**Example .2 /** A continuous fractionating column, operating at atmospheric pressure, is to be designed to separate a mixture containing 15.67 per cent CS2 and 84.33 per cent CCl4 into an overhead product containing 91 per cent CS2 and a waste of 97.3 per cent CCl4 all by mass. A plate efficiency of 70 per cent and a reflux of 3.16 kmol/kmol of product may

be assumed. Using the following data, determine the number of plates required. The feed enters at 290 K with a specific heat capacity of 1.7 kJ/kgK and a boiling point of 336 K. The latent heats of CS2 and CCl4 are 25.9 kJ/kmol.

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**Solution**

The equilibrium data are shown in Figure 11c and the problem may be solved using the method of McCabe and Thiele. All compositions are in terms of mole fractions so that:



In this problem, the feed is not at its boiling-point so the slope of the *q*-line must be determined in order to locate the intersection of the operating lines. *q* is defined as the heat required to vaporise 1 kmol of feed/molar latent heat of feed, or



where *λ* is the molar latent heat. *Hf s* is the enthalpy of 1 kmol of feed at its boiling-point, and *Hf* is the enthalpy of 1 kmol of feed. The feed composition is 27.4 per cent CS2 and 72.6 per cent CCl4 so that the mean molecular mass of the feed is given by:





The intercept of the *q*-line on the *x*-axis is shown from eq.blow to be *xf /q* or:



Thus the *q*-line is drawn through *(xf , xf )* and (0.196, 0) as shown in blow. As the reflux ratio is given as 3.16, the top operating line may be drawn through *(xd, xd )* and *(*0*, xd/*4*.*16*)*. The lower operating line is drawn by joining the intersection of the top operating line and the *q*-line with the point *(xw, xw)*. The theoretical plates may be stepped off as shown and 9 theoretical plates are shown. If the plate efficiency is 70 per cent, the number of actual plates = *(*9*/*0*.*7*)* = 12*.*85, Thus: 13 plates are required

