A horizontal research activity involving SMEs (Collective research) Part financed by the European Commission under the Sixth Framework programme

Innovative Polymer Flow Visualisation for Optimised Machine Design, Improved Mixing and Materials Properties, Process Efficiency and Energy Reductions

Summary

The Plastics Industry represents a major contributor to European wealth generating sales in excess of €160 billion. Plastic Extrusion is undoubtedly the most important processing technology representing 36% of all plastics consumed. The process design flexibility and complexity involved in mixing require a comprehensive understanding of the physical processes involved.

Twin-screw extrusion is recognised as a key knowledge-based technology. There is a fundamental lack of understanding of the relationships between machine design, total process operation, polymer flow and mixing behaviour. This gap in knowledge represents a major barrier to the advancement of twin-screw extrusion for knowledge-based processes.

The ***PEPT-Flow project*** will use Positron Emission Particle Tracking (PEPT), an innovative, non-invasive, flow visualisation technique to address this barrier. The project will also develop new knowledge-based machine design criteria and simulation software, thus contributing to the continued sustainability and competitiveness of the industry sectors concerned.

PEPT-FLOW

▲ *An industrial twin screw extruder*

The intermeshing, co-rotating screws are located in the barrel cavity. The screws are rotated by the motor and as material is introduced it is transported by the screws and mixed by a combination of dispersive, shear and extensional flow mechanisms.

Screw Design is a vital consideration and the modular design increases the complexity of the process.

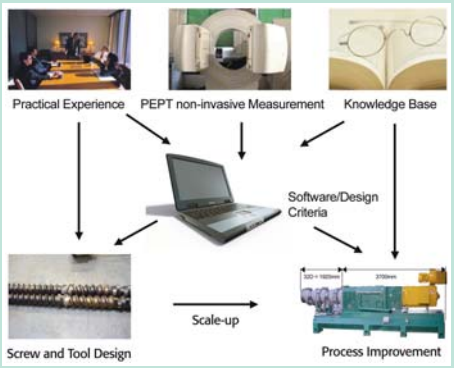
The threads can be tightly intermeshed or slightly apart. The screw usually has one flight but multiple flights are also possible. The pitch and angle of a spiral can be stipulated (or even reversed to promote backpressure). Kneading discs of stipulated length and width can be added or removed and the angle of stagger set between them. Added to this, specialist mixing elements can be introduced.

The Core Project Strategic Objectives

1) **Knowledge**: To undertake detailed quantitative and qualitative investigation of twin-screw extrusion and consider the influence of machine design, total process operation and specific polymer / additive systems.
2) **Design Criteria**: To define knowledge-based twin-screw extruder design criteria and guidance.
3) **Simulation Software**: To develop and validate accurate flow simulation software for twin-screw extrusion.
4) **Demonstration**: To demonstrate the new design criteria, simulation software and processing know-how within 5 commercial twin-screw processes.
5) **Transfer**: To achieve effective technology and knowledge transfer throughout the communities of European SMEs.

Methodology

PEPT-flow brings together a supply chain of SMEs to the plastics industry with researchers in the field, thus pooling existing understanding. The partners bring extensive practical knowledge of screw design and machine construction together with processing know-how and applications. A target trade and technical literature survey will also be carried out. In addition the project will develop new insights into the mixing process using the non-invasive PEPT. The results will be included in state of the art software models which can feed design criteria into machine construction and investigate industrial scale up. The role of the member organisations will be to disseminate this new knowledge base for the benefit of SMEs throughout the plastics supply chain across the EU. The resulting processing solutions to real world plastics problems can then be scaled to production applications.



▲ *Flow diagram for the Peptflow Project*

Tacit and implicit knowledge are combined with trade and technical literature and novel PEPT measurement to improve software tools for machine design.

Company/Organisation	Country
Research Organisation	
Smithers Rapra	UK
Fraunhofer ICT	Germany
University of Birmingham	UK
University of Eindhoven	Holland
Small/Medium sized Enterprise	
Rondol Technology	UK
Treffert	FR
Vamp Tech	IT
Extricom	DE
DGTec	FR
ICMA San Giorgio	IT
Centre for the Development of Plastic Applications	IT
IonPhasE	FI
Science Computer Consultants	FR
MAPEA	FR
RCT	IT
Membership organisation	
Milan Chamber of Commerce	Italy
British Plastics Federation	UK
Italian Plastics Machinery Manufacturers and Rubber Association	Italy
German Plastic Converters Association	Germany
Plastics Machinery, Manufacturers and Distributors Association	UK
Turkish Plastics Manufacturers Research, Development and Educational Foundation	Turkey

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