The Development of Commercial Fischer-Tropsch Reactors

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The Fischer-Tropsch process to convert synthesis gas to liquid transport fuels and chemicals was originally developed in Germany. Initially the reaction was performed in trickle bed reactors using cobalt catalyst. The process was used commercially during the second world to produce liquid transport fuels. After the war the plants were disassembled and taken to Russia where they formed the basis of industrial operations which produced waxes and chemicals.

The German commercial process used fixed bed reactors which were operated to produce products mainly liquid at the prevailing operating conditions. After the war considerable work was done in the USA to develop higher temperature two phase processes where the products are all in the vapour phase. Two types of reactors were investigated: conventional fluidised bed and circulating fluidised bed reactors. Both used reduced and promoted fused iron oxide catalyst. The circulating fluidised bed reactor concept was eventually scaled up and in 1953 put into commercial practice in South Africa. At the same time the lower temperature German version was also put into commercial operation in South Africa using tubular fixed bed reactors with reduced promoted precipitated iron oxide catalyst.

In the 1970's in South Africa the conventional fluidised bed concept was looked at again for the high temperature process and developed further. The concept proved to be more amenable to scale-up, to need much lower capital expenditure and have considerable lower operating costs and conventional fluidised reactors eventually replaced all the existing circulating fluidised bed reactors.

During the 1980's the lower temperature Fischer-Tropsch process using tubular fixed bed reactors was used in South Africa, Russia and in Malaysia with either iron or cobalt based catalyst. The inherent limitations of tubular reactors with respect to productivity and scale up became apparent when there developed a need for cheaper, more productive reactors making better use of more active catalysts. This led to the development of slurry phase bubble column reactors which were put into commercial operation in South Africa. These reactors remove heat by generating steam in cooling coils rather than on the shell side as in the tubular fixed bed reactors. These reactors allow considerable scale up, lower capital costs and better use of the more active catalyst. Different from the tubular fixed bed reactors, their design is still early on the learning curve and considerable improvements can still be expected in productivity, control and reduction of capital costs.

This paper gives an overview of the technical considerations relevant and used in the development, application and replacement of the different types of reactors mentioned.