CLL371:Project.

Formaldehyde Production from Methanol.

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Production of Formaldehyde using Methanol:

One of the largest applications of methanol, accounting for about 35% of methanol consumption, is the synthesis of formaldehyde, which is based on one of the following reactions:

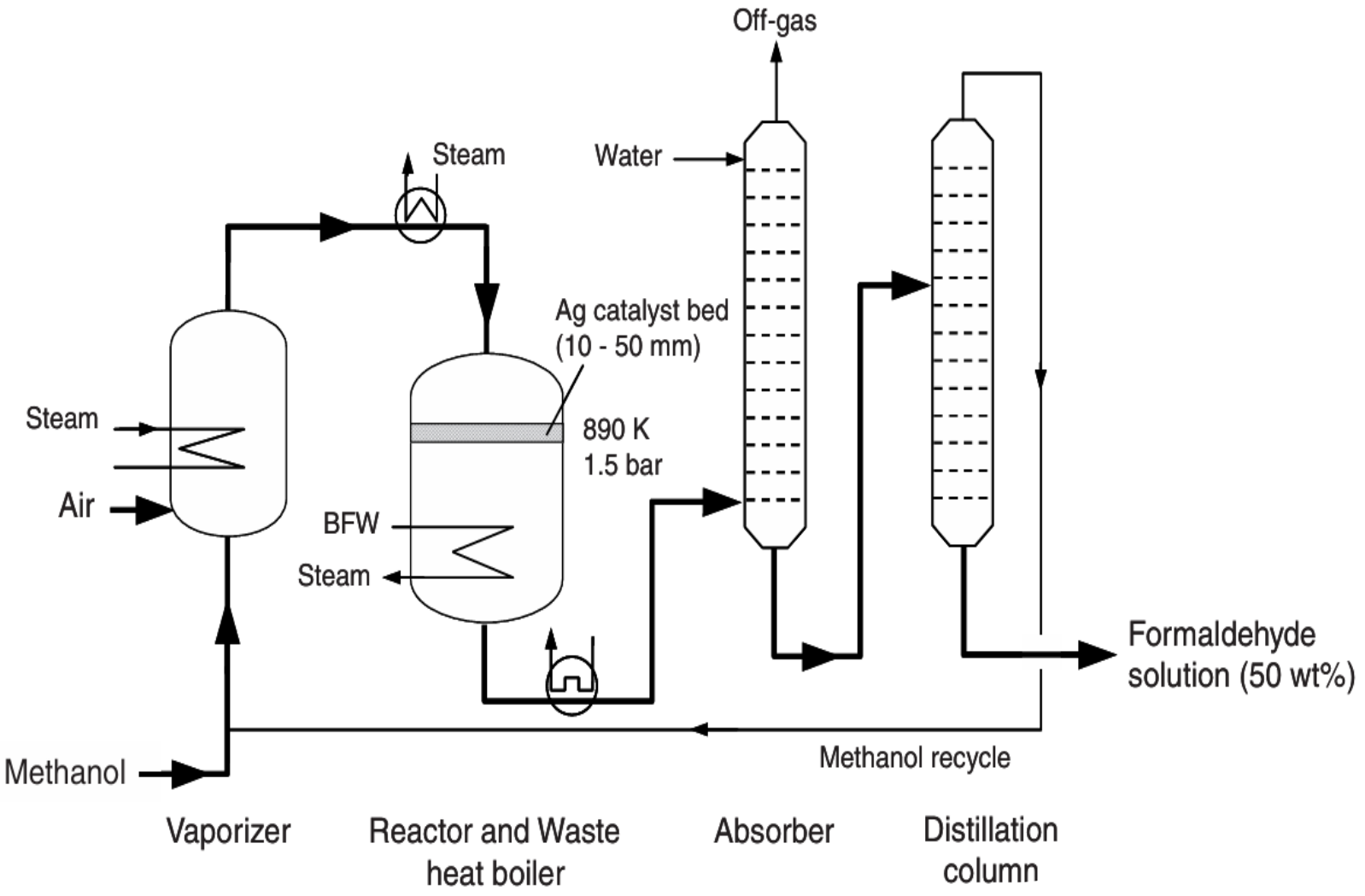
$$CH_3OH \rightleftharpoons CH_2O + H_2 \qquad \Delta_r H_{298} = 85\ kJ/mol \qquad \ldots(1)$$

$$CH_3OH + 1/2\ O_2 \rightarrow CH_2O + H_2O \qquad \Delta_r H_{298} = -158\ kJ/mol \qquad \ldots(2)$$

- formaldehyde can be produced by dehydrogenation (reaction 1) or by partial oxidation (reaction 2). Reaction 1 is endothermic while reaction 2 is exothermic. The overall reaction is highly exothermic, despite some heat consumption by the endothermic dehydrogenation reaction.

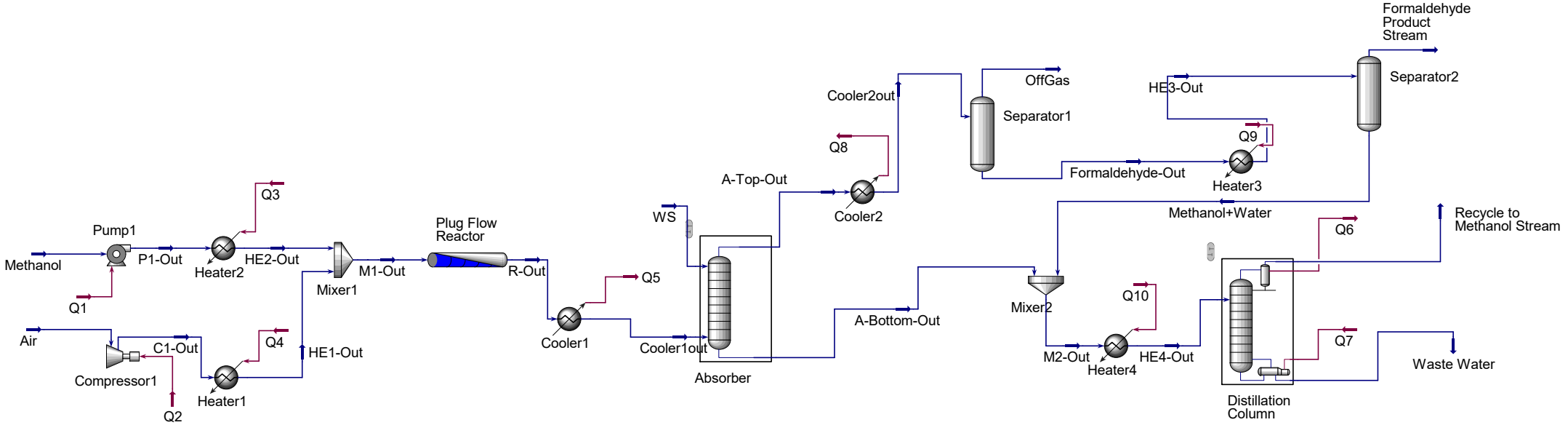
- In industrial practice dehydrogenation and partial oxidation are often carried out over a silver-based catalyst in a single reactor in which the heat produced by the exothermic partial oxidation reaction supplies the heat for the endothermic dehydrogenation reaction.

- Fresh and recycle methanol is evaporated in a vaporizer into which air is sparged to generate a feed mixture. The resulting vapor is combined with steam and heated to the reaction temperature. Reaction takes place in a shallow bed of catalyst, after which the product gases are immediately cooled in a waste heat boiler, thereby generating steam.



Process flow diagram of formaldehyde production from Methanol

- After further cooling the gases are fed to an absorber. Subsequently, distillation yields a 40–55 wt% formaldehyde solution in water. Methanol is recycled to the vaporizer.
- A process in which only the partial oxidation reaction over a metal oxide catalyst In contrast to the silver-catalyzed process, this process operates with excess air. It has the advantage that the distillation column for methanol recovery can be omitted, because in this case methanol conversion is over 99%.


Methanol
Pump1
P1-Out
Heater2
HE2-Out
Q3
Q1
Air
Compressor1
C1-Out
Q2
Heater1
Q4
HE1-Out
Mixer1
M1-Out
Plug Flow
Reactor
R-Out
Cooler1
Q5
Cooler1out
WS
Absorber
A-Top-Out
Cooler2
Q8
Cooler2out
OffGas
Separator1
A-Bottom-Out
Mixer2
Formaldehyde-Out
HE3-Out
Heater3
Q9
Methanol+Water
Formaldehyde
Product
Stream
Separator2
Recycle to
Methanol Stream
Q6
Q10
M2-Out
Heater4
HE4-Out
Distillation
Column
Q7
Waste Water