Acetaldehyde production by ethanol dehydrogenation

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Background

Acetaldehyde also known as ethanal is an organic chemical compound which occur naturally in coffee, bread, ripe fruit and is produced by plants. Acetaldehyde is one of the most important aldehydes which is produced on large in industries.

The production of acetaldehyde involves the partial dehydrogenation of ethanol in an isothermal gas phase reactor:

$$CH_3CH_2OH \rightarrow CH_3CHO + H_2$$

Other side reaction are involved which results in formation of undesirable products, acetic acid, butanol and ethyl acetate:

$$2CH_3CH_2OH \rightarrow CH_3COOC_2H_5 + 2H_2$$

$$2CH_3CH_2OH \rightarrow CH_3(CH_2)_3OH + H_2O$$

$$CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 2H_2$$

Description

Fresh feed stream1 of 85 wt. % ethanol in water is mixed with recycle stream21 which is fed to isothermal gas phase reactor at 603K and 663276 Pa in which 60.8 % of ethanol is converted. The stream leaving the reactor is cool down to 342.59 K and 655692 Pa. then the stream enters vapour-liquid separator(SEP-043) from which the top stream vapours containing 88.7 mole % hydrogen is sent to absorption column, where acetaldehyde is absorbed by stream10 containing pure water. The resulting vapour effluent is sent for further recovery of hydrogen. Stream_12 the liquid from absorption column (CSCOL-004) is combined with stream14, the liquid effluent from SEP-043, and enters as stream_15 to distillation_1 where acetaldehyde is purified to 99.9 wt. %, stream16. The bottom stream17 is sent to distillation_2 for the process of purification of ethanol. In distillation_2 some water and ethyl acetate is removed as distillate, stream18. The bottom stream19 is sent to distillation_3 unit where ethanol is separated from butanol ethyl acetate and most of water, these impurities exit as bottom stream20 and the distillate containing 70.8 mole % ethanol is recycled back.

Results

Stream table						
Object	**stream21**	**stream18**	**stream16**	**stream10**	**stream1**	
Temperature	407.925	402.776	350.74	339.983	315.15	**K**
Pressure	650176	650176	650176	650176	101325	**Pa**
Mass Flow	2.23618	0.425793	2.99476	8.17173	4.83404	**kg/s**
Molar Flow	58.1002	7.8095	68.0085	453.6	130.773	**mol/s**
Volumetric Flow	0.00309731	0.000574793	0.00506801	0.00834506	0.0058186	**m3/s**
Mixture Density	721.973	740.777	590.915	979.23	830.792	**kg/m3**
Molar Fraction (Mixture) / Acetaldehyde	0.00648409	0.0312599	0.99958	0	0	
Molar Fraction (Mixture) / Acetic acid	2.24026E-09	7.8979E-11	1.73036E-15	0	0	
Molar Fraction (Mixture) / 1-butanol	0.00352966	3.83088E-07	5.49507E-15	0	0	
Molar Fraction (Mixture) / Water	0.278178	0.206441	3.7916E-09	1	0.324501	
Molar Fraction (Mixture) / Ethanol	0.708535	0.421922	1.36633E-06	0	0.675499	
Molar Fraction (Mixture) / Ethyl acetate	0.003274	0.340377	2.21802E-06	0	0	
Molar Fraction (Mixture) / Hydrogen	0	0	0.000416625	0	0	