The purpose of the present invention is to provide a liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution.

The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution of the present invention includes: circulating a portion of liquid material, which has passed through a stripping tower for hydrogen mixing, and mixing it with a fresh feedstock oil into a liquid-phase material, which is introduced into a heating furnace to be heated; dividing hydrogen gas into n routes and then introducing into the heating furnace to be heated, or heating hydrogen gas in the heating furnace and then dividing it into n routes, where n is the number of catalyst beds in a reactor or the number of multi-stage reactors; mixing one route of hydrogen gas with the liquid-phase material in a mixer for a first stage hydrogen dissolution, and introducing the remaining (n-1) routes of hydrogen gas into a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing inside said component ~~in the reactor~~ via an inlet between beds in the reactor to be mixed with a mixture from a reaction in the preceding bed for a second stage hydrogen dissolution, while stripping the reaction byproduct, hydrogen sulfide and ammonia, wherein one stage hydrogen dissolution is added by provision of every one bed or one reactor, a reaction pressure control system is arranged on the top of the reactor, an exhaust system is arranged at each section of the reactor, and the liquid level at each section of the reactor is accomplished by controlling the discharge of gas to be generated in the next stage and the redundant hydrogen gas; introducing the reaction product into the stripping tower provided with a hydrogen-oil mixer, to strip the byproduct, hydrogen sulfide and ammonia from the product, while increasing the hydrogen dissolution capability; introducing a portion of oil product from the stripping tower into a product tank, and recirculating another portion.

In the method of the present invention, the number of catalyst beds in the reactor or the number of multi-stage reactors, n, is 3 to 5.

In the method of the present invention, the liquid-phase material flow after hydrogen dissolution is introduced into the reactor from the top of the liquid-phase circulation hydrogenation reactor, and discharged from the bottom of the reactora liquid-phase; or the liquid-phase material flow is introduced into the reactor from the

bottom of the liquid-phase circulation hydrogenation reactor, and discharged from the top of the reactor.

In the method of the present invention, a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing is arranged in the reactor.

In the method of the present invention, a hydrogen-oil mixer or a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing is arranged in the stripping tower.

In the method of the present invention, the volume ratio of hydrogen to oil on the catalyst bed is from 2:1 to 10:1.

In the method of the present invention, the mixing ratio of the circulating oil to the raw materials is determined according to the volume of hydrogen required in the reaction and the stability of the catalyst beds, so as to ensure the volume of hydrogen dissolved in the mixed material. The temperature of the material entering the reactor is controlled by using the ratio of the feedstock oil to the circulating oil. When the chemical hydrogen consumption is high and the reaction heat is high, the amount of circulating oil is increased appropriately; on the contrary, the amount of circulating oil is decreased. The volume ratio of the circulating oil to the feedstock is from 0.1:1 to 5:1, and the volume ratio of hydrogen to oil on the catalyst bed is from 2:1 to10:1.

The liquid-phase hydrogenation reaction method and reaction system with multi-stage hydrogen dissolution system according to the present invention is to carry out a two-phase hydrogenation reaction in an immobilized bed reactor, and the hydrogen required by the reaction is provided by the excessive hydrogen gas dissolved in the feedstock oil. The hydrogenation process condition is determined according to the nature of the raw materials, and the quality requirements of final product. In general, the reaction temperature is at 220 to 420°C, the hydrogen partial pressure in the reaction is from 0.5 to 15 MPa, and the volumetric space velocity is 0.8 to 15 h^{-1}.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow chart of the liquid-phase hydrogenation method and reaction system with multi-stage hydrogen dissolution system according to the present

What is claimed is:

1. A liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution, characterized in that the method comprises: circulating a portion of liquid material, which has passed through a stripping tower for hydrogen mixing, and mixing it with a fresh feedstock oil into a liquid-phase material, which is introduced into a heating furnace to be heated; dividing hydrogen gas into n routes and then introducing into the heating furnace to be heated, or heating hydrogen gas in the heating furnace and then dividing it into n routes, where n is the number of catalyst beds in a reactor or the number of multi-stage reactors; mixing one route of hydrogen gas with the liquid-phase material in a mixer for a first stage hydrogen dissolution, and introducing the remaining (n-1) routes of hydrogen gas into a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing inside said component~~in the reactor~~ via an inlet between beds in the reactor to be mixed with a mixture from a reaction in the preceding bed for a second stage hydrogen dissolution, while stripping the reaction byproduct, hydrogen sulfide and ammonia, wherein one stage hydrogen dissolution is added by provision of every one bed or one reactor, a reaction pressure control system is arranged on the top of the reactor, an exhaust system is arranged at each section of the reactor, and the liquid level at each section of the reactor is accomplished by controlling the discharge of gas to be generated in the next stage and the redundant hydrogen gas; introducing the reaction product into the stripping tower provided with a hydrogen-oil mixer, to strip the byproduct, hydrogen sulfide and ammonia, while increasing the hydrogen dissolution capability; introducing a portion of oil product from the stripping tower into a product tank, and recirculating another portion.

2. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, n is 3 to 5 stages.

3. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the liquid-phase material flow after hydrogen dissolution is introduced into the reactor from the top of the liquid-phase circulation hydrogenation reactor, and discharged from the bottom of the

reactor.

4. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the liquid-phase material flow is introduced into the reactor from the bottom of the liquid-phase circulation hydrogenation reactor, and discharged from the top of the reactor.

5. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing is arranged in the reactor.

6. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, a hydrogen-oil mixer is arranged in the stripping tower.

7. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing is arranged in the stripping tower.

8. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the volume ratio of hydrogen to oil on the catalyst bed is from 2:1 to 10:1.

9. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the volume ratio of the circulated oil to the fresh feedstock oil ~~raw material~~ is from 0.1:1 to 5:1.

10. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the reaction temperature is at 220 to 420°C.

11. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the hydrogen partial pressure in the reaction is from 0.5 to 15 MPa.

12. The liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution according to claim 1, characterized in that, the volumetric space velocity is from 0.8 to 15 h^{-1}.

Abstract

The present invention relates to a liquid-phase hydrogenation reaction method with multi-stage hydrogen dissolution. A liquid material is circulated and mixed with a feedstock oil, and introduced into a heating furnace to be heated. Hydrogen gas is divided into n routes and introduced into the heating furnace to be heated. One route of hydrogen gas is mixed with a liquid-phase material in a mixer for a first stage hydrogen dissolution. The remaining (n-1) routes of hydrogen gas are introduced into a ~~hydrogen-oil mixing~~ component for hydrogen-oil mixing in the reactor via an inlet of beds in the reactor to be mixed with a mixture from a reaction in a preceding bed for a second stage hydrogen dissolution. Reaction byproducts, namely hydrogen sulfide and ammonia, are stripped. A reaction pressure control system is arranged on the top of the reactor. An exhaust system is arranged at each section of the reactor. Reaction products are introduced into a stripping tower. The hydrogen-oil mixer is arranged in the stripping tower. The byproducts, namely hydrogen sulfide and ammonia, are stripped. Capacity for hydrogen dissolution is increased. A portion of an oil product that comes out from the stripping tower is introduced into a product tank, while another portion is recirculated. The present method has hydrogen sulfide and ammonia discharged from a reaction system while a hydrogenation reaction is catalyzed, and a solid-phase catalyst comes in contact with a liquid-phase reactant, thus increasing reaction efficiency.