

15.23 For an alternating acrylonitrile-butadiene copolymer, we are asked to compute the weight percent sulfur necessary for complete crosslinking, assuming that, on the average, four sulfur atoms participate in each crosslink. The acrylonitrile and butadiene repeat units are shown in Table 14.5, from which it may be noted that there are two possible crosslink sites on each butadiene repeat unit (one site at each of the two carbon atoms that are doubly bonded), and no possible sites for acrylonitrile; also, since it is an alternating copolymer, the ratio of butadiene to acrylonitrile repeat units is 1:1. Thus, for each pair of combined butadiene-acrylonitrile repeat units which crosslink, eight sulfur atoms are required, or, for complete crosslinking, the sulfur-to-(acrylonitrile-butadiene) ratio is 4:1.

Now, let us consider as our basis, one mole of the combined acrylonitrile-butadiene repeat units. In order for complete crosslinking, four moles of sulfur are required. Thus, for us to convert this composition to weight percent, it is necessary to convert moles to mass. The acrylonitrile repeat unit consists of three carbon atoms, three hydrogen atoms, and one nitrogen atom; the butadiene repeat unit is composed of four carbons and six hydrogens. This gives a molecular weight for the combined repeat unit of

$$\begin{aligned} m(\text{acrylonitrile-butadiene}) &= 3(A_C) + 3(A_H) + A_N + 4(A_C) + 6(A_H) \\ &= 7(12.01 \text{ g/mol}) + 9(1.008 \text{ g/mol}) + 14.007 \text{ g/mol} = 107.15 \text{ g/mol} \end{aligned}$$

Or, in one mole of this combined repeat unit, there are 107.15 g. Furthermore, for complete crosslinking 4.0 mol of sulfur is required, which amounts to $(4.0 \text{ mol})(32.06 \text{ g/mol}) = 128.24 \text{ g}$. Thus, the concentration of S in weight percent C_S (using Equation 4.3) is just

$$C_S = \frac{128.24 \text{ g}}{128.24 \text{ g} + 107.15 \text{ g}} \times 100 = 54.5 \text{ wt\%}$$