Production of Hydrogen using Water Gas Shift Reaction (WGSR)

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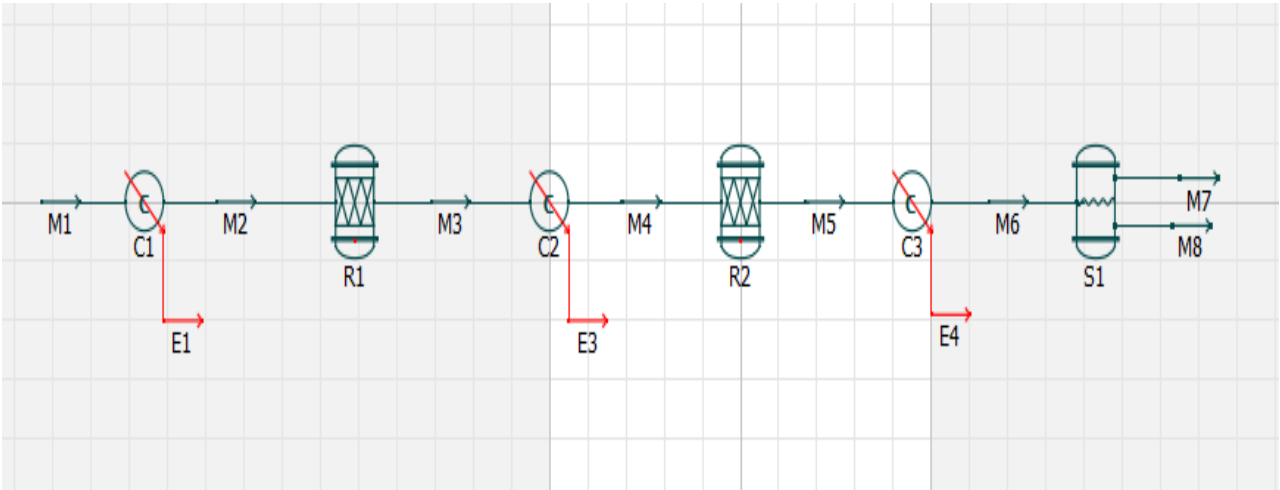
ABSTRACT

BACKGROND:

Water Gas Shift Reaction is a major part of Steam Methane Reforming process, the flue gases after methanation has Carbon Monoxide and major part of unconverted steam. WGSR increases the yield of Hydrogen produced by reacting carbon monoxide with the remaining steam. This process is important for two reasons, firstly, it increases yield. Secondly, converts CO to CO_2, hence the emission of poisonous CO gas is avoided.

WGSR is divided into two parts, High Temperature Shift(HTS) and Low Temperature Shift(LTS).Flues gases from SMR enters R1 (HTSR) which operates at 500-700K, where it converts remaining steam by 35%, then the overhead is passed through a cooler to bring down the temperature to 400K. Later, the cooled stream is taken into R2 (LTSR) which operates at 300-400k, this is industrially used to increase the H_2 yield by 2-3%. The vapour outlet is cooled and sent to Flash Column, where remaining steam is condensed to water and the product gas is taken out.

FLOWSHEET:



RESULTS:

High Temperature Shift Reaction

Open Modelica		DWSIM	
Compound	Amount	Compound	Amount
Methane	0.0161393	Methane	0.016139308
Oxygen	0.00743258	Oxygen	0.0074325759
Nitrogen	0.2835	Nitrogen	0.28349968
Water	0.16564	Water	0.16564026
Hydrogen	0.394988	Hydrogen	0.39498832
Carbon Monoxide	0.0000000034	Carbon Monoxide	2.3093299E-13
Carbon Dioxide	0.1323	Carbon dioxide	0.13229985
Molar Flowrate	4.709	Molar Flowrate	4.70899

Low Temperature Shift Reaction

Open Modelica		DWSIM	
Compound	Amount	Compound	Amount
Methane	0.0161393	Methane	0.016139308
Oxygen	0.00743258	Oxygen	0.0074325759
Nitrogen	0.2853	Nitrogen	0.28349968
Water	0.1654	Water	0.16564026
Hydrogen	0.394988	Hydrogen	0.39498832
Carbon Monoxide	0.0000000034	Carbon Monoxide	4.9595777E-15
Carbon Dioxide	0.1323	Carbon Dioxide	0.13229985
Molar Flowrate	4.709	Molar Flowrate	4.70899

Product Gas:

Open Modelica		DWSIM	
Compound	Amount	Compound	Amount
Methane	0.019211	Methane	0.019212208
Oxygen	0.00885397	Oxygen	0.0088477164
Nitrogen	0.337785	Nitrogen	0.33747781
Water	0.0077521	Water	0.0068413518
Hydrogen	0.470638	Hydrogen	0.47019373
Carbon Monoxide	4.049E-8	Carbon Monoxide	5.9038776E-15
Carbon Dioxide	0.155764	Carbon Dioxide	0.15742718
Molar Flowrate	3.9520788	Molar Flowrate	3.95581

PROBLEM DURING SIMULATING FLOWSHEET:

In Open Modelica one problem occurred while simulating the flowsheet, Flash column did not give proper results. When the Flash column was simulated separately it gave perfect results. To overcome the problem, results of separate Flash column were given as inputs of guess model in the Output stream of Flash column.