Gasification processes

In the practical realization of gasification processes a broad range of reactor types has been and continues to be used. For most purposes, these reactor types can be grouped into one of three categories: *moving-bed gasifiers*, *fluid-bed gasifiers*, and *entrained-flow gasifiers*. The gasifiers in each of these three categories share certain characteristics that differentiate them from gasifiers in other categories.

Moving-bed gasifiers (sometimes called fixed-bed gasifiers) are characterized by a bed in which the coal moves slowly downward under gravity as it is gasified by a blast that is generally, but not always, in a counter-current blast to the coal. In such a counter-current arrangement, the hot synthesis gas from the gasification zone is used to preheat and pyrolyse the downward flowing coal. With this process the oxygen consumption is very low, but pyrolysis products are present in the product synthesis gas. The outlet temperature of the synthesis gas is generally low, even if high, slagging temperatures are reached in the heart of the bed. Moving-bed processes operate on lump coal. An excessive amount of fines, particularly if the coal has strong caking properties, can block the passage of the up-flowing syngas.

Fluid-bed gasifiers offer extremely good mixing between feed and oxidant, which promotes both heat and mass transfer. This ensures an even distribution of material in the bed, and hence a certain amount of only partially reacted fuel is inevitably removed with the ash. This places a limitation on the carbon conversion of fluid-bed processes. The operation of fluid-bed gasifiers is generally restricted to temperatures below the softening point of the ash since ash slagging will disturb the fluidization of the bed. Some attempts have been made to operate into the ash-softening zone to promote a limited and controlled agglomeration of ash with the aim of increasing carbon conversion. Sizing of the particles in the feed is critical; Material that is too fine will tend to become entrained in the syngas and leave the bed overhead. This is usually partially captured in a cyclone and returned to the bed. The lower temperature operation of fluid-bed processes means that they are more suited for gasifying reactive feedstocks, such as low-rank coals and biomass.

Entrained-flow gasifiers operate with feed and blast in co-current flow. The residence time in these processes is short (a few seconds). The feed is ground to a size of 100 μm or less to promote mass transfer and allow transport in the gas. Given the short residence time, high temperatures are required to ensure a good conversion, and therefore all entrained-flow gasifiers operate in the slagging range. The high-temperature operation creates a high oxygen demand for this type of process. Entrained-flow gasifiers do not have any specific technical limitations on the type of coal used, although coals with a high moisture or ash content will drive the oxygen consumption to levels where alternative processes may have an economic advantage. There are one or two processes that do not fit into any of these three main categories. These include *in situ* gasification of coal in the underground seam, as well as molten bath processes. One important point to note throughout all the above is the significance of the slagging behavior of the ash. At temperatures above the ash-softening point, the ash becomes sticky and will agglomerate, causing blockage of beds or fouling of heat exchange equipment. Once above the slagging temperature, at which point the ash has a fully liquid behavior with a low viscosity, it is possible again to remove it from the system reliably. Thus, for all processes there is a

feedstock-specific "*nogo*" temperature range between the softening and slagging temperatures of the ash.

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