289r Waste Incineration in Fluidized Bed: Testing Total Oxidation Catalysts at Pilot Scale for Gas Clean up

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Seven different total oxidation catalysts (PRO*CLEAN*500, EF 258 H/D, SIEMENS A, ZERONOX and Ru, Pd and V_2O_5 on a TiO_2 support) have been tested for abatement of principal organic hazardous compounds (POHCs) in the flue gas from a waste incinerator, fluidized bed type. These catalysts were placed in a slip flow downstream from the waste incinerator. Catalytic reactors used were both metallic and glass made, for monoliths and for particulates. Temperatures used in the catalytic reactors ranged from 240 till 510º C and volumetric gas hourly space velocities (GHSV) from 1,200 till 5,700 [($m^3_{gas,n.c.}$/h)/$m^3_{catalyst}$]. The catalysts operated under a 100 % realistic flue gas which was sampled before and after the catalytic reactor at different times on stream. Condensates after the catalytic reactor were also analyzed for organics and for compounds lost sometimes from the catalyst. Gas sampling and analysis were carried out under standarized methods. Conversions (destructions) of most of the POHCs were 99.99 % but small GHSV values (high residence times for the gas) were required, indicating low reacting rates.

Waste incineration is hindered by the formation and emissions of products of incomplete combustion (PICs) or principal organic hazardous compounds (POHCs) which include the famous polychlorinated dibenzo dioxins and furans (PCDD/Fs) and polycyclic aromatic hydrocarbons (PAHs). Much is known nowadays about the influence of operation variables on emissions from incinerators.

When there is some chlorine in the feedstock to be incinerated, PCDD/Fs can be present in the exit or stack gas. Several methods for their elimination have been developed of which the most widely used are absorption with some liquids or slurries and adsorption by activated cokes. Nevertheless, these methods do not destroy the PCDD/Fs but simply transfer them from the flue gas to another phase or flow, not solving well enough the problem of the disposal or destruction of the formed PCDD/Fs (1, 2). For this reason, some people, including these authors, thought that the best method for the PCDD/Fs elimination, in an incineration flue or stack gas, would be their catalytic destruction by total oxidation. This idea is again well known and it is applied in some countries in which the MSW incineration plants have a DeNOx unit with one layer, or even another unit, of catalyst for the so-called DeDioxins. These DeNOx/DeDioxins units operate nowadays in MSW combustion plants at around 250 ºC (3) when the flue gas is re-heated after the filter or the absorption unit, and in coal power plants between 320 and 400º C (normally 340º C). Since the flue gas has particulates in suspension, these catalysts are usually monoliths with typical values of 64 cells/$inch^2$.

Catalysts for DeDioxins are similar, if not the same, that those used for DeNOx whose typical formula is V_2O_5-WO_3/ TiO_2 (also called TiO_2-based V_2O_5(/WO_3) or simply V-W-Ti catalysts). Nevertheless, V_2O_5-TiO_2 monoliths are not very much used for dioxins abatement alone (in MSW incineration plants) because they would require a big unit (which implies an high cost and an important surface in the whole plant) due to the high residence time required for the gas. Since both temperature and POHCs concentration are relatively low, the reaction rate of POHCs total oxidation is quite low, even with a good catalyst. It implies high residence times for the gas or low volumetric gas hourly space velocities (GHSV), which, in turn, implies a relatively high volume for the DeDioxins catalytic reactor. To avoid such space for the DeDioxins catalyst, it is usually located as an additional layer in the DeNOx unit. DeNOx and DeDioxins are usually found together then and such technology may be competitive with adsorption technologies.

In the market there are also a lot of other types of catalysts, such as those based on noble metals (Pt, Pd, ...) or on chromia, which can be manufactured as monoliths too, but excepting in Korea (ref. 4), they are not used till date for the DeDioxins application.

A good (which includes cheap too) catalyst for DeDioxins, would eliminate one of the main problems or constrains in the use and installation of new waste incineration plants.

Although the high social and economical impact of the research on the catalytic abatement of dioxins, there are only a few institutions worldwide carrying out some research (or, at least, publishing it) on this field. At University Complutense of Madrid (UCM) research on catalytic abatement of dioxins started ten years ago (2, 5, 6) working initially with some targeted chlorinated VOCs (Cl-VOCs), using thus a synthetic flue gas. Such catalysts screening tests were made with chromia-based (7), noble metal (Pt, Pd, Ru)-based (8, 9) and V_2O_5-based (10) catalysts. A lot of useful information concerning their activity, selectivity and life for Cl-VOCs abatement was then obtained the best catalysts were selected from those lab tests. The last step in such research has been testing of such selected catalysts at pilot scale under a realistic flue gas composition. The intention has been to get data under 100 % realistic conditions about their respective usefulness and temperatures and GHSV values which should be used with these catalysts. A “good” catalyst should work at high GHSV values and low temperatures to avoid flue gas reheating.

Catalysts testing and comparison has been carried out with full size, not grounded. It is not a comparison of their intrinsic chemical activity thus because some internal diffusion control might exist. Catalysts will be compared using the temperature and the GHSV values [$(m^3_{\text{gas, normal conditions}}/h)/m^3$ of catalyst, independently the catalyst be spheres or monolith] at which more than 99 % conversion (destruction) of POHCs is obtained.

Several tests of this type had been made previously (6, 10). From such previous experience, it was known how the key factor for the accuracy in this research was a correct or good sampling and analysis of the POHCs from the flue gas. If the upstream incinerator has a good design and is well operated, as it was intended, the POHCs concentrations in the flue gas are very very low and their sampling and characterization is not easy. Much care concerning this point has been taken in this work, thus.