial and environmental applications.

Of course, there are many ways to prepare the catalysts, preferably the inexpensive method, which gives a final product that has excellent specifications and desirable in the least time and with the least effort. The most important of these methods is the combustion method [18,19].

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