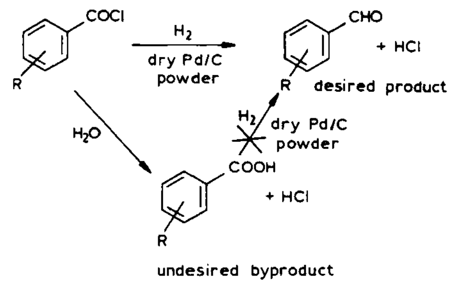
Paste or Powder?

Platinum group metals (pgms) when used as catalysts in liquid-phase batch reactions are frequently dispersed on a powdered support material. The main function of the support is to increase the surface area (and hence increase the activity) of the pgm. The highest pgm dispersions are found on supports with the highest surface areas. Activated carbons have surface areas in the range 500–1500 $m^2 g^{-1}$ (1000 $m^2 g^{-1}$ being a typical value). This is much higher than those of other common support materials, such as silica or γ-alumina. Additionally they are readily available and relatively cheap.

While surface area is important it is not the only parameter which determines whether a particular catalyst support will be utilised or not. Other critical properties include pore volume, pore shape, pore size distribution, particle size, attrition resistance, pH, impurities (to act as catalyst modifiers), and chemical stability with respect to reactants, products and (when utilised) the solvents. All these parameters will dictate which particular activated carbon is chosen, or whether an alternative support would be more effective for a given reaction.

Activated carbon-supported pgm catalysts are supplied in two forms: 'dry powder' containing ≤ 2% water and 'wet powder' containing 50–60% water. In order to distinguish clearly between the two, the 'wet powder' version is referred to as a 'paste'. However, it is important to realise that the water is held completely within the pores of the activated carbon and that no supernatant liquid is present. Therefore the so-called paste catalysts have the physical characteristics of a freely flowing powder. So why are there two forms of pgm/activated carbon catalyst?

In practice, paste catalysts are safer (to reduce fire hazards and dust explosions), easier to handle (reduced dust, and hence pgm, losses) and usually more active than their dry powder analogues. Thus, the use of paste catalysts is preferred unless the reaction being catalysed is in any way adversely affected by the presence of water. One such



reaction is the Rosenmund reduction, see the Figure. Pd/activated carbon paste catalysts should not be used in this application. Nevertheless, in the great majority of hydrogenations (over 95% of all liquid-phase batch chemical reactions which use a pgm/activated carbon catalyst) the small amount of water contained in the paste catalyst does not adversely affect the reaction. Indeed, in many hydrogenations water is an inevitable product of the reaction.

Every commercial pgm catalyst is sold on its pgm content. All chemical analyses to determine the pgm content are performed on dry samples. The term 'dry weight as paste' or 'd.w.a.p.' is used to describe the pgm content of a paste catalyst. Suppose a paste catalyst contains 55.0% water and that when dried, the pgm content is 4.95%. Such a catalyst would be described as having a pgm content of 4.95% d.w.a.p. (The actual pgm content of the paste catalyst, as received, would, of course, be 2.23%.)

Thus, when comparing catalytic data it is important to ensure that all the reported catalyst weights refer to paste weights, or all to (dry) powder weights. The 'paste' versus 'dry powder' issue is a result of the unique ability of activated carbon to take up large amounts of water. For all other catalyst supports, a powder is always a powder and never a paste.

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