MoMAS®

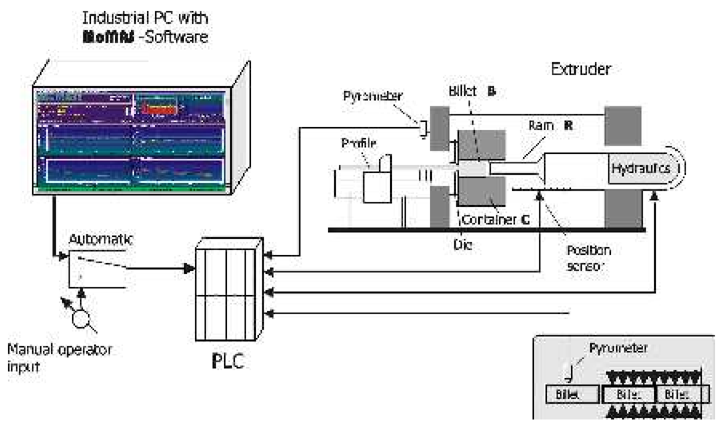
Modular Measurement and Automation System for Extruders

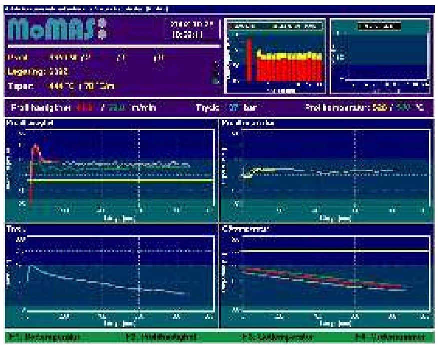
MoMAS® and what it can do for an extruder

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. **MoMAS®** consists of measurement and control sub-systems which serve to achieve tight control of crucial variables such as extrusion rate and exit temperature.

MoMAS® offers operators and managers of extrusion plants a flexible and effective tool which can be employed to achieve various optimisation and automation goals. The operator can himself select the degree of autonomy with which **MoMAS®** operates. He can even operate the extruder manually and yet 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 crew.

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.





Display for operaor

Layout of extruder installation equipped with **MoMAS®**

MoMAS® installations hitherto

3 presses in Germany (SAPA , ALCAN and Research Centre for Extrusions, Berlin)
1 press in Sweden (SAPA)
2 presses in Italy (ALEX and COMETAL)
2 presses in USA (SAPA)
4 presses in Australia (CAPRAL)
2 presses in Russia.

Production statistics in 6 months in an industrial press comprising 50 000 extrusions showed that the mean extrusion rate with ***MoMAS®*** *is 6% higher than without.*

The functions of **MoMAS**®

MoMAS® 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 cycles.
MoMAS® calculates the optimal input functions for iso-thermal extrusion employing measured and input data and displays these at the start of each cycle. The operator can select the run of the inputs proposed by **MoMAS**® or modify it.
Alternatively he can switch on the fully automatic mode of operation. A direct on- line control can be superimposed during the extrusion.
MoMAS® offers a data base in which all process data including best recipes can be stored and retrieved. This includes the actual runs of extrusion rate and billet and profile tempera-ture for every extruded profile, besides the best values of process parameters corresponding to the shortest extrusion time for every order or die.
MoMAS® is provided with a language module which enables the language of display and dialog at the operator console to be set by selecting the appropriate language.

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 iterative learning 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.

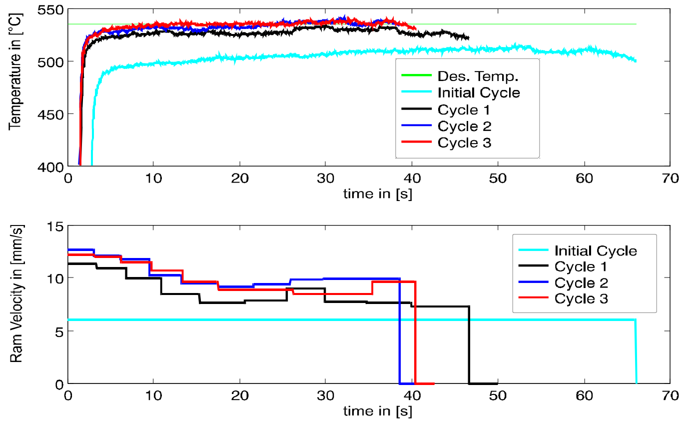
Choice of control input and modes of operation of **MoMAS**®

Following control inputs and operation modes can be selected

1. *Ram velocity as control input*
   - A billet temperature run is given as reference input to the furnace manually.
   - The billet temperature is measured before loading the billet into the container. The optimal ram velocity is calculated using the measured billet temperature and given as input to the velocity loop in PLC.
   - The extrusion cycle is run.
2. *Ram velocity as control input with successive lowering of billet temperature*
   - Extrusions are performed as above 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.
3. *Billet temperature as control input*
   - 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 measured billet temperature and given as input to the velocity loop in PLC.

Additional features

All the process data is stored and can be archived and retrieved, e.g. over a LAN. The data can be exported in ASCII format and can be used in any programme (e.g. Excel, MS Word etc.)



Runs of profile temperature and ram speed over cycles retrieved from the **MoMAS** *Data base*

Features of **MoMAS**® which contribute to its success in industrial installations

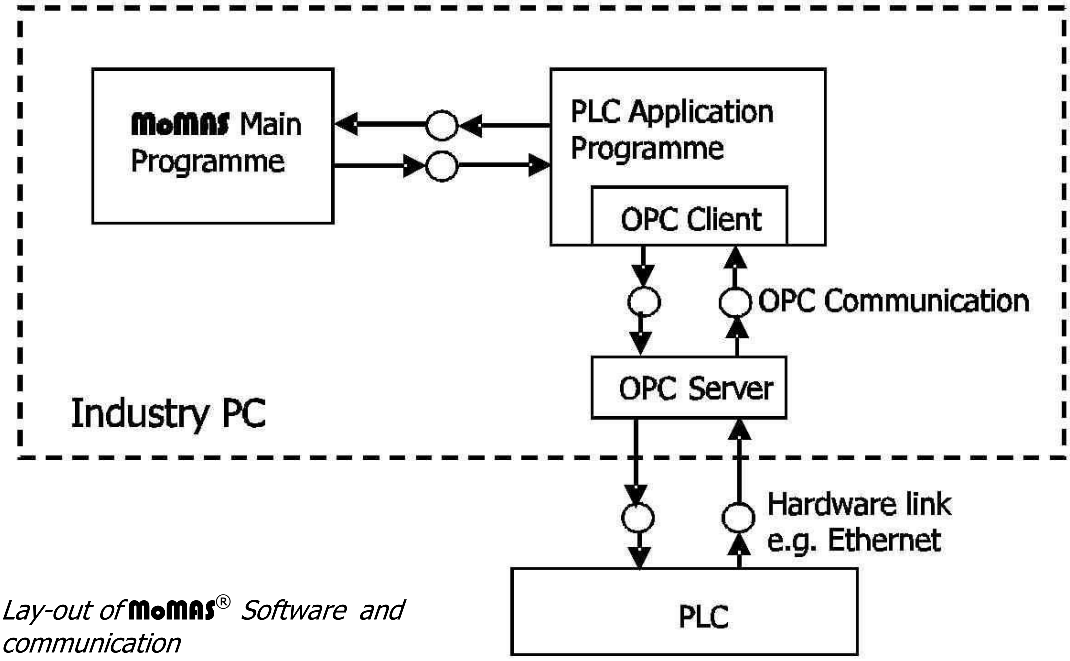
- Ease of using the system by the operator for process and control and monitoring
- The PLC - software part is open; it can be easily adapted to the PLC by plant crew
- The communication between extruder PLC and **MoMAS**® PC is simplified by using OPC
- An easy - to - use and - access data base with simple connectivity
- Changes in PLC system or data base system can be effected easily by plant crew
- No additional hardware apart from an Industry PC and temperature sensors necessary
- Language in operator monitor can be changed simply

Pre-requisites for Installation of **MoMAS**®

- Control and communication
  - The PLC controlling the extruder should have adequate reserve for handling data transfer with **MoMAS**® computer
  - OPC Server for PLC for data communication
  - Ethernet link
- Process variables and handshake signals which should be made available at the PLC and transmitted with OPC
  - Profile exit temperature
  - Billet temperature
  - Pressure in hydraulic cylinder
  - Position of ram
  - elapsed time
  - handshake signals concerning state of extrusion
- Prerequisites for exploiting the full optimising potential of
  - Ram velocity control
  - Billet temperature control
  - Taper furnace

Hardware and software components of **MoMAS**®

- Industrial-PC (Operating system: Microsoft Windows XP) for use in the shop floor
  - Touch screen or keyboard
- **MoMAS**® software
- Communication link; e.g. Ethernet and OPC



Lay-out of **MoMAS**® *Software and communication*

Work necessary for installation and commissioning of **MoMAS**®

- Connecting PLC to industry PC
- Programming PLC to relay sensor and hand shake signals and receive optimised inputs via Ethernet / OPC etc.
- Running in **MoMAS**®, briefing and training of operation crew

Contact address

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The Checklist is to summarise relevant data required for installation of **MoMAS**®
Mail or fax to:

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MoMAS® The Modular Measurement and Automation System for Extruders

- **Check List** (Information to be provided by the extruder crew) –

I Extruder, Furnace, Puller

Project: ....
Firm: ....
Place: .... Date:.........................
Product types ....

No. of shifts / per week .... *Annual tonnage ....*

No. of extrusions per die change .... (typical)
Percent of extrusion cycle during which pressure is at its upper limit .... (typical)

Extruder: *Manufacturer and year of installation........................*

Type:	direct / indirect	Extrusion force:	.... tonnes
Alloy:		Hydraulic control/actuation:	....
Block length:	.... mm	Control electronics:	Relay / PLC Type: ....
Block-Ø:	.... mm	Velocity control:	Yes / no
Extrusion time / billet	.... s (typical)	Idle time between extrusion cycles	.... s (typical)

Variable which is controlled and which the operator gives as input	*Ram speed*	*Oil flow*	*Valve position* ....

Billet furnace:

Type: Gas / Oil/ Induction

Taper heating: yes / no No. of zones ....

Puller: Details of puller and control of puller motion: ....
....

II Process variables and sensors

Sensors available and sensor signals which can be tapped at PLC:

Variable	*Sensor installed: yes / no;* *Sensor type*	*Signal at PLC*
Extrusion speed (Ram velocity)		
Ram position		
Profile exit temperature		
Hydraulic pressure		
Billet temperature		
Container temperature		

III Programmable Logic Control (PLC)

Make, Type and Date of installation of PLC ....

....

OPC available ☐ yes ☐ no

Availability of links between PC – PLC (e.g. ETHERNET) ....

Provision to access process parameters and batch data from PLC ☐ yes ☐ no

IV Data Base (if in use) ....

Contact person for PLC:

Name... Designation/Position ....

Tel. No. .... Telefax...

Email..

Contact person for project:

Name... Designation/Position ....

Tel. No. .... Telefax..

Email..

Date................................ Signature..

V General Prerequisites

Commercial viability

Item	*Yes / no*
Is the extruder plant working at its full capacity ?	
Is there a demand for increased product output?	
Is a new market sector being envisaged?	
Is a customer to be catered to, who asks for proof of the ranges of process parameters which have been adhered to during production?	

Technical feasibility

Item	*Yes / no*
Are the hydraulics and ram position / speed control adequate? [1]	
Is the billet furnace temperature control in order? [2]	
Is the puller control adequate? [3]	
Is the PLC capable of handling the data traffic to the PC? Is an OPC server available for the data transfer? [4]	

[1] Modern extruders are equipped with PLCs and velocity control. Best performance is obtained if the ram speed is controlled and the profile speed just displayed. Profile speed display is necessary, because operators almost always observe and adjust the profile speed. Some extruders have profile speed control. This is not suited for operating the extruder with varying speed required for iso-thermal extrusion. Iso-thermal extrusion demands a speed which generally varies with the ram position. Check whether the actual ram speed follows changes of the set point with negligible error, if the set point is varied during an extrusion cycle.

[2] For a constant reference input to the billet temperature control loop, the billets coming out of the furnace should have the same temperature after the steady state has been reached. If the reference input is changed, a few bars pass before the new steady state is reached, i.e. before the bars have the temperature equal to the reference input temperature. The transition should not comprise more than 2 or 3 billets.

[3] When the ram speed changes with the reference input, the puller motion control should be adequate so that the profile speed varies correspondingly.

[4] This is a vital requirement. MoMAS receives measurement data sent by the PLC during extrusion and the process data and the measured billet temperature during the idle time between 2 cycles. It transmits the optimised data (reference inputs for the billet temperature control and ram speed) to the PLC also during idle times between two cycles.

Expertise of and acceptance by the crew

Item	*Yes / no*
Installation and maintenance [1] Is expertise in PLC programming available ?	
Process engineering [2] Are the services of such a process engineer available, who can specify the extrusion parameters / ranges/ limits of extrusion parameters ?	
Enthusiasm of the operating crew [3] Is the crew enthusiastic and open to new ideas ?	

[1] *Installation and maintenance*
MoMAS depicts an open system whose functions can be integrated into the overall working of

the plant data processing system to gain maximum advantage. In order to exploit the capabilities fully, technicians capable of programming the PLC and configure the data transfer and PLC set-up to operate in concert with the plant data base would be very useful.
Is such expertise available?

2 *Process engineering*

MoMAS helps operate the extruder under prescribed conditions, viz. limits of process parameters. In order to exercise this possibility, the expertise of a process engineer is needed who can prescribe the limits and / or evaluate the data acquired and supplied by MoMAS to find the optimal parameters and limits. Underlying this expertise is the knowledge of the relationship between material parameters such as Young´s modulus, hardness, tensile strength etc. on the one hand and the process parameters such as billet temperature, extrusion speed, profile temperature etc. on the other.
Are the services of such a process engineer available, who can specify the extrusion parameters / ranges/ limits of extrusion parameters to the operators and interact with the process?

3 *Enthusiasm of crew*

The success of any system which is added to the extruder depends upon the will of the operator to make it work and his competence. Is the crew capable of operating a new system and does it have the spirit to exploit the capabilities of the new system. Would it have difficulty to look at both temperature and speed instead of concentrating only on the speed?