THE STEAM REFORMER IS THE MAJOR PIECE OF EQUIPMENT IN THE METHANOL PLANT

The steam reformer is the most important and expensive single item of equipment in the methanol plant. It is therefore important to optimize the size and number of steam reformers required to produce methanol within technical limitations. A most recent plant using the ICI Low Pressure Methanol Synthesis Process - the M5000 methanol plant build 2005 and operated by Methanol Holdings (Trinidad) Ltd. - has the capacity of 5,400 MTPD ~ 2½ billion liter methanol per year and contains about 2,000 reforming tubes of 10 cm internal diameter; 13 m heated length. A process down seized to 10 million l/y needs ten tubes only. Further downsizing is neither technically nor economically recommendable.

Biogas instances are often scattered and small - often too small for the traditional tube reformer. For example, on Samsø there is only biomass for 5 MTPD methanol. To accomplish this task, our idea is to use a plate heat exchanger instead of the traditional tube heat exchanger. In the plate heat exchanger biogas is heated with hot flue gas. Plate intervals will be up to 1 cm wide. The space is split with one or more ribs to extend the distance the gas has to travel. By an odd number of ribs inlet and outlet will be at the same end of the heat exchanger. This allows free movement of the opposite end during heating and cooling. The biogas frame is filled with a nickel catalyst. The ribs forms a rectangular cross section of the pathway with a distance from the heating surface to the center of approx. ½ cm, which is ten times lower than for our traditional tube heat exchanger. For this reason heat transfer is increased and retention time reduced by a factor 100.

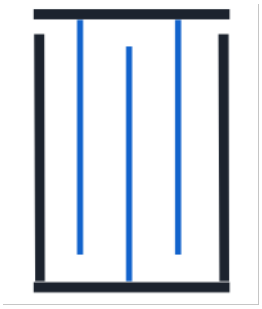
It is our intention to test and optimize a steam reformer with a few 2 x 3 m frames: Hot purified biogas (350 - 400 ^{o}C, 10 – 15 bar) is mixed with steam and enters the reformer (R-171). The biogas frame is filled with a nickel catalyst. A direct-fired heater generates hot flue gas (800 – 900 ^{o}C) fed to the hot side of the reformer. The pre-dominant reaction that takes place is the steam reforming of methane:

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

This reaction is endothermic and conversion is enhanced by high temperature, low pressure and high steam to carbon ratios. In addition to the reforming reaction to produce carbon monoxide and hydrogen, a water gas shift reaction takes place:

$$CO + H_2O \rightarrow CO_2 + H_2$$

The water gas shift reaction is exothermic and the amount of carbon dioxide formed is determined by the reaction equilibrium at the outlet conditions of the reformer. High temperatures causes the reaction to go to the left and high water concentrations cause the reaction to shift to the right.



Biogas frame of plate heat exchanger (R-171). Biogas inlet left. Syngas outlet right. Frame in black. Baffles in blue.

This design is applicable to other catalyst processes as the exothermic methanol synthesis and exothermic Methanol dewatering to DME on ships or even in road vehicles.