Advanced extrusion technologies for superior fish feed characteristics

Back pressure valve (FLEXTEX™) and Expansion Control System (ECS™) – Combining two unique process technologies for full feed controllability.

Extruding fish feed is primarily a matter of cooking the starch. The better starch cook, the better feed quality. However, it is equally important to control the expansion of the feed and thus influencing the density which determines the sinking and the floating properties.

Screw configuration for optimum cook

By making a specific screw configuration on the extruder, it is possible (to a certain extent) to supply the specific mechanical energy (SME) necessary to produce a given product with an optimum degree of cook. The degree of cook is decided from both a nutritional as well as a physical product quality point of view.

The physical quality of fish feed product can be defined by:

- Density
- Shape and size
- Uniformity
- Durability
- Water stability

The nutritional quality of fish feed can be defined as:

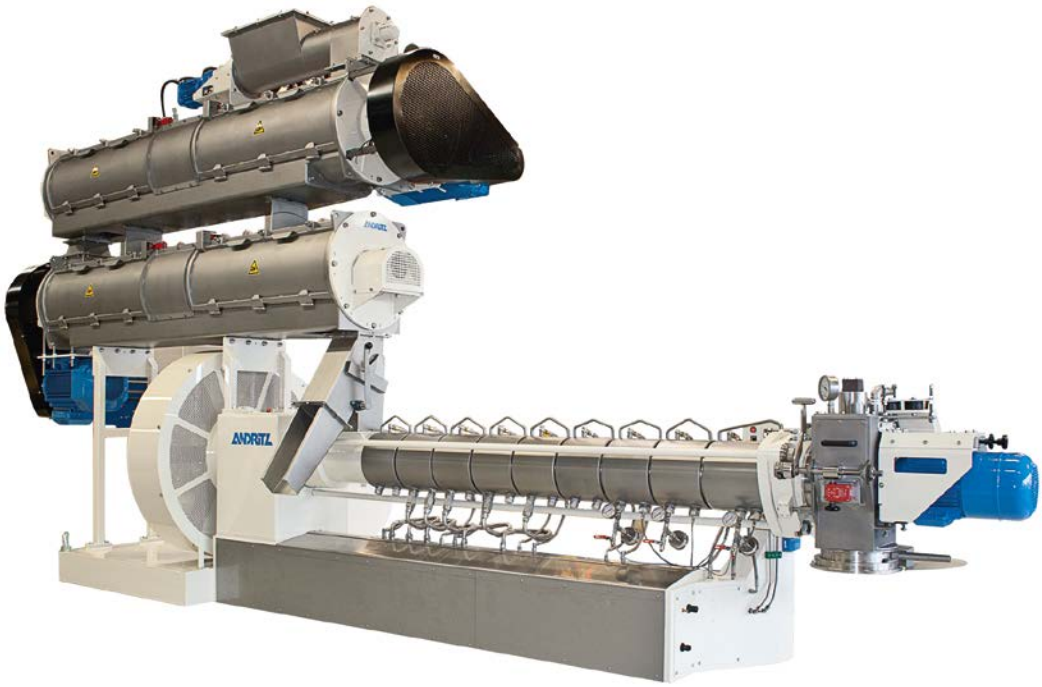
- Recovery of essential amino acids and specific vitamins
- Digestibility

On most newer extruder designs, an optimum screw configuration can be established in order to apply the SME quantity necessary for matching a specific product (for example salmon or trout feed) with a high content of fat/oil, internal oil or similar products with high nutritional value. A screw configuration can be optimized to apply more SME by implementing the following components:

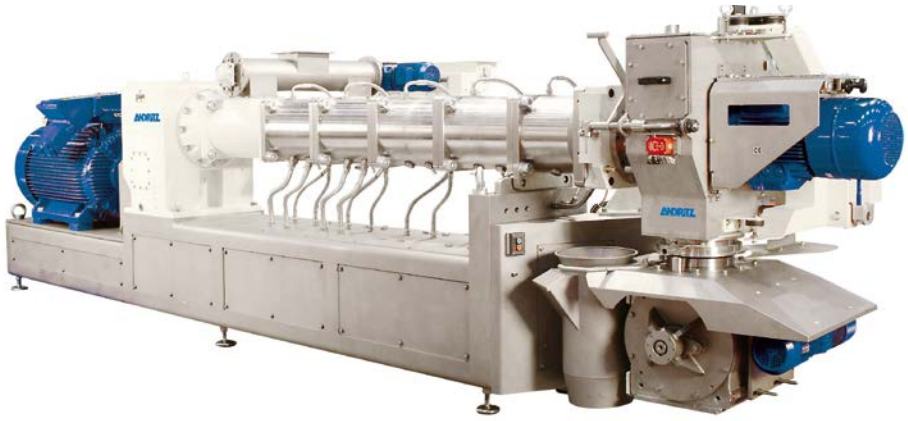
- Screw design and geometry
- Shear locks
- Kneading blocks
- Reverse elements

An optimum screw configuration is not always capable of applying sufficient SME to produce a given product. Often it is also necessary to optimize other parameters that can be used to increase the SME supply in the extruder:

- Screw speed
- Open area of venturi die
- Open area of die plate
- Extruder capacity



ANDRITZ extruder EX1021. Capacity: 2-12 tph



ANDRITZ extruder EX1250. Capacity: 10-12 tph

The ANDRITZ FLEXTEX system – reduced downtime and optimum production flexibility

Changes in screw configuration and other measures that contribute with either higher or lower SME values are all operations that usually result in down time and increased production costs. These changeover procedures can easily take up to 0.5 - 2 hours to adapt. Therefore, technological advances focusing on both cost savings in the form of reduced down time as well as optimal flexibility in terms of capacity and quality are in high demand by the aquaculture industry.

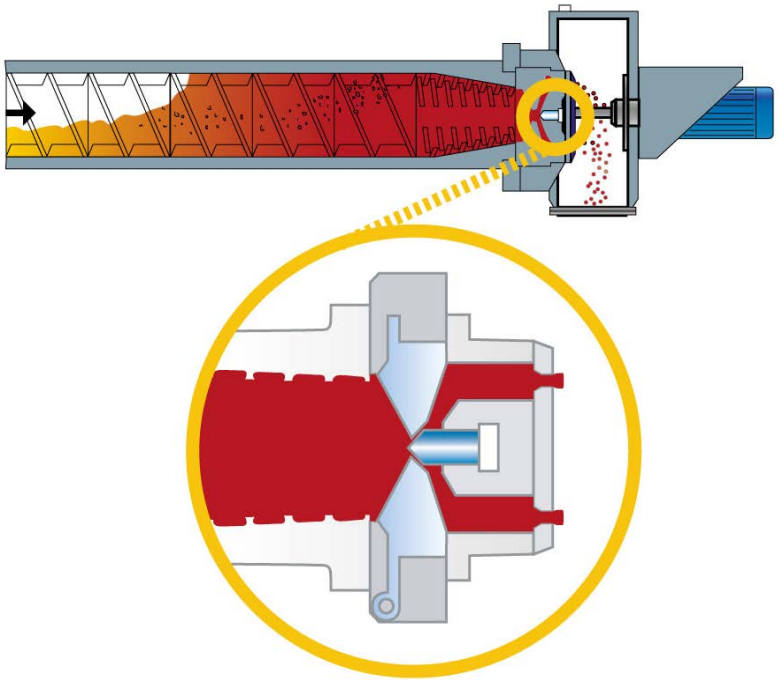
The FLEXTEX working principle

The FLEXTEX system is able to continuously control the SME applied in the extruder during operation without changing the extruder configuration or other parameters. By changing only this one parameter, it will have the following advantages in the production of fish feed:

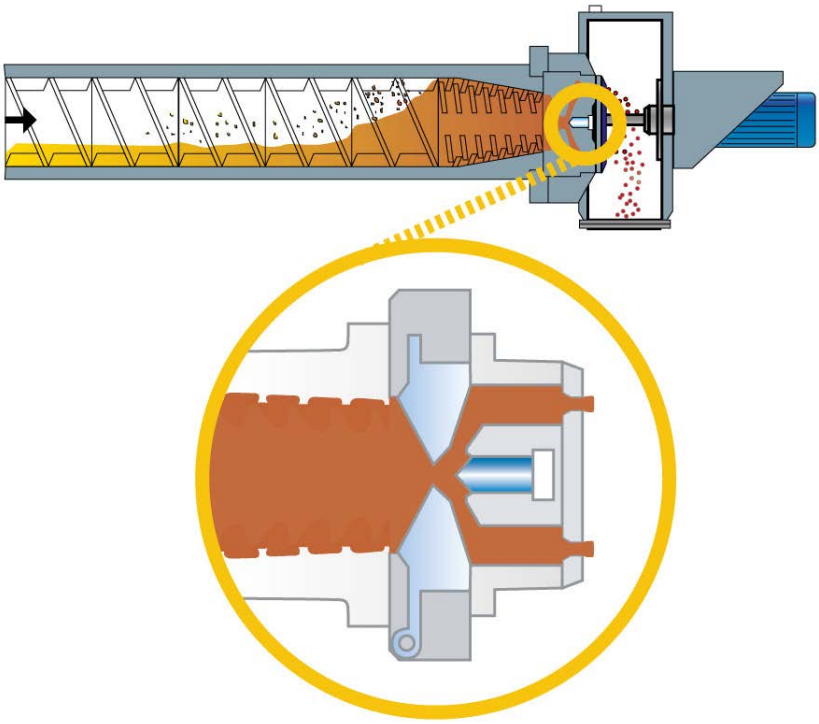
- The starch cook (up to 100%) is completely controlled during operation
- The bulk density of the product can be reduced by up to 30% and can be controlled with an accuracy of ±5 g/l (0.3 lbs/ft^3)
- Higher addition of oil and less starch in the formula without significant influence to bulk density and product quality

The system adjusts the opening area in the venturi die plate, which is placed between the last screw and the die plate in the extruder. The venturi die is used in many extruders in a stationary design to decrease or increase the kneading zone in the extruder in order to control the SME applied. This is done by adjusting the size of the hole and thus the opening area and the pressure against it. Smaller holes increase the pressure and thus more energy consumption from the main motor. With the FLEXTEX system the opening area of the venturi die can typically be adjusted from 3000 mm^2 to 100 mm^2 (4.65 to 0.15 in^2) depending on throughput.

With the FLEXTEX system, the extruder operator can determine how much specific mechanical energy (SME) the product needs. From a control system, for example a separate control or alternatively a control integrated in the extruder control, the operator can make a set-point for example kW/ton (HP/ton) dry matter. By means of a hydraulically controlled piston, the FLEXTEX system automatically adjusts in relation to the set-point by decreasing or increasing restriction of the venturi die by moving a piston.



FLEXTEX in neutral position – no additional SME applied



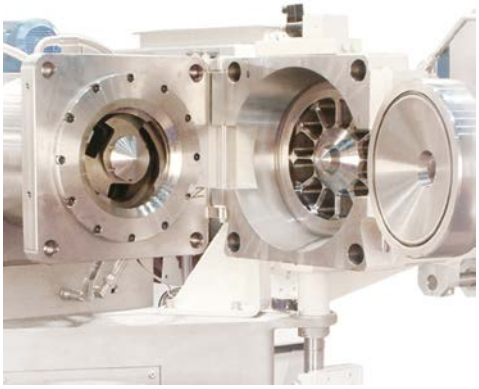
FLEXTEX in closed position – additional SME applied

The mechanical design

The FLEXTEX system consists of 3 parts:

1. The PLC control system
2. The venturi die and the piston system
3. The hydraulic station

The FLEXTEX system is designed with focus on simplicity and consists of a few components. However, the critical part of the system is the piston which, besides from being used as a restriction for the meal flow, also distributes the meal to the die plate. When restricting the meal flow, it is essential that this takes place synchronically in order not to hinder the flow ability. Changes in the meal flow will influence the visual quality of the product due to an uneven pressure at the die plate. The piston in the FLEXTEX system is moved axially and at the same time it is conical, so that the meal flow is not negatively influenced.



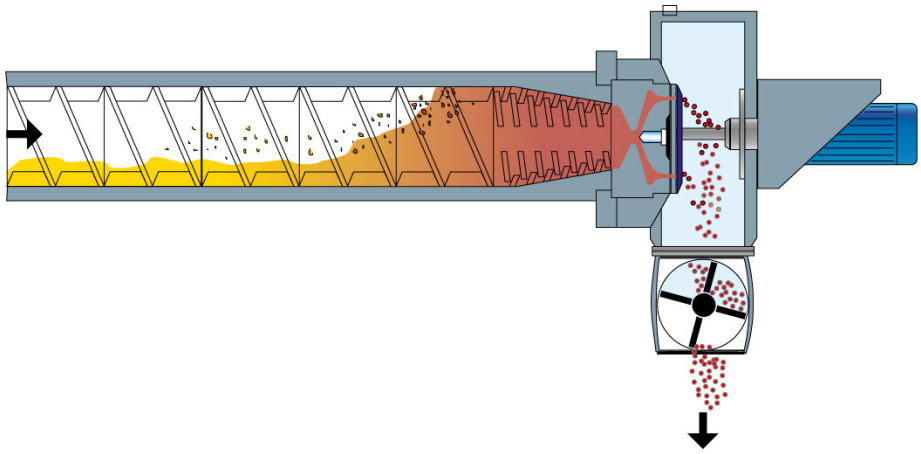
Extruder with FLEXTEX installed

The ANDRITZ Expansion Control System (ECS) – for increased bulk density

To be able to control the bulk density of products in a wide range and at the same time obtain an optimum product quality, the ANDRITZ Expansion Control System (ECS) is unique. The ECS concept is based on controlling the expansion in the extruder knife house without influencing the product quality. Thus all desirable parameters can be used in the extruder without regard to expansion. The main focus here is product quality.

Extruder with ECS installed

By adding compressed air in the knife house, it is possible to control and adjust the pressure. This is made possible by mounting an airlock under the knife house (see figure below). An increased pressure in the knife house results in a reduction of flash-off and thus an increase of bulk density (less expansion). Higher overpressure, higher density (less expansion).



FLEXTEX and ECS

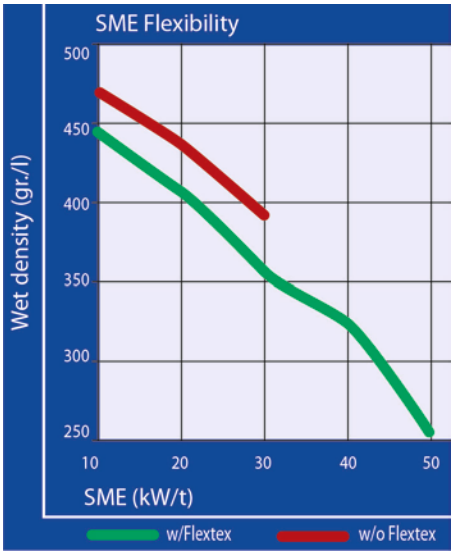
Documented results from the FLEXTEX and ECS systems

The FLEXTEX and the ECS systems can be installed individually or as a combined concept. This is simply a question of each producer's requirements for their production. Documented tests supported by experience from systems in full scale operations have shown significant advantages when using the

ANDRITZ FLEXTEX and ECS system. During a series of tests with a shrimp feed formula (70% protein), below tests were conducted.

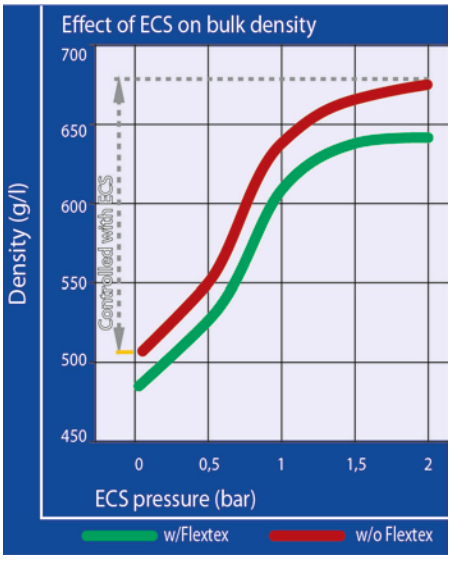
Test A: FLEXTEX effect on starch cook

By increasing the SME in the extrusion process by approximately 12%, the cook rate was increased by 11.8%.



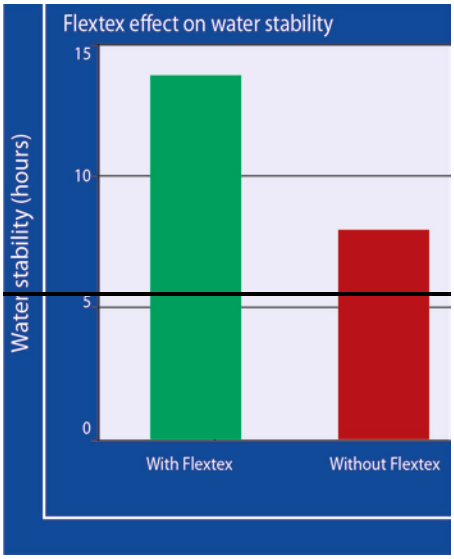
Test B: ECS effect on bulk density

The ECS can increase the bulk density by 25% by adjusting the pressure in the knife house only.



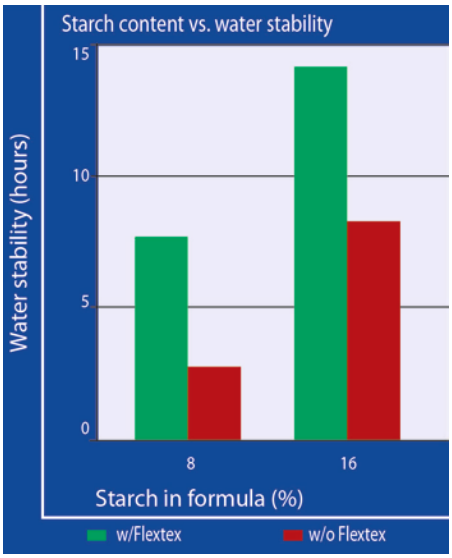
Test C: FLEXTEX effect on water stability

By increasing the SME it was possible to increase the water stability by additionally 6 hours.



Test D: Reduced starch contents in formula by means of FLEXTEX

By reducing the starch contents by approximately 50%, equal water stability (8 hours) could be obtained as with original high starch formula, but without FLEXTEX (8 hours).



Summary

The FLEXTEX and ECS system provides significant flexibility in the production of feed for all fish species. By continuously controlling the SME during operation, it is possible to achieve an optimum physical quality. At the same by using the ECS to control the density, two unique tools for controlling finish product characteristics are present. The advantages of the systems can be summarized into:

- Increase starch cook by 10-15%
- Decrease bulk density by 20-30%
- Increase bulk density by 0-5%
- No change of screw configuration which means reduced down time
- Only two parameters needed for controlling starch cook, reduced and increased bulk density