

## **The Fifth Green and Sustainable Chemistry Award**

Awarded by the Minister of Environment

Cosmo Oil Co., Ltd.

Nippon Oil Corporation

(Order of co winners: alphabetical arrangement)

### *Development of Environmentally-Friendly Low-Sulfur Fuel Production Technologies*

This achievement is related to ultra-low desulfurization technologies that can reduce sulfur contents in fuel oils less than 10ppm. Ultra-low desulfurization of fuel oils is an urgent and crucial issue, because sulfur in them has both adverse effects on the environment by sulfur itself and carbon emission effects by performance decrement in exhaust gas treatment.

In 1999, Cosmo Oil Co., Ltd. took part in the national research project, the “Research and Development of Petroleum Refining Pollution Reduction”, organized by the New Energy and Industrial Technology Development Organization (NEDO) and the Japan Petroleum Energy Center (JPEC), and challenged to develop a highly active hydrodesulfurization (HDS) catalyst. All over the project period, Cosmo Oil Co., Ltd. had successfully developed a new CoMo HDS catalyst, C-606A, for the production of ULSD fuels. C-606A has a three times higher HDS activity compared with the conventional CoMoP/Al<sub>2</sub>O<sub>3</sub> catalyst. This catalyst has superior activity, which enables <10-ppm sulfur content in products using a commercial diesel hydrotreater designed to produce 500-ppm sulfur diesel fuels. The catalyst was prepared by coimpregnation using an aqueous solution containing Co, Mo, orthophosphoric acid and organic acid on a HY-Al<sub>2</sub>O<sub>3</sub> support. After impregnation, this catalyst was air-dried only without calcination. Our new catalyst preparation method can increase the formation of the active phase, i.e. CoMoS phase, and provide more highly active CoMoS Type II, which is located at the edges of the MoS<sub>2</sub> multi-layers.

Based on the environmental and economical advantages, Cosmo Oil Co., Ltd. has utilized C-606A in all diesel hydrotreaters at the Cosmo Oil refineries. High catalyst performance has been demonstrated for each application.

From the viewpoint of energy conservation, the minimum of capital investment, and the reduction of CO<sub>2</sub> emissions and industrial waste, it is greatly expected that this HDS catalyst technology get a wider distribution.

Nippon Oil Corporation established the package of the technology for sulfur free fuel production.

Nippon Oil developed the ROK-Finer Process for gasoline HDS. The process is the only domestic technology for selective HDS of catalytic cracked gasoline. The special catalyst

and process enable us to avoid olefin hydrogenation, in other words, to avoid the reduction of octane number, in HDS reaction. A demonstration plant as a research project of Petroleum Energy Center with the subsidy of METI has a capacity of 20,000BD. This plant has been producing sulfur free gasoline since 2004.

Nippon Oil also developed highly active catalysts for HDS of gas oil fraction. The catalysts have wide surface area of the support and highly dispersed active metals. More than 2000m<sup>3</sup> of the catalysts are being used for sulfur free fuel production.

A traditional hydrocracking (HDC) catalyst containing zeolite shows high HDC activity and low middle distillates selectivity. Nippon Oil adopted specially modified zeolite and achieved higher HDC activity and higher selectivity of middle distillates production than those of a traditional catalyst.