THICKNESS CONTROL IN SHEET EXTRUSION

SBI Produktion techn. Anlagen GmbH & CO KG
HARDWARE / Components in extrusion lines

Thickness gauge

Software

Controlling components

Automatic system
HARDWARE / Overview

Standard solution

Customer solutions
Controlling Hardware

- **Solid State Relays**
  - 1 piece for each die bolt
  - Divided into groups of 8 die bolts

- **Protection for each group of 8 (fuse)**
  - Shut down in case of a fault
  - Fuse monitoring for fault insertion
PLC Components

- Dedicated CPU
  - Controlling software
  - Communication to the thickness gauge via TCP/IP

- Digital output modules
  - For controlling the individual relays
  - Signal exchange with the extrusion line (e.g. control on, …)

- Digital input modules
  - Monitoring the group fusing
  - Signal exchange with the extrusion line (e.g. die ready, …)
The image shows a software interface with various charts and data tables. The interface is likely used for analyzing and controlling roll changes and product parameters in a manufacturing or industrial setting.

### Chart Details
- **Title:** Software Interface
- **Date:** 11:44:47
- **User:** fstempler
- **Level:** 255

### Chart Description
- The upper chart displays a profile with measurements in millimeters. The values range from 215 to 265 mm, with a peak at 1424.4 mm.
- The lower chart shows a more detailed profile with varied measurements across different positions.

### Data Table
- **Bolt Number** | **Set Value Bolt [μm]** | **Act Value Bolt [μm]** | **Delta [μm]** | **Control Value Bolt [%]** | **Engine Bolt [%]**
- 1 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 2 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 3 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 4 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 5 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 6 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 7 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 8 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 9 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 10 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 11 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 12 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1
- 13 | 233.1 | 233.1 | 0.0 | 44.6 | 46.1

### Additional Data
- **Actual Measure:** 0.000 [μm]
- **Average:** 233.100 [μm]
- **2 Sigma:** 5.30 [μm]
- **Net Width:** 1300.0 [mm]
- **Tolerance:** 10.0 [μm]
- **Set Value:** 240.0 [μm]
- **20.0 [μm]
SOFTWARE / Flow Chart

Thickness Gauge
(measure the profile of the sheet)

auto die system

Control PLC

Controlling hardware

TCP/IP

230V/AC

+ 24 DC
To be able to regulate the die lip in + and - direction at all, the die bolts must be **preheated**.

- adjustable preheating level
- automatically or manually preheating

**After preheating:** Manual centering of the die lip.
The **control interval** is the time required for the cross profile control unit to compare the set-profile against the actual profile and then send a new correcting variable to the controller.

Correcting variable calculation:

**Next correcting variable** = 
Sheet runtime between die and thickness gauge + Time for 1 measurement

Sheet runtime:

- Line Speed *(Measured with the measuring roller of the thickness gauge)*
- Distance between extrusion die and thickness gauge *(needs to be measured once during start-up)*
SBI is using a 3-step PID Controller:

- Actuating variable $>\ max.\ threshold$
  - Large correcting variable
- Actuating variable $\leq max.\ threshold \lor \geq min.\ threshold$
  - average correcting variable
- Actuating variable $< min.\ threshold$
  - smaller correcting variable

Actuating variable: deviation (offset) between real- and set- thickness
SOFTWARE / Controller settings

- 3 zone PID parameter
- Special parameter for edge bolts
- Adjustable deadband
- xw- controller

Special controlling mode to keep the area of the lip gap constant.
SOFTWARE / die bolt settings

- number of bolts for symmetric/asymmetric deckling
- adjustable heating power for closed bolts

Manual settings for die bolts in border area
Average thickness - set profile for controller

heating profile of the die bolts

thickness profile divided into die bolts
SOFTWARE / Conrolling modes

- control automatic  →  cross profile control is in automatic mode
- control hold value  →  freezing the last heating profile
- control manual value  →  set all die bolts to adjustable heating value
- control open die  →  open the die lip (e.g. cleaning the die lip,..)

Adjustable preheating level
SOFTWARE / Adjustable Thickness Profile

Thickness profile
- correction of average

Thickness correction for 1 bolt

Thickness correction for a range of bolts
SOFTWARE / Adjustable Thickness Profile

[Image of a software interface with data analysis and charts indicating thickness measurements and profiles.]