Manufacture of N,N-Dimethylformamide (N,N-DMF) by the methyl formate route

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Background:

Dimethylformamide (DMF) is a crucial industrial solvent in most processes wherein solvent extractions are carried out. DMF is also used in the manufacture of various plastics viz. polyurethanes and in stabilizing acetone while transport. Due to its low volatility, and high dielectric nature, it is also used sometimes as a thermal regulator in electrical transformers apart from its major use in the chemical industry. There were very few well established methods for the large-scale production of DMF apart from as by-products in the petrochemical industry.

Process settings:

System of units: C5

Special operations/blocks used: CAPE-OPEN (ChemSep) extractive distillation column

Logical blocks: Energy recycle block

Process description:

In the flowsheet 1 (without any reuse of streams), methanol and carbon monoxide streams are heated to 50^{o}C at atmospheric pressure and fed to an equilibrium reactor as a mixture, whose outlet is methyl formate (MF), the first and foremost precursor to DMF synthesis. The MF stream is then separated of its vapour and liquid, post which the liquid stream is heated to 200^{o}C and mixed with preheated Mono-methylamine (MA) feed. The mixture is then fed to a conversion reactor which converts the feed to our product, Dimethylformamide. The product stream subjected to a gas-liquid separation process, post which the vapour is extractively-distilled for N,N-DMF in a column and the bottom liquid products are cooled to 25^{o}C.

In the current process, without the use of recycles, the purity of DMF obtained is just 45%. Hence in order to increase the purity of the desired product, in the second flowsheet, we re-introduce the other process side streams go obtain a higher purity

In the flowsheet 2, most of the energy streams are recycled to reduce cost and power consumption, also vapor streams from the Equilibrium reactor is re-fed to the GL-Separator (GLS-B-1). The liquid stream of GLS-B-2 is also re-utilized into the distillation column, to obtain the highest purity of DMF, around 99.99% in the stream SB-21.

Flowsheet:

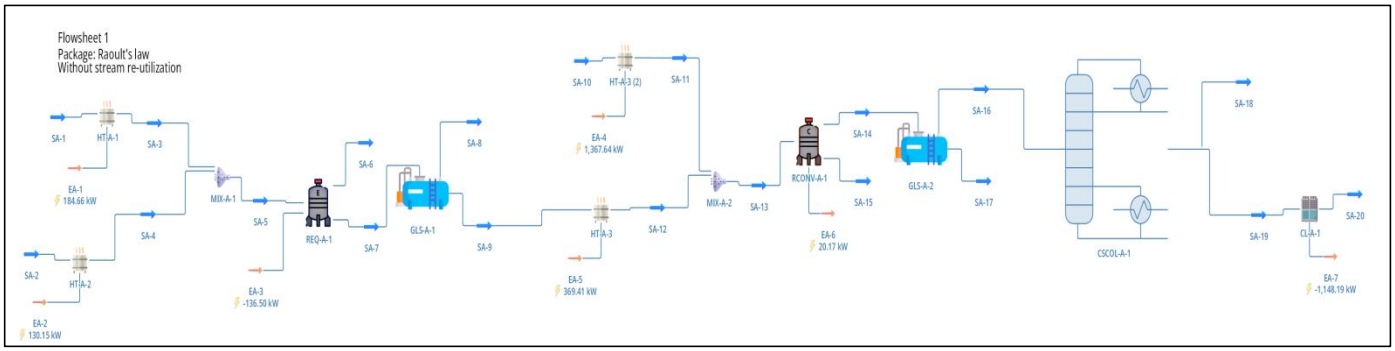

Fig 1: Flowsheet 1 without stream re-use

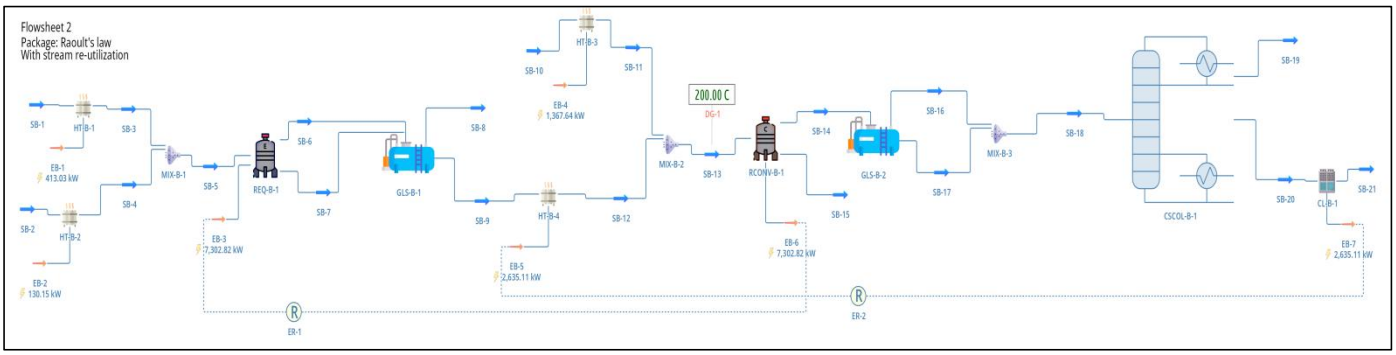

Fig 2: Flowsheet 2 with stream re-use

Results:

Material stream: SA-20		
Parameter	**Value**	**Unit**
Temperature	25	C
Pressure	1.01325	bar
Mass Flow	5974.3	kg/h
Molar Fraction (Overall Liquid) / Methanol	3.34E-05	-
Molar Fraction (Overall Liquid) / Carbon monoxide	7.59E-25	-
Molar Fraction (Overall Liquid) / Methyl formate	0	-
Molar Fraction (Overall Liquid) / N,N-dimethylformamide	0.45358	-
Molar Fraction (Overall Liquid) / Water	0.262378	-
Molar Fraction (Overall Liquid) / Methylamine	0.284009	-
Material stream: SB-21		
Temperature	25	C
Pressure	1.01325	bar
Mass Flow	32661.2	kg/h
Molar Fraction (Overall Liquid) / Methanol	3.10E-13	-
Molar Fraction (Overall Liquid) / Carbon monoxide	0	-
Molar Fraction (Overall Liquid) / Methyl formate	2.02E-14	-
Molar Fraction (Overall Liquid) / N,N-dimethylformamide	0.999983	-
Molar Fraction (Overall Liquid) / Water	1.67E-05	-
Molar Fraction (Overall Liquid) / Methylamine	0	-

Table 1: Properties of output streams SA-20 (Flowsheet 1) and SB-21 (Flowsheet 2)