Catalysts for the oxidation of tritiated hydrogen

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Experimental results of catalytic activity investigation of hydrophobic catalyst RCTU-3SM (platinum coated on copolymer of styrene and divinylbenzene) and hydrophilic catalyst Johnson Matthey of type 73 (platinum coated on 3mm alumina pellets) in the reaction of oxidation of hydrogen by oxygen of air has been report. This reaction is the important part of tritium confinement systems at atmosphere Detritiation System at nuclear buildings of ITER.

The RCTU-3SM catalyst activity was measured in the temperature range 293-325K at air flow rates between 0.5 and 16 Nm^3/h and with the initial concentrations of hydrogen in the air ranging from 40 to 400ppm. Rate constant of hydrogen oxidation reaction can be evaluated as $3.7\pm0.4s^{-1}$ at 298K and the reaction's apparent activation energy is $E_{app} = 12 \pm 2$kJ/mol.

Activity of the hydrophilic catalyst in hydrogen oxidation reaction at temperatures close to room temperature is so small, that it can hardly be measured even at maximum contact time of the reaction mixture with catalyst. With temperatures rise above 360K, this catalyst begins to show a noticeable catalytic activity in the hydrogen oxidation reaction. Rate constant was measured in the temperature range 366-513K and with the initial concentrations of hydrogen in the air ranging from 50 to 5000ppm. Rate constant of hydrogen oxidation reaction can be evaluated as $1.6\pm0.2s^{-1}$ at 366K and the reaction's apparent activation energy is $E_{app} = 35 \pm 5$kJ/mol. Attempt was made to activate the JM catalyst by its heating in a stream of air. Heating to a temperature of 670-680K for 1.5h leads to decrease the activity of the catalyst. However, heating the catalyst to a temperature of 920-930K for the same period of time entails about a 4-5-fold increase in its activity.

Finally the possible technological schemes for catalytic oxidation of hydrogen allowing reduction of tritium concentration by 1000 times have been analyzed.