Planetary roller extruder (PRE)

Identification

Key words  Extrusion, planetary roller extruder, shear low extrusion
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How does it work?

Primary objective  Continuous production of products (e.g. ice cream, fats, meat products) with controlled temperature profile (esp. in cold area) and low shear forces acting on the product.
**Working principle**

Configuration of the planetary roller extruder (PRE) is based on a tempered jacket, rotating screws and an outlet die. Method of operation of the screws is special versus to traditional mono or twin screw extruders. Working principle can be compared to a planetary gear. There is a central screw, which is connected to the motor; the jacket is configured as an internal teethed pipe and in the gap between screw and jacket there are small screws called planets, which are loosely integrated. When the central screw starts to rotate, the planets also begin to rotate, this means they are rolling up the central screw. Result of this configuration and movement is that material is conveyed to the outlet die, drawn out in thin layers again and again and of course mixed very well.

![Diagram of PRE configuration](image1)

**Figure 1:** Configuration of a planetary roller extruder

Planets are made of metal or PEEK (polyether ether ketone)

To avoid direct contact between metal and metal planet are manufactured from special plastic material.

![Image of PRE with 3 modules and feeding zone](image2)

**Figure 2:** Design of planetary roller extruder with 3 modules and one feeding zone

PRE is built on single modules; the temperature of each module can be controlled independently. Between the modules stop rings are integrated, the gap between central screw and stop ring can be diversified by use of different rings. Configuration can be adapted to the product also by changing geometry and number of planets used in the modules. It is possible to control temperature and pressure of the system, to inject liquids and to degas the system. PRE is distinguished by a very shear sensitive way of processing, which allows presetting of a defined temperature profile also in the field of deep temperature extrusion down to -15 °C. (1, 2)

![Image of ice cream production using PRE](image3)

**Figure 3:** Planetary roller extruder for ice cream production

Images
**Additional effects**
- thin-layering the product
- most precise temperature control because of shear sensitive working principle which means no self heating
- big processing spectrum of different foods
- optimized self-cleaning
- modular construction (extruder is build up using singles modules represented in fig. 1)
- the sealing between process room and gear up to 70 bar, which allows dosing materials under pressure
- possibility to process liquids as powdery materials

**Important process parameters**
- temperature (monitored by sensors between each module and before outlet die)
- pressure (monitored by sensors between each module and before outlet die)
- rotation speed/shear rate
- additionally configuration
- screw profile and the profile

**Important product parameters**
- dry matter
- fat content
- abrasiveness

**What can it be used for?**

**Products**
- e.g. chocolate, ice cream or baby food like puree, shear sensitive products,
- products in the field of cold and deep temperature extrusion

**Operations**
- Structure forming

**Solutions for short comings**
- Crystallisation by controlled temperature profile an low shearing;
- Chopping and homogenizing of high viscous materials in cold temperature area, e.g. for meat batters

**What can it NOT be used for?**

**Products**
- Processing coarse and lumpy materials, pieces would be destroyed by processing
- Expanded products with needs to build up high pressure in the extruder.

**Operations**
- Production based on extrusion technology requires a lot of experience; a need of trained employee, trouper for running this very sensitive apparatus resp. process.
- High pressure extrusion without a gear pump.
- Standard treatment for different products, extrusion needs adaption of recipe, process and apparatus configuration.

**Other limitations**
- Investment cost of extruder

**Risks or hazards**
- Problems in processing dry, abrasive materials like e.g. lactose

**Implementation**

**Maturity**
- Lines in the capacity range from 10 – 10.000 kg/h are commercially available

**Modularity /Implementation**
- The continuous mode of working can be easily integrated into existing processes also in the field of “cold processes”

**Consumer aspects**
- Consumers perceive the technique as environmental friendly and are positive to naturalness of the product.

**Legal aspects**
- Planetary roller extruder is a relative new technology in the food industry, but there is no need for special certification.

**Environmental aspects**
- The extruder combines different devices and thus can work more effectively and save other equipment.
Facilities that might be interesting for you

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<th>Title</th>
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<td>BC 21, Nano 16- Extruder-HES-SO Valais-HEI</td>
<td>University of Applied Sciences and Arts Western Switzerland Valais</td>
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Further Information

**Institutes**
- DIL, Institut für Getreideverarbeitung GmbH

**Companies**
- Entex, battenfeld-cincinnati

**References**
Until now, there is no scientific literature available using this technology in the food industry.
