SENSORS & CONTROLS

Project Fact Sheet

INTELLIGENT EXTRUDER

BENEFITS

- Improvement of up to 2% in the first-pass yield of compounding processes
- An estimated $780 million per year savings in raw materials and processing costs in the U.S. compounding industry
- Savings of some 0.02 Quad Btu of total energy per year
- Waste reduction of about 80 tons of volatiles and 820,000 tons of solids every year
- Cost-efficient production of smaller lots of material, especially those made to order with short lead times (72 hours)

APPLICATIONS

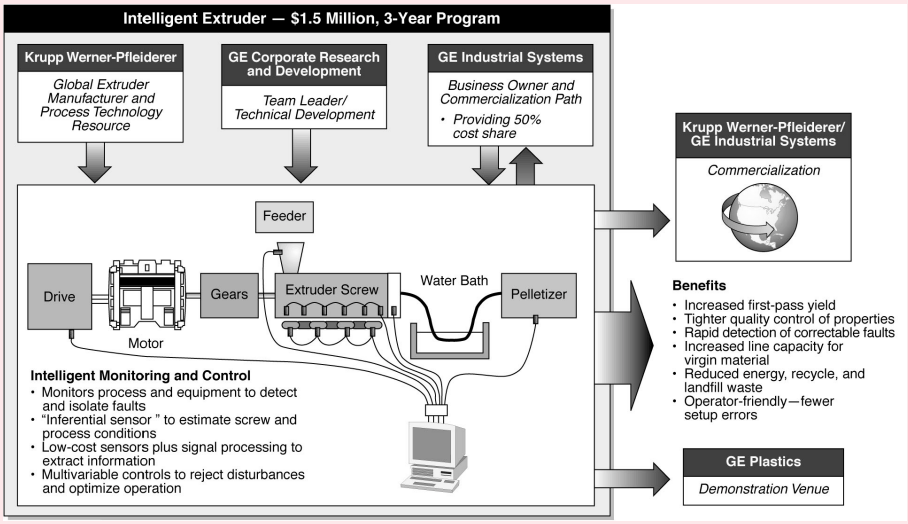
The intelligent extruder development effort targets the extruded and molded plastics industry for primary use. Additionally, the core modeling, analysis, and feature extraction tools developed under this project would be readily transportable across implementation platforms and beyond the extruded product industries. Potential applications include maximizing loading in carbon electrodes production for the aluminum industry, controlling the injection molding of the metalcasting operation, profiling stability during ceramic extrusion, and monitoring properties of wear and stability in the coal, wood, or waste gasifier feed.

INTELLIGENT EXTRUDER WILL PRODUCE COMPOUNDED MATERIAL RIGHT THE FIRST TIME AND EVERY TIME

The intelligent extruder system will use advanced diagnostic and control tools to reduce product variability and increase first-pass yield, while reducing energy use and waste generation in the compounding of polymer resin. During normal operation, inferential sensors and closed-loop process controls will be used to adjust key process parameters to obtain the right product quality when changes in material properties and/or extruder performance are detected. Currently, the present open-loop extrusion process has limited ways to compensate for raw material variability using process modifications.

The intelligent control of extruder operation is becoming critically important to increase the first-pass yield as the trend in the injecting molding industry moves toward narrowing acceptable quality limits on extruded polymer resins. The increase in first-pass yield of manufactured resins by the use of an intelligent extruder will produce savings in raw materials and processing costs, with associated reductions in waste, energy consumption, and environmental pollution.

INTELLIGENT EXTRUDER



The intelligent extruder system will reduce production variability, energy use, and offgrade waste stream generation.

Project Description

Goal: Develop and demonstrate at commercial production rates an intelligent extruder monitoring and control system that will reduce production variability, energy use, and offgrade waste stream generation.

This project will develop and implement three major aspects of machine intelligence in extruder systems for polymer processing:

(1) model-based process and equipment diagnostic software to detect problems in compounding line components before unacceptable material is produced,

(2) an inferential estimation system using a few vital variables from readily available extruder data to estimate material properties for use in continuous quality audits and process control, and

(3) closed-loop multivariable process control to keep process parameters within acceptable limits, despite incoming material variations and correctable process upsets.

Technologies for new product or retrofit applications of diagnostics, inferential estimation, and closed-loop control will be developed and demonstrated at interim milestones over the three-year course of development, culminating in commercial product and service offerings from a GE Industrial Systems / Werner-Pfleiderer partnership. System prototypes will be tested, going from a 30-mm (50 lb/hr) laboratory scale to 58-mm (500 lb/hr) pilot scale to 133-mm (>2,000 lb/hr) commercial production scale compounding line.

Progress and Milestones

This project was selected through the Sensors and Controls Program FY 1999 solicitation and was awarded in January 1999. Project tasks are scheduled for completion in 36 months. Key tasks that have been performed or are planned are:

- An initial scoping effort identified key technical barriers on a laboratory-scale compounding system.
- Testing and implementation of an extruder diagnostic system on the 30-mm platform with simple polymer blends was completed in June 2000. It will also be demonstrated on a production-scale 133-mm system.
- An inferential estimation system for polymer viscosity has been demonstrated on the 30-mm system, with 5-7% repeatable accuracy over a wide range of viscosity, comparable to capillary rheometry accuracy without the waste stream. A full production-scale demonstration on a 133-mm extruder at rates of 2,000 lb/hr will be completed at GE Plastics in Selkirk, NY.
- Control systems based on inferential sensing will be demonstrated on the same 30-mm and 133-mm extruder systems.
- An integrated platform combining diagnostics, estimation, and control will be demonstrated on a 133-mm (or other) production-scale extruder.
- The developed “intelligent” monitoring and control products and services will be offered for new and retrofit high-end twin screw compounding equipment by a commercial marketing partnership formed between GE Industrial Systems Services and Werner-Pfleiderer, initially targeting polymer products but with growth planned for other products through GE and Werner-Pfleiderer international market channels.

Project Partners

General Electric (Prime)
Corporate Research and Development
Niskayuna, NY

General Electric
Industrial Systems Solutions
Atlanta, GA

General Electric Plastics
Mount Vernon, IN

Krupp Werner-Pfleiderer Corporation
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