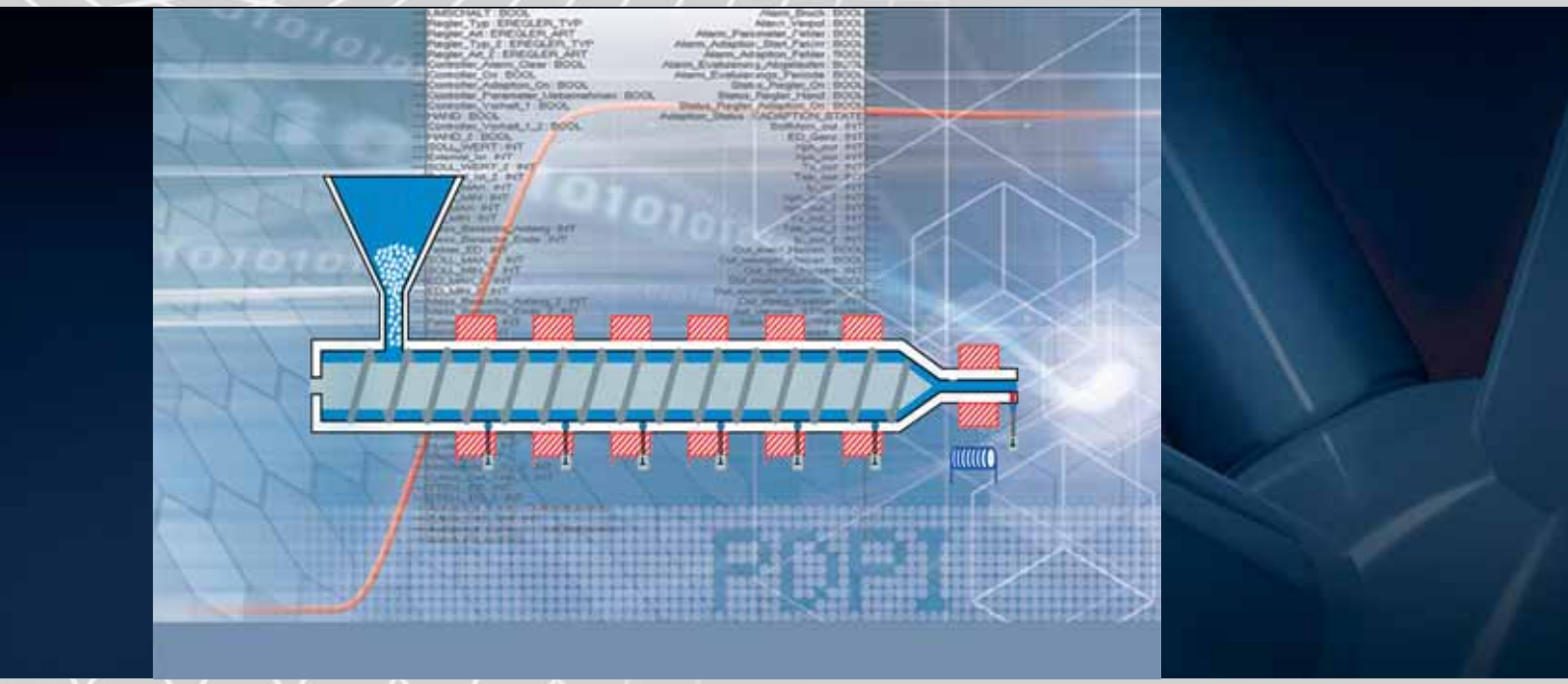
GOSSEN METRAWATT

Safety through Competence

# Special Edition




## PDPI - Algorithm for Induction Heating Systems

# In-House Developed PDPI Algorithm for Induction Heating Systems Helps Reduce Energy costs

**Energy costs continue to rise in 2009.**

verivox | 19 Dec. 2008
Heidelberg – There's **no end to the wave of energy price increases**. From a total of 920 German electrical power suppliers, 504 have already announced price increases. 99% of these will increase their prices by an average of 8.1% during the first quarter of 2009.

SPIEGEL ONLINE Economy Page | 19 August 2008
**Energy as a luxury article**: According to the German Federal Office of Statistics, costs for heating and electricity in Germany have increased by more than 55% since 2002 – and they continue to rise. Consumer protection agencies are now demanding an examination of the electric utilities' pricing policies.

Over the years, demands placed upon injection molding and extrusion technologies have become increasingly strict. Requirements for increasingly flexible and productive machines and systems at lower prices represent a more and more demanding challenge for control technology. Control systems have to complete more and more tasks in extremely short periods of time, and regulating systems must settle in at a value as quickly as possible, and keep it steady.

Due to rising energy costs, reduced energy consumption has also become an important issue for keeping manufacturing costs as low as possible. Excerpts from the trade journals document this trend.

For example, thanks to the use of electrical machines, energy efficiency has been significantly improved in the field of injection molding. In the meantime, this technology has established itself within the market. An additional concern is the loss of heat energy from the heater bands due to physical characteristics (low barrel heating efficiency).

### New Technology: Induction Heating Systems

Amongst other advantages, a new technology for contactless induction promises to reduce energy costs by means of:

- Faster warm-up
- Reduced heat loss

### Accurate Temperature Control

Where plastics processing machinery is concerned, special attention is allotted to temperature control, and the hardware and software required to this end can be incorporated into the existing control system either centrally, or in a decentralized fashion. Temperature is one of the most frequently measured physical quantities. Nevertheless, precise temperature measurement and control are two of the most difficult tasks in the fields of process and automation technology, because their characteristics have a direct influence on quality, quantity, process reliability and unit costs of the finished manufactured product. The acquisition and quick correction of many temperatures is thus a special challenge for all demanding applications.

With its in-house developed, dead-beat PDPI algorithm and an adaptation procedure for ascertaining the control parameters, Gossen Metrawatt provides users with an instrument which meets the demands of the new technology.

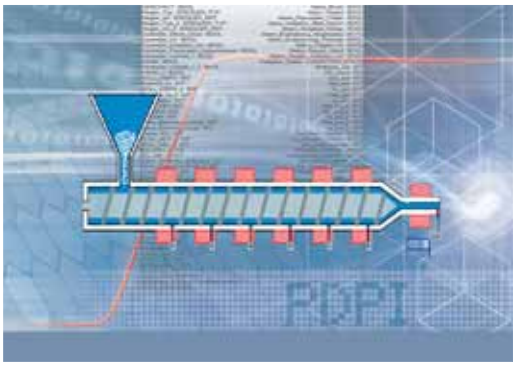



Figure 1: Schematic Representation – Extruder Heat Zones

### Controller Requirements

- Shortest possible settling time:
  During start-up, the heater must run at full power for as long as possible in order to keep settling time short.

- No overshooting:
  When setpoints are changed, above all when settling in, the actual temperature must not exceed the setpoint, because the material would otherwise be damaged.
- Fastest possible correction of disturbances:
  Starting and stopping the machine results in, for example, a considerable shift of the working point, which must not be permitted to result in temperature drops.
- No back-and-forth between heating and cooling for three-step zones:
  This type of energy waste can be prevented with the help of a dynamic dead band – without any occurrence of system deviation.

These requirements necessitate acute control which is not possible with a PID algorithm, but rather only with the **PDPI algorithm** which has proven its worth in the field of plastics processing machinery manufacturing over a period of years.

Figure 2: R2500 and R2700 Controller, Limiter, Programmer

## Optimization Requirements

- Self-tuning must *always* result in viable control parameters.
  The user is not bothered with time consuming adjusting rules.
- Self-tuning should not influence operation at all if possible:
  No overshooting allowed, as little time required as possible.
- It must be possible to start self-tuning at any time: No procedural rules, tolerant to user error.

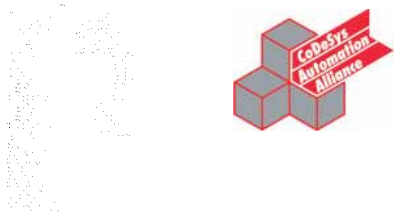


Figure 3: CoDeSys SOFTcontroller

These requirements are fulfilled by integrating self-tuning into the start-up process. The ascertainment of parameters doesn't actually begin until self-tuning detects that the control loop is closed due to a rise in temperature.

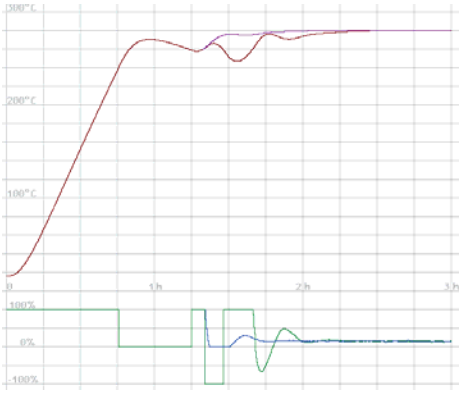


Figure 4: Two and Three-Step Self-Tuning

## Additional Requirements for Induction Heating Systems

As a result of direct induction of heat energy into the cylinder, delayed heat transfer between the heater band and the cylinder is eliminated. This means that the control loop has a significantly shorter delay time, and the controller has to react considerably faster.
Thanks to further development of Gossen Metrawatt's PDPI algorithm leading to shorter measuring and manipulating cycles, minimal delay time has been turned into an advantage resulting from faster arrival at the setpoint temperature and quicker correction of disturbances in the event of small system deviations.

Figure 5: R355, 4/8-Channel Controller Module for the Siemens S7-300 and VIPA's System 300 V/S

Michael Roick, Dr. Horst Hänel, Feb. 2009

GOSSEN METRAWATT

Safety through Competence

**GMC-I Messtechnik GmbH**
Südwestpark 15
D–90449 Nürnberg
Telefon: +49 911 8602-111
Telefax: +49 911 8602-777
E-Mail: info@gossenmetrawatt.com
www.gossenmetrawatt.com

Printed in Germany · Subject to Change without notice · 1/2.09 · Order no. 3-337-225-03