The products of decomposition of ammonium nitrate are water, oxygen and nitrogen gas. Ammonium nitrate has a high proportion of oxygen, hence has a positive oxygen balance (Akhavan 2011, p. 88).

$$2NH_4NO_{3(s)} \rightarrow 2N_{2(g)} + 4H_2O_{(g)} + O_{2(g)}$$

Both tetryl and HMX explode in oxygen to form water, carbon (IV) oxide and nitrogen gas.

$$C_4H_8N_8O_{8(s)} \rightarrow 4CO_{2(g)} + 4N_{2(g)} + 4H_2O_{(l)} - 2O_{2(g)} \text{ (Tetryl)}$$

$$4C_7H_5N_5O_{8(s)} \rightarrow 28CO_{2(g)} + 10H_2O_{(l)} + 10N_{2(g)} - 17O_{2(g)} \text{ (HMX)}$$

For HMX and tetryl, the oxygen molecules on the right are negative. This is because the amount of oxygen present is insufficient for complete oxidation and hence oxygen should be added to the explosive, for example in form of ammonium nitrate (Akhavan 2011, p. 88). To balance the reactions of HMX and tetryl a negative sign is used for oxygen.

To get the most effective explosion mixture, 1 mole of HMX requires 4 moles of ammonium nitrate to supply enough oxygen as shown in the equation below. This represents a mixture of 52% ammonium nitrate and 48% HMX.

$$4NH_4NO_{3(s)} + C_4H_8N_8O_{8(s)} \rightarrow 8N_{2(g)} + 12H_2O_{(g)} + 4CO_{2(g)}$$

Mass of reactants = 4 (14 + 4 + 14 + 48) + (48 + 8 + 112 + 128) = 320 + 296 = 616g,

Mass of NH_4NO_3 required = 4 (14+4+14+48) = 320g

Concentration of NH_4NO_3 = 320/616 = 52%, Concentration of Tetryl = 296/616 = 48%

To get the most effective explosion mixture of ammonium nitrate, 4 moles of tetryl requires 34 moles of ammonium nitrate to supply enough oxygen as shown in the equation below. This represents a mixture of 70% ammonium nitrate and 30% tetryl.

$$34NH_4NO_{3(s)} + 4C_7H_5N_5O_{8(s)} \rightarrow 44N_{2(g)} + 78H_2O_{(g)} + 28CO_{2(g)}$$

Mass of reactants = 34 (14 + 4 + 14 + 48) + 4 (84 + 5 + 70 + 128) = 2720 + 1148 = 3868g

Mass of NH_4NO_3 required = 34 (14 + 4 + 14 + 48) = 2720g

Concentration of NH_4NO_3 = 2720/3868 = 70%, Concentration of Tetryl = 1148/3868 = 30%

Reference

Akhavan, J. 2011, *The Chemistry of Explosives*, 3rd edn, Royal Society of Chemistry, London.