MoMAS

Mobile Measurement and Automation System for Extruders

MoMAS and what it can do for your extruder

MoMAS is a system for optimising the operation of extruders for metals with the goal of achieving high productivity and enhance product quality. Basis for the optimisation is the mastering of the thermal processes underlying the extrusion process. In particular MoMAS consists of measurement and control sub-systems which serve to achieve tight control of crucial variables such as extrusion rate and exit temperature.

By virtue of the variety of options it offers, MoMAS provides operators and managers of extrusion plants with a flexible and effective tool which can be employed to achieve various optimisation and automation goals. Thereby the operator can himself select the degree of autonomy with which MoMAS operates. Most importantly, he can operate the extruder manually and still exploit the information of process variables acquired and supplied by MoMAS. This provision for introducing the automation in steps alleviates its application and makes it easily acceptable on the part of operating persolnell.

MoMAS controls the exit temperature by suitably varying the extrusion rate automatically. It can be employed to achieve a reduction in the extrusion time per billet by employing exit temperature control in conjunction with a successive lowering of the furnace temperature. In case controlled tapered heating is possible, MoMAS can be employed to obtain constant exit temperature with constant ram velocity.

The functions of MoMAS

A first important and useful function of MoMAS is that it measures various process variables such as exit temperature, extrusion force, ram velocity etc. continuously and displays runs of the runs of these variables in the current and previous cycles. Also displayed is information such as the extrusion time per billet, idle times between cycles and the mean and standard deviation of the exit temperature over the cycles.

The second main function of MoMAS is calculating the optimal input functions employing data of the previous cycles and displaying these at the start of each cycle. The operator can

select the run of the input, e.g. the extrusion rate, proposed by MoMAS or a modified version of this and apply it to the extruder.

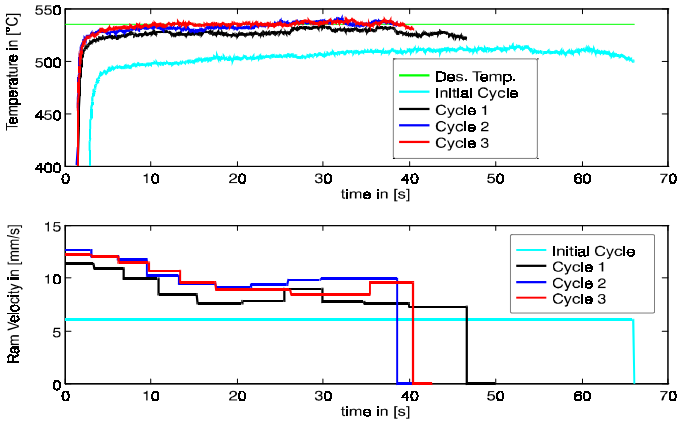
Alternatively he can switch on the fully automatic mode of operation.

A direct on- line control is superimposed during the extrusion.

The control principles used in MoMAS

The core of MoMAS is the exit temperature measurement and control system which is employed to maintain the exit temperature at a constant predetermined value. MoMAS employs the predictive feed- back and adaptive feed- forward control principles. The extremely robust off- line open-loop control in conjunction with an on- line closed loop permits a variety of possibilities for optimising the extrusion process. The off-line technique facilitates the application of non-causal filtering for lag-free smoothing of the pyrometer signal and the elimination of effects of the inherent sluggishness of the extruder.

Isothermal extrusion with predictive learning control
(notice the reduction of extrusion time per billet)



Choice of input functions and modes of operation of MoMAS

Following input variables can be employed for control:

1. Ram velocity

- A billet temperaure run is given as reference input to the furnace by the operator. This will take effect only after a few cycles.
- The actual billet temperature is measured before introducing the billet into the container.
- The ram velocity is calculated using the data of the previous cycles and the exit temperature measured in the current and given as input to the velocity loop.

2. **Billet temperature**

- A constant desired ram velocity is given by the operator.
- The billet temperature run is calculated and given as reference input to the furnace temperature controller.
- The actual billet temperature is measured before introducing every billet into the container.
- The ram velocity is updated using the actual billet temperature measured and the data of the previous cycles and the exit temperature measured in the current and given as input to the velocity loop.

3. **Ram velocity with successive reduction of billet temperature**

- A billet temperature run is given as reference input to the furnace by the operator
- The actual billet temperature is measured before introducing the billet into the container.
- The ram velocity is calculated using the data of the previous cycles and the exit temperature measured in the current and given as input to the velocity loop.
- The preceding two steps are repeated till the desired exit temperature is achieved.
- The billet temperature is reduced by a pre-selected value – say 5° C
- The procedure is repeated till the allowed minimum billet temperature is reached.

Options of the degree of automation offered

To facilitate a gradual increase in the level of automation a step-wise installation is envisaged:

- Manual operation on the basis of the displayed runs of the process variables

  The measured process variables in current and past cycles are displayed as functions of the ram-position and/ or time.

  The operator operates the extruder manually taking into consideration the effects of his adjustments which he can assess from the depicted runs.

- Manual operation supported by the MoMAS optimisation algorithm

  Optimal runs of input variables, viz. the billet temperature and extrusion rate as functions of the ram position are calculated and displayed.

  The operator operates the extruder manually and adjusts the inputs using the information of the optimal input supplied by MoMAS as well as his experience and discretion.

- Semi- automatic operation employing the MoMAS optimisation algorithm

  Optimal runs of input variables, viz. the billet temperature and extrusion rate as functions of the ram position are calculated and displayed.

  The operator signals his acceptance to the MoMAS computer which takes over the automatic adjustment of the inputs.

- Automatic operation employing the MoMAS optimisation algorithm

  Optimal runs of input variables, viz. the billet temperature and extrusion rate as functions of the ram position are calculated and displayed.

  The MoMAS computer takes over the automatic adjustment of the inputs as long as the operator does not override the automatic operation.

Installation of MoMAS

Corresponding to the phases described above MoMAS installation is performed in following stages

1. Installation of equipment for temperature measurement and visualization of process variables.
2. Implementation of semi-automatic operation: Installation of a computer system for determining the optimal extruder velocity trajectory at the beginning of every cycle and displaying it to the operator.
3. Implementation and commissioning of the fully automatic operation in which the optimal velocity trajectory is generated and applied by MoMAS itself.

A switch over from automatic to manual operation mode can be effected at any time with ease.

Other features

All the process data is stored and can be archived and retrieved.

The data can be exported in ASCII format and can be used in any programme (e.g. Excel, MS Word, Editor etc.)

The data can be transmitted over a LAN by employing a suitable network plug-in card. The data can be thus decentrally evaluated and utilised for statistical analysis etc.

MoMAS demonstration system

MoMAS has been installed at the Research and Development Center of Extrusion, TU Berlin. For a visit and demonstration contact the addresses given below.

Pre-requisites for Installation of MoMAS

- Process variables for which sensors are necessary
  - Exit temperature
  - Billet temperature
  - Pressure in hydraulic cylinder
  - Position of ram

  as analog voltage or current signals

- Prerequisites for exploiting the full opimising potential of
  - Ram velcity control
  - Billet temperature control
  - Taper furnace

Hardware components of MoMAS

- Industrial-PC (Operating system Microsoft Windows NT)
  - Touch screen or keys
  - Plug- in measurement card with realtime operating system

- Interface unit for potential isolation and pre- filtering
  - In a 19”- rack for installation in control console
- Computer and interface unit enclosed; max. operating temperature 60°C
- Position and velocity sensor (if not already installed)

The Demonstration Programme (MoMASSim.exe)

A demoprogramme can be obtained from the adresses show below and can be run on a pc to get acquainted with MoMAS.

Pre-requisites re. computer hardware and software

Pentium CPU; ca. 1.5 MB storage in hard-disc; Windows NT or 9x operating system

Installation

The disc contents are to be copied into a separate file in the hard disc and run from there. The programme contains the Demonstration Programme

MoMASSim.exe.

Function description

The Demonstration Programme consists of the original MoMAS filtering, control and optimising software and a simulation model. It shows some of the features offered by MoMAS. The default settings correspond to values obtained by experience and is representative for a medium capacity extruder. The displayed functions, display form and default settings can be modified as desired in the original programme, but not however, in the demonstration programme. The programmenu gives an overview of the various settings which can be selected. Also these cannot be altered in the demonstration programme.

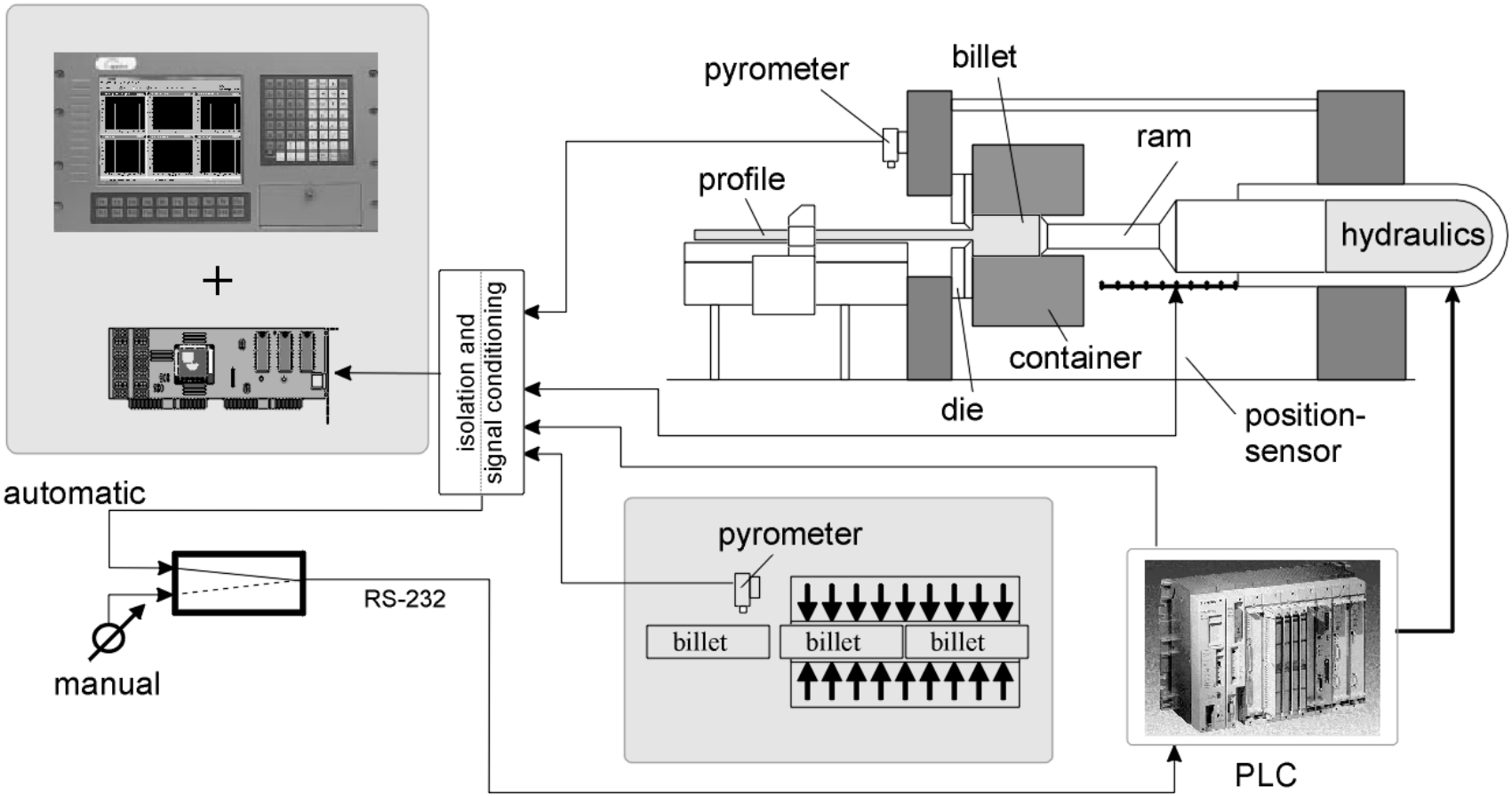
The extruder itself is substituted by the simulation model.

The programme is started by pressing the key F1. The default value of the initial ram velocity can be altered. The simulation run is started by pressing the key O.K. The cycles are run automatically and the runs of the process variables "Ram Speed", "Profile Temperature" und "measured Billet Temperature" displayed. After the set exit temperaure is reached, the billet temperature is sunk by 5°C and the simulation continued. The state of the programme is displayed in the top right hand corner. Also shown in the display are the history of the extrusion times, idle times and the mean and standard deviation of the exit temperature over the previous cycles. At the left lower corner these values are displayed in figure for the current cycle.

The simulation is finished after fifteen cycles. It can be interrupted by pressing the key F1. The programme is stopped by pressing F10.

Industrial-PC with OILEX-Software
and measurement-card

extruder



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