

## Soybean processing systems



Little is known about professional soybean processing technology in Europe. This document describes them by referring to farms or enterprises in Germany and Austria. Through an assessment of advantages and disadvantages, the brochure provides guidance for practitioners including farmers and advisors, with relevance for conventional and organic farming.

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Only the contact information for the companies were updated.

## I. Thermal processing systems

### I.1 Dantoaster 20/6000 feed processor from Cimbria

The feed processor "Dantoaster" from Cimbria is a machine for thermal treatment of soybeans and other crops. The machine was developed in Denmark specifically to heat treat feeds for easy digestibility. The Dantoaster continuously produces uniformly roasted soybeans in a continuous process. In Germany, the Dantoaster is used on the Gerauer farm in Bavaria.

#### Functionality

Toasting is based on the H.T.S.T. (High Temperature Short Time) principle. The four main elements of the Dantoaster are the combustion chamber, the drum, the extractor housing and the stand. The soybeans are heated by infrared rays and by the heat of the combustion gases passing through the drum.

A gas burner with a firing capacity of 970 kW is installed in the front part of the rotating column. The gas flame heats with a temperature of approx. 900°C, a special ceramic wool with which the combustion chamber is lined. The ceramic wool is vibrated by this energy input and emits intensive infrared radiation mainly vertically into the drum's centre. The soybeans are then fed vertically from above over a guiding plate into the border area between the end piece of the burner chamber and the drum's beginning. On entering the drum, the beans are protected by a guard plate from the direct heat of the gas flame. The length of time spent in the front part of the drum with relatively high heat exposure is only approx. 40 seconds, while the total time spent in the "Dantoaster" is about four minutes.

The drum, which is equipped with shovel-like elements, is rotated by a 7.5 kW motor and its inclination can be varied. The length of time the soybeans spend in the drum is thus determined on the one hand by the drum

speed and on the other hand by the inclination of the drum.

The aim of adjusting the drum speed is to ensure that the beans are evenly distributed in the rotating drum with a layer of soybeans about ten centimetres high on the inside of the drum.

In order to avoid protein damage in the beans due to uncontrolled and excessively long exposure to heat, after the actual roasting process, the product, which can be as hot as 110°C, must be cooled to below 20°C after the toasting process. Mr Gerauer's plant is operated with natural gas since a natural gas connection is already available on the farm. However, the system could also be fired with fuel oil.

#### Advantages

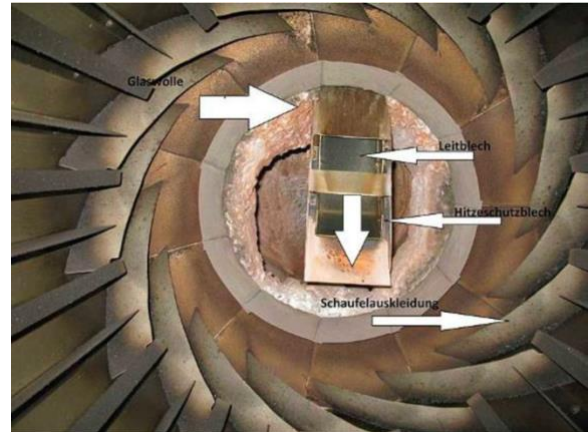
- Compact, uniform system
- High volume output
- Moist soybeans can be processed directly after harvest without drying
- Low-maintenance technology (ceramic wool should be replaced approx. every two years)
- Versatile system (can also be used for drying corn, for example)

#### Disadvantages

- For control, a person must be permanently directly at the plant (no automatic correction of the parameters in case of changes, e.g. the crop flow etc.)
- Sometimes end product is too dry (only 6% residual moisture)
- Fire hazard is given; therefore, the product must be pre-cleaned as well as possible (e.g. the core content should not be too large)
- No concrete specifications from the manufacturer for setting the duration of treatment and thus the intensity of the temperature exposure. The processor has to find the optimal setting himself.



*Cimbia Dantoaster 20/6000.*



*Dantoaster drum – inside view.*

### **Manufacturer**

Cimbia Unigrain A/S.

Cimbia House Faartoftvej 22, P.O. Box 40

7700 Thisted / Denmark

cimbria.holding@agcocorp.com,

www.cimbria.com

### **Provider in Germany**

Gerauer OHG

Reith 4

94148 Kirchham, Bavaria / Germany

## 1.2 Electric fan heater from Roastec

This roaster, which produces hot air, is manufactured by the company Roastech in South Africa.



*Roastec electric roaster.*

The machine generates hot air, which is utilised for roasting the soybeans without the addition of moisture. The grains are continuously moved through the machine, mixing them. Subsequently, the roasted product is cooled (the company Roastech offers separate coolers). The roaster can be used for grains with a size of at least 2.5 mm (soy, peas, etc.). In order to obtain uniformly roasted products, the beans should be as evenly sorted as possible, as well as dust-free and not stick together.

The thermal efficiency of this electric roaster ranges from 6 kg/kWh to 9.6 kg/kWh for roasted soy, depending on the product moisture of the raw material. The machine is controlled by the temperature of the hot air introduced and the drum speed.

## Technical specifications Model R 50

Machine	Model 50*	
	Metric units	Imperial units
Height	2.1 m	88"
Length	3.8 m	149"
Width	1.8 m	72"
Weight	1.1 tonnes	2500 lbs
Fuel consumption	22 L/tonne	5 gal/tonne
Capacity	1.5 tonnes/hour	1.5 tonnes/hr

\*in addition to model 50, there are other, more powerful models

### Advantages

- Simple system, only one moving part in the machine
- Easy control and adjustment of the machine (rotor speed and temperature)
- Relatively low purchase price
- Lightweight, easy to transport
- Low wear / spare parts can be ordered
- Low maintenance required
- Energy efficient (recirculation of air/hot steam from product moisture into machine)

### Disadvantages

- Heating of the device with electricity not energetically optimal and relatively expensive
- So far lack of experience with the device in Europe

**Manufacturer**

Roastech  
Forced Convection Roasting

**Contact person**

Fritz Teseling  
4C Mill Street  
Hamilton Bloemfontein / South Africa  
info@roastech.com, www.roastech.com



### 1.3 Toasting on the fields' edge

The company Möhler Technik (Rainer Möhler) company developed the Mobile Soy toaster in cooperation with the Italian company Mecmar and Jürgen Möhler CNC-Machines. The goal was to develop a mobile soy toaster with which the soy can be toasted directly on every farm. The contract toasting in the region is carried out by Rainer and Jürgen Möhler GbR.



Mobile soy roaster from Rainer Möhler.

#### Functionality

The soybeans enter the toaster at the machine's rear through a grain receiving area employing a trailer. There, they are first weighed by the device and conveyed to the toasting line.



Grain receiving area on mobile soy roaster.

The product is circulated through a redler with an external perforated floor. An air stream heats the soybeans at a temperature of approx. 230°C for a short time. A high-performance centrifugal blower ensures proper air circulation. As a result, a clean, heated air

stream constantly hits the soybeans. Feeding and swirling the product results in constant mixing of the soybeans, exposing them to the heat continuously and uniformly. The heating power is achieved utilising gas burners and heat recovery.

After toasting, the soybeans are homogenised in the silo at 120°C for one hour. Then the soybeans are cooled back to match the outside air temperature using a fan. The toasted beans are then loaded by a transfer auger and stored directly at the farmer's premises.

The mobile soybean toasting plant processes 2 to 2.5 tonnes of soybeans per hour. One gas tank is sufficient to operate the plant for ten hours.

#### Advantages

- Saves expensive transportation costs to distant soy toasting plants
- Toasting possible on the field
- Sufficient reduction of trypsin inhibitors and increase of palatability
- Possibility to process peas, field beans and lupins with the toaster
- Production of on-farm feed mixtures possible
- Separate drying is not necessary for moist crops
- Toasting technology can also be used on organic farms

#### Disadvantages

- In general, thermal processes expose the outer layer of the beans to heat more intensively than the inner layer
- There may be waiting times for farmers if toasting is done directly at harvest time

#### Operator and distributor:

Rainer und Jürgen Möhler GbR

Eichelshof 2

74214 Schöntal / Germany

rm@sojatoasten.de, www.sojatoasten.de

## 1.4 Mobile roaster from Schnupp's Grain Roasting

This mobile roaster was developed in the USA and is widely used by contractors in the United States. The manufacturer offers a small roaster "Model 50" and two larger machines for multi-farm use.

### Functionality

The grains are conveyed into a rotating stainless steel drum via the feed hopper into a variable-speed auger that controls the intake quantity. Via a roasting screw, they are conveyed for about 1 to 1.5 minutes directly through a burner flame generated using propane gas (so-called "flame kissing"). In this process, the soybeans reach an internal grain temperature of about 132°C (270°F). In this process, the grains are directly exposed to the hot flame. The grains are kept in constant motion, which is intended to prevent burning. The time the soybeans spend in the roaster is determined by the drum rotation speed and the gradient of the auger. The beans then flow out of the roaster through the outlet. A combination with various loading devices, such as screws or conveyor belts, is possible. When leaving the roaster, the grains are very hot and must first be cooled. Following the roasting process, it is possible to transport the beans to a container employing a blower where they are cooled down by means of a grain drying system in which only a fan is used for cooling. Furthermore, flow-through coolers are also offered.

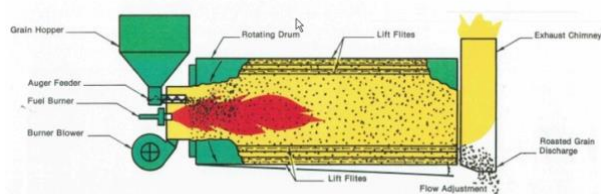


Figure 1. Schematic system model of the Schnupp's Grain Roasting Model 50 mobile roaster

### Technical specifications

Machine	Model 50*	
Parameter	Metric units	Imperial units
Height	2.1 m	83"
Length	3.8 m	149"
Width	1.8 m	72"
Weight	1.1 tonnes	2500 lbs
Fuel consumption	22 L/tonne	5 gal/tonne
Capacity	1.5 tonnes/hour	1.5 tonnes/hr

\*in addition to model 50, there are other, more powerful models

### Advantages

- Moist soy batches could be processed directly after harvest without drying
- Mobile application
- Easy control and adjustment of the machine

### Disadvantages

- Grains come into direct contact with the flames, risk of toxin formation
- When operating with fuel oil, there may be a risk of dioxin residues
- So far, no experience with the device in Europe

### Manufacturer:

Schnupp's Grain Roasting

416 Union Road, Lebanon, 17046

Pennsylvania / USA

### Contact person:

Paul Lehman, [www.roast-a-matic.com](http://www.roast-a-matic.com)

## 1.5 Dilts-Wetzel roaster, electrically heater

This soybean roaster was developed in the USA by Jim Wetzel. The machine consistently produces uniformly roasted soybeans in a continuous process.



Company logo

### Functionality

Inside the tube is a heating chamber, which contains about 600 litres of special oil. The oil is heated electrically, and the heat is transported to the inner heating chamber - this roasts the soybeans. Inside the tube there is also an auger that continuously transports the beans. Due to the natural temperature stratification, the oil flows through the heating jacket and back to the heating element.



Dilts-Wetzel roaster.

According to the manufacturer's recommendation, the beans are roasted for approx. 1.5 hours at approx. 180°C and they leave the heating chamber at approx. 120°C. The system is fully automatic, and the temperature is controlled by the temperature and rotation speed of the auger.

The system is operated with 220 volt single-phase electricity (electricity must be converted to European electricity standards).

Due to the relatively low purchase price and the uniform, compact system, it is possible to integrate the machine into farms and small feed mixing plants. Joint purchase by several farmers is also conceivable.

### Technical specifications

Parameter	Metric units	Imperial units
Height	2 m	7'
Length	10 m	32'
Width	1 m	3'
Weight	1.6 tonnes (without oil)	3500 lbs (without oil)
Fuel capacity	600 L	150 gal/tonne
Capacity/day	2,5 tonnes/hour	6,000 lbs/24 hrs



Exit point for the roasted soybeans.

### Manufacturer

Wetzel Soybean Roaster Dilts-Wetzel Manufacturing Co.

2501 Washington Rd., Ithaca, 48847

Michigan / USA



### **Contact person**

Jim Wetzel, sales@diltswetzel.com,  
www.diltswetzel.com

### **Operators in Europe**

The company MOSEGÅRDEN in Denmark has been operating a Dilts-Wetzel electric roasting system since 2012; it is conducting upgrading trials with various grain legumes (field beans and bitter lupins) on a farm together with the Knowledge Centre for Agriculture, Aarhus. The machine was converted to European electricity standards by the company MOSEGÅRDEN. The import of further machines to Denmark (Europe) is planned.

A technical conversion of the machine for other heat sources is under consideration by the company MOSEGÅRDEN. This would eventually result in the possibility of using waste heat from biogas plants. The combination of the Dilts-Wetzel unit with an oil press has not yet been tested.

### **Contact**

MOSEGÅRDEN A/S: Dalgårdsvej 82  
7600 Struer Denmark

post@mosegarden.dk, www.mosegarden.dk

## 1.6 Soy roasting at Stadlhuber Agrar

A classic drum toaster has been installed on the Stadlhuber Agrar premises since 1993. It is fired with natural gas.



*Processing plant Stadlhuber.*

### Structure/functionality

The installed soy toaster was imported in 1993. Originally, the installed model was a semi-mobile toaster that could be transported from farm to farm as needed.

The delivered soybeans are conveyed into an elevator. This transports them to a small storage silo, where the crop is sprayed with water using an installed sprinkler. The aim is to achieve a minimum moisture content of 14% in the treated product. From the storage silo, wetted soybeans are fed horizontally into the toaster via a metering auger. In the drum, which is slightly horizontally inclined, the soybeans are continuously conveyed upwards using fan-like paddles as they rotate. The beans fall down inside the drum. As they fall back to the bottom of the drum, they then pass through the gas flame in the centre of the drum, which is fired by a gas burner.

This is followed by adequate cooling utilising a roof compartment cooler with outside air and, if necessary, remoistening of the processed product. The process thus exerts direct heat on the beans, with the processing air heated to approx. 300°C by the modulating burner and surrounding the beans almost

during the entire drum passage. During the treatment process, the moisture in the product is caused to evaporate. According to Jansen & Friedrich (1985) and Ahmed (2001), such a process usually results in a moisture loss of 30 to 40%, depending on the setting. The temperature in the drum at the outlet from the drum at the current setting is 230°C. The outlet temperature of the treated bean from the drum should ideally be between 110 and 115°C to ensure optimum use in feeding monogastric livestock. About a year ago, it was decided to wet the beans in advance. On the one hand, this is intended to prevent protein damage, and on the other hand, it reduces the risk of fire.

### Advantages

- Simple, relatively low-maintenance technology with long service life
- Lower initial costs compared to other systems
- Toasting of other grain legumes also possible
- Variable application possibilities: e.g. also for "popping" grain

### Disadvantages

- Without prior wetting, high risk of fire
- Risk of under-treatment with large beans or risk of over-treatment with small beans if the raw material is heterogeneous
- In general, the outer layer is constantly exposed to heat more intensively than the inner layer
- Time spent toasting and burner temperature must be adjusted according to the raw bean condition so that the beans are treated with as equal intensity as possible

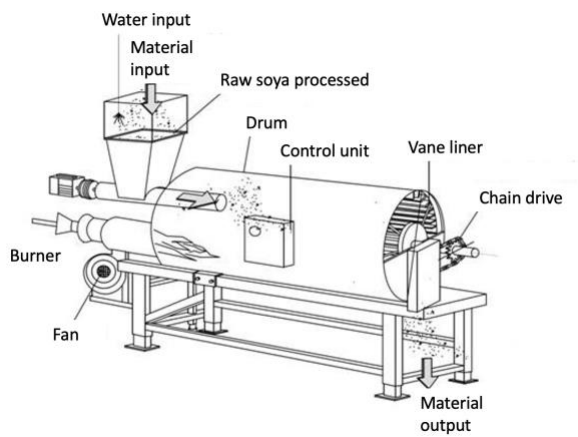


Figure 2. System schematic diagram of the drum roaster installed at Stadlhuber Agrar.

### Manufacturer

Stadlhuber Agrarservice GbR

Thann 17, 84544

Aschau am Inn / Germany

info@stadlhuber-agrarservice.de,

www.stadlhuber-agrarservice.de

## 2. Hydrothermal system: Meika animal nutrition

On the company premises of the organic compound feed manufacturer Meika Tierernährung GmbH there is a soy processing plant from Streckl and Schrader in Hamburg. The hydrothermal steaming and flaking system with the option of subsequent partial oil extraction was developed for the food industry to produce cereal flakes and muesli. At Meika Tierernährung, the plant is successfully used for the protein-preserving thermal treatment of organic soybeans.

### Functionality/components

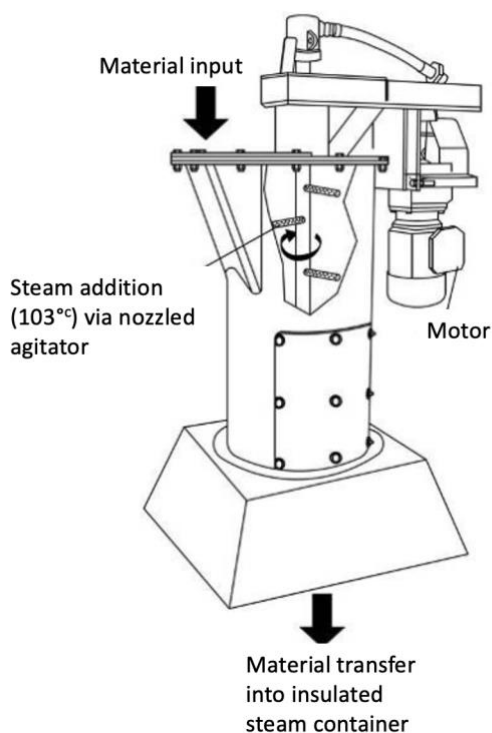


Figure 3. System schematic diagram of the circular steamer.

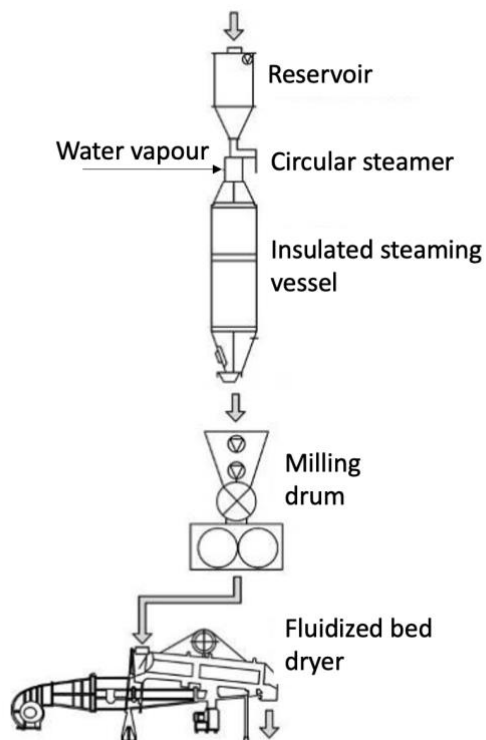


Figure 4. Layout of the hydrothermal treatment system with circular steamer, steaming vessel, milling drum and fluidised bed dryer.

The basic principle of the soybean processing plant is based on steaming the whole raw bean at approx. 103° C for approx. 40 minutes, flocculation in a roller mill followed by drying in an eddy current dryer. Partial oil extraction of the flaked soybean in several screw presses is optional.



Meika roller mill.

The system's central elements are the RD 500 circular steamer (Streckl and Schrader) and an adjoining tempering tank with a volume of 3.1 m<sup>3</sup>. After thorough cleaning, the raw

material is fed into a storage silo, from where it is transported in a continuous flow system to the circular steamer, which is equipped with empty and full detectors. During the 40-minute steaming process in the circular steamer, steam is first introduced uniformly into the product from a steam generator operated separately with fuel oil. This causes the temperature of the product to rise to approximately 103°C. The product then enters the insulated steam tank, where the steam is boiled into the product for approx. 40 minutes. This results in gelatinisation of the starch and significant inactivation of heat-labile, antinutritive substances. The steam is incorporated directly into the product by a hollow shaft, with the steam nozzles arranged on an agitator. This ensures homogenisation at the same time. For better temperature control, the secondary vessel is fully insulated, optimising energy efficiency and steam consumption. The uniform discharge from the tempering tank, which is made entirely of stainless steel, is then carried out using a filling apparatus directly into the one-meter-wide rolling mill, where the heated soybeans are flaked. In the rolling mill, auxiliary fluting of the rolls contributes to uniform product intake over the entire working width.



*Meika vortex flow dryer.*

The steamed and flaked product is then dried in a fluid bed dryer (Streckl and Schrader).

This is a machine specially designed for gentle drying and cooling of cereal flakes and thus also soy flakes. The dryer, whose action is

based on the principle of convection, is directly connected to the roller mill. In the stainless steel construction with side viewing windows, the moist warm steamed material is first passed through with hot drying air in the front part of the passage and cool air in the rear part of the passage.

The time spent in the machine and ultimately the final moisture content of the finished product can be precisely regulated by variable inclination of the fluidised-bed dryer. For heating the cold air for drying, a heating coil heats the air from room temperature to approx. 105 °C. To ensure optimum cooling and thus optimum storage conditions in the summer months, a 150 kW grain cooling system is used in addition to the normally installed capacity.

The output capacity of the steaming system is approx. 3-4 t/h, depending on the set dwell time and raw material properties. The steam requirement is approx. 300 kg/t of steamed material. The additional steam consumption for the fluid bed dryer is approx. 100 kg/t. The installed electrical power of the entire plant is 150 kW.

#### **Advantages**

- Consistent product quality
- Many possibilities to intervene in the semi-automated process in a regulating way/ to keep the process very constant and to adapt control parameters to qualitative fluctuations of the raw material or customer requirements if necessary
- Significant reduction of all heat-labile antinutritive substances
- Protective of protein, as comparatively low temperatures, are used compared to other processes
- Long residence time ensures hygienisation of the product
- Comparatively low wear of the main plant components: There is the possibility of partial extraction to approx. 11-12%



residual fat content in 3 of Florapower's own screw presses.

#### **Disadvantages**

- Large overall height
- The optimisation of the plant, which initially comes from the food industry, is relatively costly. Partly own rebuilding by the operator was necessary
- More energy-intensive drying necessary for whole or coarsely flaked beans (compared to drying broken beans after steaming processes)

#### **Manufacturer**

Steckl & Schrader kg  
Hinschenfelder Straße 35  
22041 Hamburg / Germany

#### **Operator**

Meika Tierernährung GmbH  
Bahnhofstrasse 95 - 99  
86845 Großaitingen / Germany  
kontakt@meika-biofutter.de, www.meika-biofutter.de

### 3. Extruder: Farnet - Soybean extruder

In the Czech Republic and other Eastern European countries, soybeans are mainly processed utilizing extruder technology. The Farnet extruder is operated, among others, by the company "Primasoja" presented here.

At Primasoja, farmers can choose between three soybean feeds: Primasoja classic (full-fat soy), Primasoja By-Pass (soybean cake) and a mixture of these two feeds. The soybeans are purchased from the region.

#### Functionality

Before processing, the soybeans must first be dried and cleaned to a moisture content of no more than 14 %. They are then crushed to a quarter of their original size by a roller mill. From there, they enter a storage bin and are metered into the extruder via a screw conveyor. The extruder (Farnet E1000) is a special screw with special shaft elements, driven by a motor with an output of 110 kW.



*Farnet Extruder.*

In the extruder, the temperature is measured at three different points via heat sensors. The further the material is transported to the exit of the extruder, the higher the temperature. The energy input is exclusively via mechanical friction energy, as the soybeans are pressed through a small opening and experience friction within the extruder. The small opening consists of a cone whose opening gap is fixed by a screw. To ensure that the treatment sufficiently reduces the urease content, the plant operator specifies 130°C product temperature of the soybeans at the rear end piece of the extruder as the target for the treatment. This requires an energy input of about 60 kWh/t. After a treatment time of around 30 seconds, the soybean "squirts" out of the extruder through a small opening.

At the extruder's exit, 2-3 % of the initial moisture evaporates and the material lands on a vertical vibrating cooler. On this cooler, the extruded soybeans are transported in a circle from the bottom to the top using vibration over a very slight incline. Above the vibrating cooler is a fan that exhausts the air outside. This cools the treated material further, and the cooling evaporates another 1-2 % of the moisture from the soybeans. At the end of the treatment, they have a residual moisture content of 8-9 %, they can be stored for at least three months.

The extruder has a capacity of 1 t/h. Wear depends on the intensity of use for the shaft elements and matrix cone.



*Farnet radiator.*

After the soybeans have cooled, they are transported to the warehouse for loading or conveyed to another silo. From this silo, the extruded soybeans are fed via an auger into two Farnet oil presses (model L200). These screw presses consist of square strainer elements in which a special screw is located. This transports the soybeans against the pressure of a die in the front section of the oil press. The gap between the die and the screw can be narrowed mechanically so that the oil is squeezed out and runs out of the strainer elements. Below the strainer elements, coarser turbidities are removed by a sieve before the oil is filtered through a chamber filter and filled into 1000 l containers for sale.

### **Advantages**

- Simple construction, compact
- Favourable purchase price
- Possibility of combination with oil presses and integration into existing plants is possible

### **Disadvantages**

- Soybeans must be cleaned and crushed prior to treatment; otherwise, the extruder can become clogged
- Wear detection on the extruder is difficult
- Without preconditioning, it is difficult to achieve optimum treatment values

### **Manufacturer**

Farnet  
Jirinkova 276  
55203 Ceska Skalice / Czech republic  
[farnet@farnet.cz](mailto:farnet@farnet.cz), [www.farnet.cz](http://www.farnet.cz)

### **Plant operator**

Marcela Pluharova  
Brezina 41  
Loukov un Mnichova Hradiste

#### 4. Extraction plant: BAG oil mill operations gmbH

The oil mill of BAG oil mill operation in Güssing, Austria, currently processes 200-230 tonnes of GMO-free, European soybeans per day. Soybean processing is carried out using chemical extraction in the following steps:

- Cleaning
- Fluting
- Conditioning / drying
- Hulling
- Flocculation
- Extraction
- Desolventising
- Toasting
- Drying / cooling
- Water degumming
- Soybean oil



*Extraction plant, BAG oil mill operations gmbH, Austria.*

##### Functionality

###### Cleaning

During cleaning, all unwanted foreign matter is separated from the soybeans utilizing a screening machine, magnet and destoner.

###### Fluting

In fluting, the bean is cut rather than crushed. It is cut so that not too many particles are produced. As a rule, the beans are quartered at the top roller passage and quartered on the second passage.

###### Conditioning / drying

During conditioning/drying, the fluted beans are heated up to 65 °C with indirect steam to optimally carry out the subsequent process steps of hulling and flaking.



*Conditioner at BAG oil mill.*

###### Husking

Husking consists of wind sifting and a plansifter. In this process step, the free husk is separated so that the crude fibre and protein content specification for the meal can be met later.

###### Flaking

Flaking of the beans is necessary to achieve good oil extraction later in the following processing step. The flake thickness should usually be between 0.25 mm and 0.35 mm, depending on the raw product.





*Fluted soybeans.*



*Flaked soybeans.*

### **Extraction**

The flakes are extracted for oil in a Rotocell extractor. The residence time is usually about 60 minutes. Oil mill grade hexane is used for extraction and is pumped over the product in a reverse-flow process. The resulting miscella is separated into soybean oil and hexane in the distillation unit.

### **Desolventization**

In the desolventiser, indirect steam at temperatures between 100 and 105°C is used to evaporate the hexane from the solid meal.

### **Toasting**

In the two toaster chambers, toasting is carried out using direct steam at temperatures between 100 and 103°C. The toasting process is carried out employing indirect steam. In addition to desolventising, enzyme activities, digestion-inhibiting or undesirable substances are deactivated. The direct steam also serves as a carrier medium to transport the hexane

separated during desolventisation. The toasting process's duration is between 40 and 70 minutes, depending on the plant's capacity.

### **Drying/cooling**

The meal is then dried in the drying chamber with indirectly heated air and then cooled in the cooling chamber with ambient air, blown through the product. The temperature of the meal after the cooling stage is between 20 and 45 °C, depending on the season.

### **Water extraction soybean oil**

The so-called "crude" soybean oil is "degummed" downstream of the distillation unit by adding water and citric acid in a centrifuge, i.e. the phosphorus content is reduced to < 50 ppm. The meal and water-degummed oil are then temporarily stored and then delivered to customers by truck.

The plant has a processing capacity of 250 tonnes per day. Only GMO-free goods are processed at the oil mill in Güssing.



*Lecithin separation.*



*Finished extracted soybean meal.*



### **Advantages**

- All but 1% of the oil is extracted from the soybeans, resulting in higher oil removal than mechanical pressing
- Versatile feed can be used for all animal species in high proportions
- Standard feed that can be well adjusted in ingredients
- Oil achieves higher added value than soybeans or soybean expeller
- Less wear than mechanical pressing of soybeans

### **Disadvantages**

- Extraction is a difficult process to control
- Equipment is very complex and expensive to purchase
- Very high capacity utilisation is necessary; minimum is about 200 t/day
- Working with hexane is difficult, as it is an explosive substance and many safety requirements have to be met

### **Operator**

BAG Oil mill Operations gmbH

Wienerstraße 12a

7540 Güssing / Austria

bagoffice@bgoil.at, [www.bagoil.at](http://www.bagoil.at)

### **Contribution for this chapter from authors:**

Thomas and Ingrid Schlichmaier, Oil mill advisory service OILMEX

## 5. Microwave system: Florapower continuous oscillating heater

Florapower, a company based in Augsburg, Germany, has developed a microwave treatment process that gently removes antinutritive substances from soybeans.

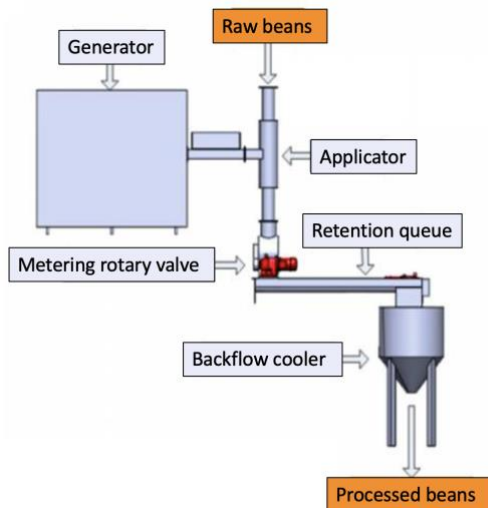


Figure 5. Model for the Florapower continuous oscillation heater

### Functionality

Continuous oscillation heating is a process based on high-frequency technology in which the soybean continuously flows through the applicator and is heated. In this process, the high-energy vibrations (microwaves) stimulate the bean's water molecules to vibrate. The vibrations generate friction and thus heat, which warms the initial product from the inside out.

Thus, the bean is cooked with its own water content (10-15%), and the required energy is optimally utilised. Due to the variable temperature setting, the bean is heated only as far as is necessary for the degradation of the antinutritive ingredients. As a rule, 100°C is sufficient for this. These low temperatures, compared to other processes, allow important components to be largely preserved. After

heating, the temperature can be maintained for a freely adjustable period of time. This time is required to break down the antinutritive ingredients. The pilot plant operates with 2 KW power and can process 35 kg/h. Higher capacities are available for industrial use.



Florapower continuous oscillating heater.

### Advantages

- Gentle and homogeneous treatment of soybeans
- Fast preparation
- No pressure effect on the soybeans
- Efficient heating (from inside to outside: no external energy needed)
- Machine does not emit radiation
- Precise control of the treatment (quality parameters)

### Disadvantages

- High price for the equipment, as it is a new technology

### Contact details

Thomas Kühnel, Dipl.-Ing. Managing Partner  
Florapower GmbH & Co. kg  
Am Mittleren Moos 48  
86167 Augsburg / Germany

## 6. Facilities combining different processes: Asam farm - Kissing plant

On the Asam farm in Kissing, Germany, there is a soybean processing plant from the company Amandus-Kahl, which processes soybeans in a hydrothermal, high-pressure treatment process. The expander plant is specially optimised for the heat treatment of various feedstuffs. The plant produces, among other things, uniformly processed full-fat soybeans or optionally processed soybean cake in a continuous process.

### Functionality

The soybeans or other protein feeds, such as peas and field beans, are treated in a continuous flow process with steam, moisture, temperature and pressure according to a precise schedule. For soybeans, it is also possible to extract the oil before processing by using the Straehle screw press.

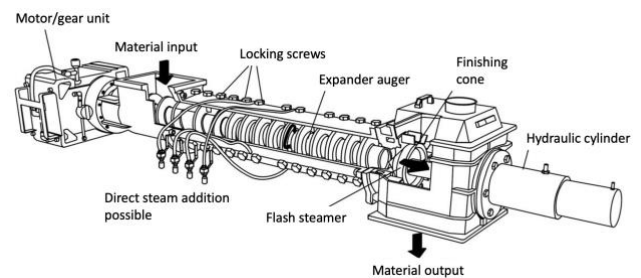


*Expander on the Asam farm.*

In the process, the soybean or soy cake is first coarsely ground with a crushing roller mill. It is then transported in a pre-hopper via a metering screw first into a horizontal continuous mixer equipped with fast rotating "stirring paddles". This mixer-conditioner ensures lump-free mixing and heating of the material to be treated with steam to a maximum of approx. 95°C. The mixing

paddles can be adjusted to the required temperature. By adjusting the paddles, both time, which is approx.

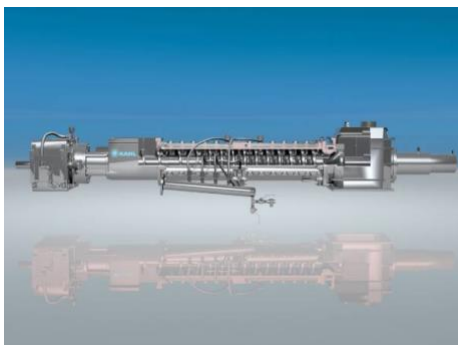
30 seconds and the strength of the mixing can be influenced. It is thus possible to adapt the conditioning to the particular raw material.



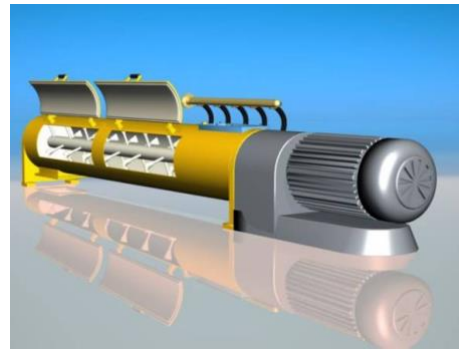
*Figure 6. Schematic structure of the Asam farm, Kissing plant.*

Subsequently, the material preconditioned with steam enters a so-called hydrothermal reactor, equivalent to a large cooking pot. The hydroreactor consists of a housing with several levels divided by steam-heatable bottoms (with openings). There is a pressureless heat treatment with steam at 102°C with a 10 minute residence time. There is an axially arranged shaft in the centre of the reactor, which is equipped with stirring arms. These agitator's arms carry the product out through the openings of the tier bottoms according to the "first in, first out" principle, whereby the flaps of the shelf openings open in a controlled manner when a defined filling level of the shelves is reached (and thus when the desired retention time is reached). The reactor ultimately allows an improvement of the product properties and ensures the degradation of digestion-inhibiting and harmful components such as trypsin inhibitors, lectins and other antinutritive substances. Uniform and at the same time gentle treatment is ensured in this section by separately controllable temperature and humidity and, to a limited extent, by variable residence time.

The actual special feature of the system is the subsequent pressure-heat treatment in the expander. The expander consists of a thick-walled mixing tube with replaceable wear inserts and a shaft mounted on one side, equipped with metering, mixing and kneading elements (such as "stop screws"). The annular gap is formed between the end of the tube and the hydraulically adjustable cone. Due to the gap width during operation, the hydraulic regulation of the pressure, energy absorption, intensity of friction, and temperature are continuously adjustable. The maximum pressure is approx. 50 bar, whereby the pressure drops spontaneously at the outlet and leads to "expansion" of the material. During this process, a part of the supplied water evaporates (so-called flash evaporation). The expander operates according to the HTST (High Temperature Short Time) principle. The advantage is that the very short treatment time (1-5 seconds) at a relatively high temperature (125-165°C) leaves valuable components of the feed, such as vitamins, largely intact. However, the cell structure of the feed to be treated is intensively affected by the combination of temperature, pressure and friction. The expansion process results in up to 60 % starch digestion and improved protein and oil availability.



*Expander system.*



*Conditioner system.*

The plant can process both full-fat products and soybean cake (7-10% residual fat). Following processing, drying and cooling take place at Asam farm in a belt cooler and dryer to ensure the highest possible shelf life of the product.

The output of the plant is currently approx. 3.3 t/h.

#### **Advantages**

- Protein-preserving treatment of soybean cake/full-fat soybean and very good regulation of parameters
- Special starch digestion and oil availability due to pressure expansion
- Many possibilities to intervene in the process in a regulating way and to adapt the process to the customer's requirements
- Processing of other feeds possible, e.g. field beans, peas
- Plant can also be used flexibly for the production of hygienised compound feed and compound feed pellets

#### **Disadvantages**

- Relatively high investment costs
- Relatively energy-intensive process
- Water treatment for the steaming plant is maintenance-intensive and very costly
- Costly wear on the 130 kW expander

#### **Plant operator**

Rieder Asamhof GmbH & CoKG Managing Director Josef Asam

Hauptstraße 1  
86438 Kissing / Germany

**Manufacturer**

AMANDUS KAHL GmbH & Co. kg

Dieselstraße 5-9  
21465 Reinbek / Germany

info@akahl.de. [www.akahl.de](http://www.akahl.de)



## 7. Processing plants in Germany

### Börde-KRAFTKORN-SERVICE GmbH

- Thermo - special - straight feed
- Wage toasting of full-fat soybeans using a rotary drum toaster of the company CROCUS - DK

Börde-KRAFTKORN-SERVICE GmbH An der Schäferlei 76 a  
39397 Gröningen, OT Dalldorf

Contact person:

Dipl. Agr. Ing. Gerald Eichelmann , Dr. agr.  
Ulrich Abraham info@boerde-kraftkorn-service.de, www.boerde-kraftkorn-service.de

### Gerauer OHG

- Toasting of Soya

Gerauer OHG  
Reith 4  
94148 Kirchham, Niederbay Reith  
gerauer-ohg@web.de

### Kraichgau Raiffeisen Center eG

- Hydrothermal toasting of soybeans at the cooperation partner Mühle Ebert Dielheim

Kraichgau Raiffeisen Zentrum eG  
Contact: Siegmar Benz Raiffeisenzentrum 11  
75031 Eppingen  
mail@krz-eg.de, www.krz-eg.de

### Meika Tierernährung GmbH

- Hydrothermal processing and oil extraction of soybeans

Meika Tierernährung GmbH Bahnhofstrasse  
95 - 99 86845 Grossaitingen  
kontakt@meika-biofutter.de, www.meika-biofutter.de

### Rainer und Jürgen Möhler GbR

- Contract toasting with the "Mobile Soy Toasting Plant

Rainer und Jürgen Möhler Gbr Eichelshof 2  
74214 Schöntal

rm@sojatoasten.de www.sojatoasten.de

### napus GmbH

- Preparation with simultaneous oil extraction from soybeans

napus GmbH  
Leunisstraße 3  
31171 Nordstemmen/Mahlerten

Contact person:

Jan Wittenberg, Phone.: +49(0)5069-804768

### Raiffeisen Kraftfutterwerk Kehl GmbH

- Toasting of soy

Raiffeisen Kraftfutterwerk Kehl GmbH  
Weststr. 29

77694 Kehl

info@rkw-kehl.de www.rkw-kehl.de

### Rieder Asamhof GmbH & Co. KG

- Oil extraction and processing of soybean utilizing a hydrothermal expander plant

Rieder Asamhof GmbH & Co. kg  
Hauptstraße 1  
86438 Kissing  
info@assamhof-kissing.de, www.assamhof-kissing.de

### Stadlhuber Agrarservice GbR

- Toasting of soya

Stadlhuber Agrarservice GbR Thann 17  
84544 Aschau am Inn  
info@stadlhuber-agrarservice.de,  
www.stadlhuber-agrarservice.de

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**Authors** Ludwig Asam, Kerstin Spory, Ann-Kathrin Spiegel, FiBL Germany, Stefan Thurner, Robert Zeindl, Bayerische Landesanstalt für Landwirtschaft, LfL

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1: Schnupp's Grain Roasting

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