Fabrication and Processing of Glasses and Glass-Ceramics

13.9 We are asked to compute the weight of soda ash and limestone that must be added to 125 lb_m of SiO_2 to yield a glass composition of 78 wt% SiO_2, 17 wt% Na_2O, and 5 wt% CaO. Let x = the weight of Na_2O and y = the weight of CaO. Then, employment of a modified form Equation 4.3, we may write the following expressions for the concentrations of Na_2O (C_{Na_2O}) and CaO (C_{CaO}):

$$C_{Na_2O} = 17 \text{ wt\%} = \frac{x}{125 + x + y} \times 100$$

$$C_{CaO} = 5 \text{ wt\%} = \frac{y}{125 + x + y} \times 100$$

Solving for x and y from these two expressions yields x = 27.2 lb_m Na_2O and y = 8.0 lb_m CaO.

Now, in order to compute the weights of Na_2CO_3 and $CaCO_3$, we must employ molecular weights. The molecular weights of Na_2CO_3 ($MW_{Na_2CO_3}$) and Na_2O (MW_{Na_2O}) are as follows:

$$MW_{Na_2CO_3} = 2(A_{Na}) + A_C + 3(A_O)$$

$$= 2(22.99 \text{ g/mol}) + 12.01 \text{ g/mol} + 3(16.00 \text{g/mol}) = 105.99 \text{ g/mol}$$

$$MW_{Na_2O} = 2(A_{Na}) + A_O$$

$$= 2(22.99 \text{ g/mol}) + 16.00 \text{ g/mol} = 61.98 \text{ g/mol}$$

And, finally, the mass of Na_2CO_3 ($m_{Na_2CO_3}$) is equal to

$$m_{Na_2CO_3} = (27.2 \text{ lb}_m)\left(\frac{MW_{Na_2CO_3}}{MW_{Na_2O}}\right)$$

$$= (27.2 \text{ lb}_m)\left(\frac{105.99 \text{ g/mol}}{61.98 \text{ g/mol}}\right) = 46.5 \text{ lb}_m$$