PMP *compact* - Particulate Materials Processing

Part 2 Modules of the Process Analysis Comminution

In contrast to classification the description of comminution does not posses such an uniform description form. Because of that, different strategies are followed in PMP which

- ❒ posses a high level of generality
- ❒ are derivable under real operating conditions
- ❒ are easy adjustable.

The modules MILL 20 / MILL 30 as well as MILL 21 / MILL 31 contain model- and machine independent descriptions, which are based on balance sheet calculations in operating conditions. They are analogue to classification modelling. The method can be verified easily by a consequent generalization and applied for different processes.

Module: MILL 20

Description of operating states of the grinding process by means of

- a reduction ratio rr on a reference value p
- and the characteristic curve r_pcr(x) "relative particle concentration ratio" (quotient of distribution densities of mill feed and grinding product, whereas the distributions are standardised regarding the quantile size x(p)).

Contains methods for

- setting up problem-related data structures
- determining and editing characteristic curves
- calculating comminution characteristics
- visualising characteristics and -curves in various table- and graphic views
- balancing the characteristic curve from experimental data
- pre-calculating comminution results

Module: MILL 30

This model is based on description MILL 20 and contains:

- characteristic fields where the comminution proportion rr is described in dependence of process determining influencing values. Influencing values being dominant for the task can be applied for the respective process.
- a medium characteristic curve r_pcr(x), which is presentable in the validity area

Additional methods for

- setting up machine specific data structures
- calculating the characteristic field and the medium average relative particle concentration ratio
- visualizing operating states and characteristic fields
- adjusting operating conditions and pre-calculation of grinding results

Module: MILL 21

Description of operating states of the grinding processes by means of

- the reduction ratios rr_l and rr_h on two reference values p_low and p_high
- and the characteristic curve s_pcr(x) "standardised particle concentration ratio" (quotient of the distribution densities of mill feed and grinding product, whereas the distributions are transformed regarding the quantile particle sizes x(p_low) and x(p_high).)

Contains methods for

- setting up problem-related data structures
- determining and editing characteristic curves
- calculating grinding characteristics visualizing characteristics and -curves in various table- and graphic views
- balancing characteristic curves from experimental data
- pre-calculating grinding results

Module: MILL 31

This model approach is based on description MILL 21 and contains:

- characteristic fields where the grinding proportions rr and rr_h are described in dependence of process determining influencing values. Influencing values being dominant for the task can be applied for the respective process
- a medium characteristic curve s_pcr(x), which is presentable validity area

Contains additional methods for

- setting up machine specific data structures
- calculating characteristic fields and the medium standardised particle concentration ratio
- visualising operating conditions and characteristic fields
- adjusting operating conditions and pre-calculating grinding results

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Part 2 Modules of the Process Analysis Comminution in Tumbling Mills

Modelling the comminution in tumbling mills will be performed under following assumptions:

- ❒ comminution kinetics: process of first order with particle size related grinding speed
- ❒ transportation behaviour: model of cells
- ❒ invariance curve: product of grinding mass and grinding speed is proportional to the power brought up

Modules MILL 13 / MILL 14 and MILL 131 define an invariant particle size related characteristic curve on this basis – the energy characteristic W_inv(x). In doing so, the power input can be formulated by an according dependence of demand conditions in the grinding volume. Is the characteristic curve not invariant under special grinding conditions, a change of the characteristic curve can be described in dependence of the grinding conditions (mill 131).

Module: MILL 13 Tumbling Mill basic

Modelling the grinding process via

- ♦ machine parameters
  - useable length
  - clear diameter
  - mixing ratio
  - effective power
  - grinding media filling degree
  - relative rotational speed
- ♦ and the characteristic curve W_inv(x) "energy characteristic"

Contains methods for

- ♦ setting up problem-related data structures
- ♦ determining and editing characteristic curves
- ♦ adjusting via a power function
- ♦ calculating grinding characteristics
- ♦ visualizing characteristics and -curves in various tables- and graphic views
- ♦ balancing the characteristic curve from experimental data
- ♦ pre-calculating grinding results

Module: Mill 14 Ball Mill

This module approach is based on module 13 and contains additional methods for

- ♦ calculating ball size compositions
- ♦ calculating characteristics of ball size compositions
- ♦ representing ball size compositions
- ♦ visualizing operating states and characteristic curves
- ♦ adjusting operating conditions and pre-calculating grinding results

Module: Tumbling Mill 131 generalised

The modelling of the grinding process is based on MILL 13 and is effected via:

- ♦ characteristic fields where a change of the characteristic curve will be described in dependence of further process determining influencing values. This might be the ball size, the grinding media filling degree or a coarse fraction in the feed for example.
- ♦ a medium energy characteristic that is presentable in the validity area

Contains methods of MILL 13 relating to this description form and additional methods for

- ♦ setting up machine specific data structures
- ♦ calculating characteristic fields and a medium energy characteristic
- ♦ visualising operating states and characteristic fields
- ♦ adjusting operating states and pre-calculating grinding results