example, ammonia synthesis),

- *intersecting*, in which the number of products as a result of the process does not change explicitly (for example, roasting of pyrites).

Based on the analysis of *MFG* (the material flow graph), *the material balance of the process* is compiled.

Material balance is an expression of the law of conservation of mass: the mass of substances (*m*) received for a technological operation (*input*) is equal to the mass of substances obtained in this operation (*consumption*), and is written in the form of a balance equation:

$$\Sigma m_{input} = \Sigma m_{consumption}$$

Items of input and consumption in the material balance are the mass of the useful component of the raw material (m_1), impurities or moisture in the raw material (m_2), the target product (m_3), by-products (m_4), production waste (m_5) and losses (m_6) received in production or operation:

$$m_1 + m_2 = m_3 + m_4 + m_5 + m_6$$

The material balance is compiled per unit mass of the target product or per unit (reactor) and is expressed in mass units (kg, t) or mass fractions (μ). For periodic processes, the material balance is compiled for one operation, for continuous processes - per unit of time.

On the basis of the material balance, expenditure coefficients are calculated, the size of the apparatus is determined and the optimal values of the parameters of the technological mode of the process are established.

The energy balance is based on *the law of energy conservation*, according to which in a closed system the sum of energies of all types is constant. Private and the most common type of energy balance in chemical production is heat balance: *the heat input in this technological operation is equal to the heat consumption in it*, which is written in the form of the heat balance equation:

$$\Sigma Q_{input} = \Sigma Q_{consumption}$$

The articles of input and consumption in the heat balance are the thermal effects of ΔH reactions, the heat of phase transitions (Q_1), the heat content of substances involved in the process (Q_2), the heat supplied to the apparatus from the outside and output from the apparatus (Q_3), the heat loss (Q_4) in this process operation:

$$\Delta H + Q_1 + Q_2 + Q_3 = \Delta H' + Q_1' + Q_2' + Q_3' + Q_4',$$

where: index (‘) refers to expense items.

Thermal contributions to the balance are determined by known formulas, and the thermal effect of a chemical reaction is calculated in accordance with the equation:

$$\Delta H = \Sigma\ \Delta H_{product} - \Sigma\ \Delta H_{\text{starting materials}},$$

in which the enthalpy values of the reaction products (product) and the starting materials (starting materials) are tabular data.

The heat content of substances is calculated by the formula:

$$Q_2 = m \cdot c \cdot t,$$

where: m *is the mass of a substance,* c *is its heat capacity,* t *is the temperature.*

The heat of phase transitions is calculated by the formula: