7. DYNAMIC MODELS OF THE CHEMICAL COMPOSITION OF GROUND MATERIALS

In this chapter dynamic models for describing the changes in the chemical composition of the ground material are dealt with. It is assumed that the mill is fed by raw materials of different chemical composition. The determination of the composition model for the raw-meal of cement production is emphasized, but the results can be generalized for other technologies, too.

The most fundamental intermediate of cement production is the raw-meal produced by the raw mills. In most factories the raw-meal requires homogenization (which may be batch or continuous) before it gets into the cement kiln. The raw-meal, as well as the cement, consists of four principal oxides; these are calcium oxide - (CaO), silica - (SiO₂), alumina - (Al₂O₃) and ferric oxide (Fe₂O₃) which constitute 95% of the total. The remainder consists of magnesium-, potassium- and sodium oxides. Relative parameters are generally used to characterize the raw-meal, containing different combination rates of the oxides, by means of which the chemical composition of the clinker produced by the kiln can be determined [239]. The most frequently used relative parameters are:

1. Calcium modulus (Kₜ):

\[ Kₜ = \frac{100 \cdot C}{2.8 \cdot S + 1.1 \cdot A + 0.7 \cdot F} \]  \hspace{1cm} (7.1)

2. Alumina modulus (AM):

\[ AM = \frac{A}{F} \]  \hspace{1cm} (7.2)

3. Silica modulus (SM):

\[ SM = \frac{S}{A + F} \]  \hspace{1cm} (7.3)

Throughout, the following abbreviations are used:

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where the letters refer to mass percentages.

(Regarding the other relative parameters, i.e. lime saturation factor, etc., see the literature [101]. Different parameters are preferred in different countries.)

To determine the dynamic composition model, consider now Fig. 7-1, where a system and process engineering model of a serially connected mill and storage silo is presented. The silo - beside the storage, especially in batch operation - serves to smooth the fluctuations in raw-meal composition by homogenization, required for the proper preparation of the cement kiln. In the Figure \( r(t) \) is the mill input resulting from the mix of different raw materials, whose composition vector is \( w(t) \). As the proportioning is performed by belt scales, the components \( w_i \) of the composition vector are called scale rates. The relationship

\[
1^T w(t) = \sum_{i=1}^{3} w_i(t) = 1 \tag{7.5}
\]

is obviously fulfilled, because \( w(t) \) is a composition vector. (Throughout, - in accordance with Hungarian practice - three raw material components are assumed; of course, the results can be easily generalized for components of any number.) The available raw materials can be characterized by a so-called composition matrix