Methanol from Coal Gasification Co-production In IGCC Power Plants

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Introduction

The global production of methanol is about 40 million ton per year, most of which is produced from natural gas. Today, the high price of oil and natural gas has spurred new interest in alternative feedstocks for the production of methanol. Various types of biomass have been considered, but on the shorter term coal appears to be the only viable alternative raw material for large scale methanol production. In fact, methanol has been produced from coal for many years in specific geographical areas, notably in China. The technology for making methanol from coal is thus well proven. Basically coal is reacted with oxygen and steam in a gasification reactor thereby generating a synthesis gas containing H_2, CO and CO_2 and minor amounts of inert gases such as nitrogen, argon and methane. A typical composition would be H_2 67%, CO 29%, CO_2 3% and inerts 1%.

Topsøe Methanol Process

Based on the unique methanol catalyst, MK-121, Haldor Topsøe has developed a methanol synthesis process that is particularly well suited for coal based plants. The heart of the synthesis unit is the methanol reactor, a tubular reactor with catalyst loaded into several tubes surrounded by a bath of boiling water. The boiling water efficiently cools the process while at the same time steam is produced that can be used outside the methanol synthesis unit. The design of the reactor ensures that the methanol synthesis is carried out at an almost isothermal reaction path at conditions close to the maximum rate of reaction. This ensures a high conversion per pass and a low formation of by-products.

Haldor Topsøe's experience with coal based methanol include the following references in P. R. China:

- Xianyang 2000 MTPD
- Zhongyuan Dahua 1500 MTPD
- Tianjin Soda 1500 MTPD
- Guizhou Jinchi 1000 MTPD
- Guizhou Tianfu 750 MTPD (+ 600 MTPD DME)

Co-production of Methanol in IGCC Power Plants

Due to the global warming associated with the emission of CO_2 there is an increased interest in building IGCC Power Plants, because the waste CO_2 from the IGCC utility is much easier (and less costly) to separate and sequestrate than CO_2 emitted by a conventional coal fired power plant.

The investment cost per kWh capacity is considerably higher for an IGCC power plant than for a conventional coal fired utility. Therefore it is important to utilize the investment as efficiently as possible. At times of reduced power demand, co-production of methanol (or other chemicals) may be considered as one way of exploiting the surplus capacity. Since only a part conversion to methanol is desired, a once-through operation, i.e. no recycle of gas to the methanol reactor, is probably the most economical process scheme. A “coal synthesis gas” as described above could yield a methanol concentration at outlet of the reactor of close to 20 vol%. In other words the heat value of the feed gas would be reduced by about 45% by removing the methanol, and the power output from the gas turbine would be reduced accordingly. Naturally, a bypass across the methanol synthesis unit can be adjusted to achieve a smaller reduction of power output as desired.

The same principles apply for co-production of dimethylether (DME), synthetic gasoline, and co-production of substitute natural gas (SNG), which has an easy outlet to the gas grid.

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