Equation:

[Triglyceride] + 3 [methanol] = [Fat acid methyl ester] + [glycerol]

Rate constant, k:

0.38

Conversion, X:

0.98

Step 1:

General equation for CSTR: FAo – FA + rA(V) = $\frac{dNa}{dt}$

 Volume for CSTR: V = $\frac{(FAo- FA)}{-rA}$

Since, FA = FAo (1-X) then, V = $\frac{FAo X}{-rA}$

 For 1st order reaction, -rA=kCA

Step 2:

Stoichiometry table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Symbol | Initial | Change | Remaining |
| Triglyceride | A |

|  |
| --- |
|  FAO  |

 |

|  |
| --- |
|  -FAOX  |

 |

|  |
| --- |
|  FA = FAO (1-X)  |

 |
| Methanol | B |

|  |
| --- |
|  FBO  |

 |

|  |
| --- |
|  -FAOX  |

 |

|  |
| --- |
|  FB = FBO - FAOX  |

 |
| Methyl ester | C |

|  |
| --- |
|  FCO = 0  |

 |

|  |
| --- |
|  FAOX  |

 |

|  |
| --- |
|  FC = FAOX  |

 |
| Glycerol | D |

|  |
| --- |
|  FDO = 0  |

 |

|  |
| --- |
|  FAOX  |

 |

|  |
| --- |
|  FD = FAOX  |

 |

Step 3:

*V*o=$\frac{FAo }{CAo}$ and CA=CAo (1-X)

So substitute, V = $\frac{Vo(X)}{k(1-X)}$

Vo= (5 kg/day )$÷$ (901.3g/$m^{3}$ ) = 5.548$10^{-3} m^{3}$

V=$\frac{(5.548x10^{-3} )(0.98)}{(0.38)(1-0.98)}$ =0.715$ m^{3}$ = Volume

D= $\sqrt[3]{\frac{4V}{π}}$ = $\sqrt[3]{\frac{4(0.715)}{π}}$ = 0.9691 m = Diameter

V = $\frac{πD^{2}}{4}$ x L

L = $\frac{4(0.715)}{π(0.9691)^{2}}$ = 0.9693 m =Height