Physico-Chemical nanomaterials

The effect of nanosized platinum metal on the activity in the methane oxidation

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In this work, the composite platinum nanosized metal – vanadium oxide catalysts were prepared by adsorption of platinum metals ions on V_2O_5. The oxide with adsorbed Pt(Pd) ions was subjected to reduction in H_2/Ar stream for 1–5 h. The temperature of reduction was stated a constant value in the range of 50–550 °C. The catalysts prepared contain from 0.1 mass% up to 1 mass% of Pt or Pd. The activity of the catalysts obtained was compared with commercial BASF and KH catalysts. The lean methane-air mixture was imitated by gas mixtures with excess of oxygen, $CH_4 : O_2 = 1–5 : 20$. The catalytic test is conducted in a flow reactor at atmospheric pressure. GC analysis shows that the catalytic activity of reduced $Pt(Pd)/V_2O_5$ composites at the oxidation of the lean CH_4-air mixture are characterized by high efficiency. The catalysts formed by reduction with hydrogen at the temperature range of 400–450 °C show highest activity, as compared with that for the catalysts prepared at the lower and at the higher reduction temperatures. To obtain high-active nanocatalysts, the reduction time should be not higher than 3 h, while the reduction time of 1 h is found to be optimal in the most cases. The methane conversion temperature over $Pt(Pd)/V_2O_5$ nanocomposites is on 80–100 °C below that found for the commercial catalysts. The composites convert CH_4 at the temperature range, where the commercial catalysts show no prominent activity. The high active state of the reduced $Pt(Pd)/V_2O_5$ nanocomposites conserves for at the least 10 cycles of heating-cooling. The degree of methane conversion ($X(CH_4)$) depends on the temperature non-monotonously and the conversion-temperature curve shows certain maxima and minimums. This curve behaviour corresponds to the surface rearrangements, which are taken place at the interface between platinum metal nano-particles and reduced oxide surface at high temperature regime of the catalysts operation. It was found that the $Pt(Pd)/V_2O_5$ nanocomposites are characterized by acceptable resistance to overheating. Among the catalysts studied, the Pd/V_2O_5 nanocomposite with 0.25 mass% Pd, which is formed by the reduction with hydrogen at 425 °C, can be considered as an alternative to the commercial products.