



Gravity spiral separators for cleaning soybeans

The principle of the spiral separator is old. Already in great-grandfather times, "screw separators" were used, for example to separate vetches from grain. The technology is always used to separate round from unround grains. In the USA the spiral separator was further developed for use in modern processing units. Spiral separators are often used in seed processing, but also in the final cleaning of animal feed and consumer goods. For example, very good results are achieved in the processing of rape seed. In the USA, special flights (planes) are also produced and widely used for the processing of soybeans. Good results are achieved at separating soybeans from broken grains, maize, stalks and pods.

Depending on their characteristics, stones can also be sorted out. However, spiral separators are not suitable for coarse cleaning. They are used at the end of the cleaning for fine separation.

The devices are available in Germany and are already being used by the first German and Austrian processors. We have tested an American soy spiral separator and talked to manufacturers and users about their experiences and recommendations.

Functionality and technical details

Spiral separators consist of a flight (plane) which is spirally wound around a central shaft. Whole, round beans quickly gain speed and fly over the outer edge of the wound flight. Unround, broken grains, stones, straw residues, maize grains etc. roll to the lower end and from there into the collection bin. A further factor for the separation is the surface texture: The smoother the surface, the faster an object gains speed in the spiral separator. Thus, for soybeans, acceleration in the spiral separator also increases with increasing dryness, because dry beans have a smoother surface.

In modern spiral separators, several flights are twisted into each other, which considerably increases the efficiency for the same space requirement. For example, in the H&T devices tested by us, one unit contains eight flights (Fig. 1). Sets of up to eight spiral cartridges in one steel cabinet are also available.



Figure 1: Eightfold soy flight from the manufacturer H&T

The flights themselves are rigid and there are no adjustment possibilities. The two decisive parameters "banking angle" and "flight angle" are set by the manufacturer. The banking angle indicates how steep the spirals run downwards on the inside. The flight angle indicates how steep the slope is inclined outwards. Basically, the angle of inclination in the outer area of the spiral is lower than in the inner area, which is in the nature of the spiral. This slows down the speed of the soybeans when they are accelerated outwards by centrifugal force. The centrifugal force decreases, and the beans roll inwards again. This goes back and forth until the beans either fly over the embankment or enter the bin at the bottom.

There are spirals with different banking and flight angles for different crops and applications. For our tests, we had eight spirals with banking angles from 37° to 49° and flight angles from 33.7° to 46° at our disposal.

Fine Adjustment

The unit offers only three simple setting options:

• Feed flow

According to the manufacturer, depending on the raw material, approx. 1 ton of soybeans can be processed per unit every hour. The feed is adjusted by means of a simple screw cone (Fig. 2), which simultaneously distributes the material flow evenly over all eight spirals.



Figure 2: Screw cone for dosing and even distribution to the eight spirals

• Seed dams

To prevent soybeans and impurities from flying over the edge before they have separated properly, simple magnetic foam strips can be inserted into the spirals at any point (Fig. 3). The material hits the foam, is thereby slowed down and forced to make a further downward turn.



Figure 3: Seed dams for slowing down the crop flow on the same level in all eight flights.

• Gate valve at the outlet

At the end of the spirals a part of the cleaning material is still in the spiral, i.e. it has not yet flown over the edge, but neither slipped all the way down to the inside of the spiral. The slider (Fig. 4) can be used to set which part of this fraction is to be fed into the collection bin.

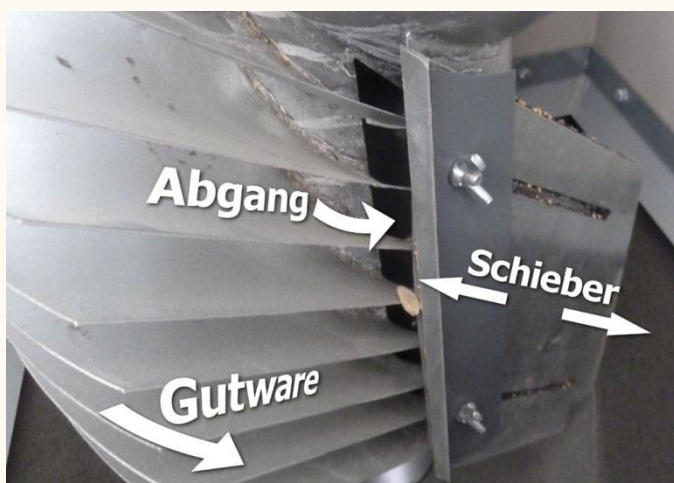


Figure 4: The end of the eightfold spiral: The adjusted is done by means of a gate valve.

Advantages and disadvantages of the technology

Advantages

- No moving parts. Therefore, maintenance and wear are minimal.
- Gentle to the grain and hardly any mechanical stress on the beans due to low drop heights. This gives the machine its value especially in the seed processing of soybeans.
- Spiral separators work solely by gravity, no energy supply is required.
- Few adjustment possibilities, therefore easy operation.
- Low space requirement.
- Low acquisition costs: The simple version of the devices is available from around 4000€.
- High percentages of broken grains are removed (an advantage for seeds - but a disadvantage for feed and consumer goods!)

Disadvantages

- Low hourly output (can be compensated by using several units).
- Few possibilities for fine adjustment. As a result, their use is more limited than, for example, with modern destoners.
- Works best with perfectly round grains (vetches, rape). Reduced efficiency with oval beans.

Spiral separator in the Taifun-test

For testing purposes, the company Reiter Seed Processing has provided us with a device with eight different exchangeable H&T spiral flights. For our tests we compared the three spirals that are suitable for soy:

• Spiral 1

This special soy spiral is produced for Amos, an American manufacturer of cleaning equipment with a banking angle of 46.9° and a flight angle of 42.9°.

• Spiral 2

With the same banking angle as spiral 1, the flight angle is 3.1° steeper at 46.0°. This spiral is specially manufactured for soy processing at Pioneer.

• Spiral 3

This spiral is not specifically designed for soy. We have tested it on the recommendation of an Austrian processor. Due to the considerably steeper banking angle of 49°, the proportion of good material in the bin is greatly reduced. The flight angle is 34°.

Three different soy varieties with different rolling behaviour were used for the test: Merlin with 156 g thousand-seed weight and almost round grains, Protibus with 172 g thousand-seed weight and slightly oval grains and Primus with 220 g thousand-seed weight and more oval grains.

For each variety three kilograms of soybeans were mixed with the following typical impurities, that can cause problems in processing:

- Soy straw
- Soy pods
- Stones
- Half soybeans
- Corn grains
- Thistle Flower



Figure 5: Impurities with which the tests were carried out. The samples come from various Taifun soy deliveries.

Test results

The feed flow was adjusted to a throughput of approx. 1 tonne per hour. A reduction of the throughput to about 0.4 tons did not result in any significant changes in the result.

The valve at the end of the spirals has been opened completely to keep the proportion of good material in the bin as low as possible. Seed dams were not used. According to our research and observations, seed dams should not add much value in soy, unless longer spirals are used.

• Straw and pods

Regardless of the spiral used, straw pieces and pods can be separated very well. The worst value was 90%; in many cases it was possible to separate straw and pods completely. With all three spirals, 100% cleaning success was achieved several times.

• Stones

In the case of stones, the differences of the spirals are clearly visible. While the somewhat flatter spirals No. 1 and 2 were able to separate on average 74% of the stones, the value for the steeper spiral No. 3 was 58%. The result depends of course strongly on the characteristics of the stones. We used a mixture of various soy deliveries. Flat stones were separated for the most part, but round stones were rarely separated.

• Half soybeans

In all tests, 50-60% of half soybeans were sorted out. In the flatter soy spirals, 60-70% were sorted out.

• Maize grains

As with stones, the differences in the spirals are also clearly visible for maize. With the steep spiral No. 3 the cleaning success was only 18% on average of all test runs. By far the most effective was spiral No. 2 (Pioneer), which sorted out 65% of the maize grains. With spiral No. 1 (Amos), which, as already mentioned, only differs in a slightly flatter flight angle, the success rate already dropped to 37%.

• Thistle flowers

On average, about 50% of the thistle flowers were separated, with a range of 40% to 74% (the latter was achieved again with spiral No. 2).

• Intact soybeans in the collection bin

Critical for the suitability of the device is, of course, how much of the intact beans end up in the bin. The amount of intact soybeans in the collection bin increases logically with decreasing banking and increasing flight angle. With the steep spiral No. 3, values of less than 1% intact soybeans in the bin have been achieved in many cases. Only for the variety Primus with its oval beans the value was 10.9%. This is probably also explained by the fact that the beans were moister than the comparative samples. With the less steep soy spirals No. 1 and 2, 1.6% and 5.0% of the intact beans were found in the collection bin.

Cleaning success of different variety/spiral combinations

Throughput: Around 1 t/h (inlet cone 1.7 cm wide open). Three repetitions per combination.

	Straw 0,7 g/kg	Pods 1.0 g/kg	Stones 7.0 g/kg	Half soybeans 5 g/kg	Maize 7 grains/kg	Thistle flowers 7 pieces/kg	Intact beans in bin
Variety Protibus, spiral 1 (Amos)	98%	100%	70%	65%	37%	50%	1,6%
Variety Protibus, spiral 2 (Pioneer)	98%	100%	78%	69%	65%	74%	5,0%
Variety Protibus, spiral 3 (steep)	96%	100%	65%	52%	15%	40%	0,8%
Variety Protibus, spiral 3 (steep); Throughput reduced to 0.38 t/h	90%	95%	54%	53%	40%	47%	0,8%
Variety Primus, spiral 3 (steep)	96%	92%	60%	59%	23%	53%	10,9%
Variety Merlin, spiral 3 (steep)	93%	95%	51%	53%	17%	53%	0,4%

Assessments from the practice

During our research we have had several conversations with manufacturers, distributors and users of spiral separators. Here are some quotations on the potential of the technology for the processing of soy:

- **Dr L. Steven Beckham, Amos AgMachinery, USA:** "You won't find a significant soy processor in the USA who doesn't know the technology. It is not used everywhere, but it is widely spread."
- **An Austrian storekeeper who uses the machine to clean around 3,500 tonnes of soy for soymilk production every year:** "I use eight units and am completely satisfied. The spiral separator does the final finishing touches for me after the conventional cleaning. In particular straw residues, which are otherwise difficult to remove, are separated superbly. Broken grains are sorted out as well, which is not a big disadvantage for me, because I can sell them as animal feed".
- **Georg Reiter, Reiter Seed Processing, Germany:** "I see the greatest opportunities for the spirals in the seed processing of soy. Here, the separation principle based on rolling behaviour comes into its own, with zero energy consumption. If the spirals are used for sorting out stones, there is always a loss of half and possibly flat beans. In individual cases this can result in financial losses if the residues must be sold at significantly lower prices. In this case a destoner would be a good alternative because there is practically no product loss."
- **A German soybean seed processor:** "I have just installed the spiral separator for soy and am satisfied with the results. It is astonishing that the device is so little widespread in Europe so far, in America it is widely used".

Manufacturer

- **Representative of the manufacturer H&T:** "We are currently developing a new test spiral flight. I am confident that this will enable us to offer even more precise spirals in the future".

The manufacturer H&T, a small forge in Arkansas, USA, has specialised in spiral separators for over 40 years. The company has a lot of experience with the subject and continues to work with heart and soul on optimising the technology. The processing quality of the spirals does not meet German standards, but they do their job. H&T supplies various providers of processing equipment with spirals for various crops. The Danish supplier Westrup has for many years offered spiral separators with H&T spirals, also for the European market. Recently, Reiter Seed Processing from Landshut has also started to offer spiral separators with H&T spirals.

Conclusion

The spiral separator for soybeans is not a precision device. But it trumps with its simple construction, great robustness, simple operation and a very favourable price. Many years of use with professional soybean processors show that the device can be used as a supplement to conventional cleaning devices. Especially when it is necessary to separate straw, hulls, sclerotia, maize or broken grain from otherwise completely cleaned beans without much effort and without damaging the grain, the machine can do a good job. As far as stones are concerned, we believe that a spiral separator can only be expected to have medium success. The fact that broken grains are inevitably cleaned out strongly is to be evaluated individually according to the desired product.

Basically, it can be said that the success of the device is strongly influenced by the condition of the soybeans. We were surprised to what extent, for example, the quality of work correlates negatively with the bean moisture. An increase in moisture by a few percent can already call into question the success of the work. The same applies to the shape of the beans: strongly oval soybeans can only be considered if larger losses can be accepted.

Links to the topic

www.spiral separators.com

Website of the manufacturer H&T from Arkansas with detailed sketches, instructions, product overview etc.

<http://amos-agmachinery.com/products-information/>

Very good, clear instructions from the plant manufacturer Amos from Indiana, who uses the H&T spirals frequently for soy and has detailed experience on the subject.

<https://www.reiter-sp.com/produkte/saatgutaufbereitung/spiralseparatoraren.html>

Website of the company Reiter Seed Processing from Landshut, which distributes H&T equipment in Germany, including competent advice.

<http://westrup.com/Products-Seed-and-Grain/Fine-cleaners/HT-2>

Website of the company Westrup from Denmark, which also offers the spiral separators from H&T in Germany.

<http://ukragro serv.com.ua/de/>

Website of a Ukrainian manufacturer. The section about the spiral separator is unfortunately only available in Ukrainian/Russian. We have not researched to what extent soy-suitable spirals are available for the device.

For comprehensive information on all aspects of soy cultivation visit:

www.sojafoerderring.de

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