Clean Method for Recovering Metals from Spent Catalysts

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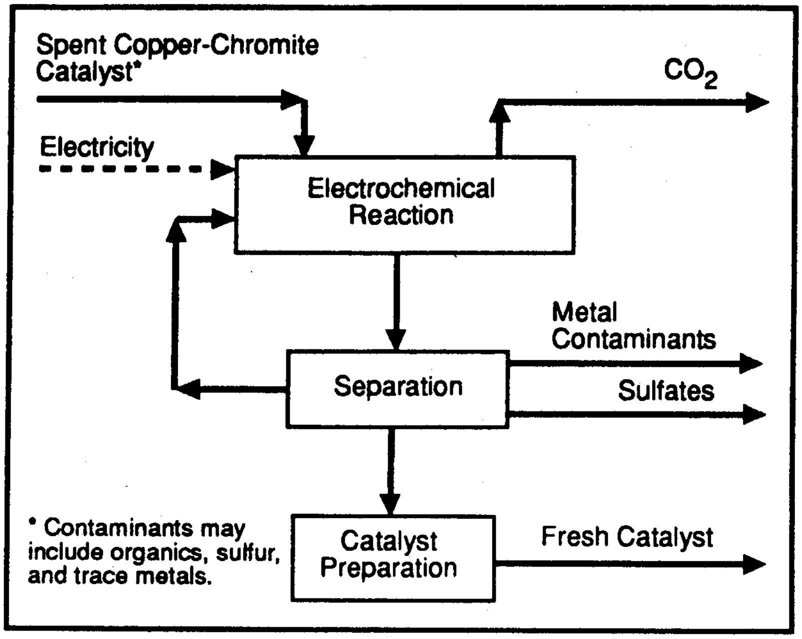
A new process is being developed using electrochemistry to destroy hydrocarbons and coke adhered to spent catalyst. The catalyst metals are then dissolved in an aqueous solution to further recover raw materials.



Spent Catalyst Recovery for Copper-Chromite Catalyst

Introduction

Catalysts are increasingly being used to produce fuels and chemical feedstocks. This use is the result of economic pressures to upgrade heavier crudes and other feeds having high levels of impurities, competition to achieve higher conversions while using less energy, and environmental pressures to increase reaction selectivities to minimize waste.

All catalysts gradually lose activity because of coking; poisoning by metals, sulfur, or halides; or loss of surface area because of sintering at high process temperatures. If the catalyst deactivation can easily be reversed, regeneration is possible, although a catalyst's economic life is ultimately limited by regeneration costs and the extent of irreversible deactivation.

Increasing concern over pollution and disposing of waste creates a need for clean alternatives for recovering or disposing of spent catalysts. More than 50 million pounds of spent hydrocracking, hydrotreating, and naphtha-reforming catalysts are consumed every year by the U.S. petroleum refining industry alone.

Spent catalysts are typically disposed of in landfills or, if the metal value is high enough, sold to a metals reclaimer. Reclaiming spent catalyst materials typically involves using conventional metallurgical processes such as roasting, acid leaching, caustic dissolution, reactions with H_2S or Cl_2, and calcination. All these materials use toxic, regulated materials, and can produce yet more waste.

Concept Description

A new process is being developed to further recover the raw materials in spent catalytic solution. The process uses electrochemistry to destroy hydrocarbons and coke adhered to spent catalyst and to dissolve catalyst metals in an aqueous solution. Hydrocarbons and carbonaceous materials adhered to the catalyst surface are oxidized to carbon dioxide and water. Sulfides are converted to aqueous sulfur species. Once dissolved, catalyst components and contaminants can be separated by further processing, which would depend on the chemistry of the system and would be tailored to specific cases.

The complexity of the catalyst chemistry will ultimately determine whether remanufacturing the catalyst onsite or processing the spent catalyst offsite is more practical. Any unrecovered constituents can be recovered or disposed of by conventional hydrometallurgical processes.

Economics and Market Potential

The catalyzed electrochemical dissolution process to recover spent catalyst promises several advantages over conventional approaches. First, the adhered carbonaceous material would be completely oxidized to carbon dioxide electrochemically at low temperatures rather than through a roasting step at higher temperatures. Producing undesirable by-products (i.e., hydrocarbons, SO_x, NO_x) during roasting is avoided. Metal sulfides present in the spent catalyst are oxidized to soluble metal cations and aqueous sulfur species rather than converted to metal oxides and SO_x. The kinetics are faster than conventional dissolution, and this process is effective at moderate temperatures and ambient pressure.

Potential applications for this technology include recycling spent catalyst materials from petroleum refining, bulk and specialty chemical production, and oils and fats production as well as coal liquefaction.

Key Experimental Results

Initial demonstration experiments have been conducted on spent catalysts for petroleum hydrotreating and copper-chromite catalyst. The kinetics are rapid at atmospheric pressure and moderate temperatures (<100°C). Selective recovery of catalyst materials has been demonstrated for the copper-chromite catalyst and a transition metal catalyst.

Future Development Needs

Efforts continue for developing generalized methods for selective separation of catalyst materials using environmentally sound technology. Partners are being sought to jointly develop this technology for specific catalyst systems.

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