BANKNOTE TECHNOLOGY REPORT

2023

HUNKELER SYSTEME

ENERGY SAVING DURING THE WHEEL OF DESTRUCTION

Energy Saving during the Wheel of Destruction

HUNKELER SYSTEME

Sustainability is becoming key for our world of tomorrow – Central Banks around the world & the banknote industry are targeting an improved cash cycle. An uncontrolled shredding process can waste up to 100 kW/h, therefore it is essential to pay attention to the end of the lifecycle of a banknote:

An optimized destruction process with the right shredding equipment can support a Central Bank's sustainability target, and support the right recycling strategy for unfit banknotes.

The Wheel of Destruction

Hunkeler Systeme created the "Wheel of Destruction" (see below graph) to achieve a sustainable process in banknote destruction via different steps (see next page(s): Notably, process steps two (2) till five (5) unveil efficiency / energy saving potentials which should be reviewed by each Central Bank.

1. SORTING/WASTE

The pre-defined quality criteria are set by a Central Bank determine the fitness of a banknote at the point of processing. Declared 'Fit' Banknotes will be re-circulated within the banking system, while soiled / worn-out and declared 'unfit' banknotes will be returned to the Central Bank for destruction.

2. SEPARATION

Polymer and cotton-based banknotes in circulation require a different destruction process in order to be "fit for recycling". At this point in the destruction process it can be noted that only with the separation of different banknote substrates a downstream recycling process is feasible.

Until now dedicated shredding lines have been processing either 100% cotton or 100% polymer banknotes. Due to the increased
switch to a mixed substrate strategy by the Central Banks we need to differentiate two different types for destruction:

(I) SEQUENTIAL or (II) PARALLEL: While for (I) the shredding process is fully dedicated to handle only one single substrate at the time, for a parallel sorting and destruction (II), different substrates can be processed simultaneously for destruction, as this system is built up on different "shredding pipelines" which are automatically switching when shredding the one or other substrate.

WHICH SUBSTRATE REQUIRES WHICH DESTRUCTION TYPE?

OPTION 1: COTTON AND COMPOSITE SUBSTRATE IN CIRCULATION.

If cotton and composite banknotes are in circulation, there is no need for separation and sequential shredding is sufficient depending on the recycling process.

Key Findings:

- Cotton and composite substrates with up to a 30% cent polymer /plastic proportion contain the same degree of briquetting feasibility
- The briquettes of both shredded banknote substrates can be used afterwards to the same degree e.g. burning for heating (systems)
- In case briquetting is not required, a big bag or container can be adapted at the end of the destruction lines. The loose material can then be used e.g. for the production of other products such as automotive parts

OPTION 2: COTTON / COMPOSITE AND POLYMER SUBSTRATES IN CIRCULATION (MIXED SUBSTRATES).

In case a Central Bank employs a mixed substrate stratetgy compromising at least one denomination on a polymer substrate, it is recommended to adapt the destruction line to a parallel shredding process. On one line the polymer banknotes will be shredded while the other line is fully dedicated to the shredding of the cotton or composite banknotes. This is required by the nature of the polymer substrate, as a high degree of purity is required for a possible recycling process afterwards. With this purity approach the shredded polymer notes are fit for recycling into other high quality plastic products. For the cotton-based substrates (100 %cotton or composite solutions) standard briquetting can be put in place at the 2nd line of the parallel shredding process (see also above explanation for Option 1).

Key Findings:

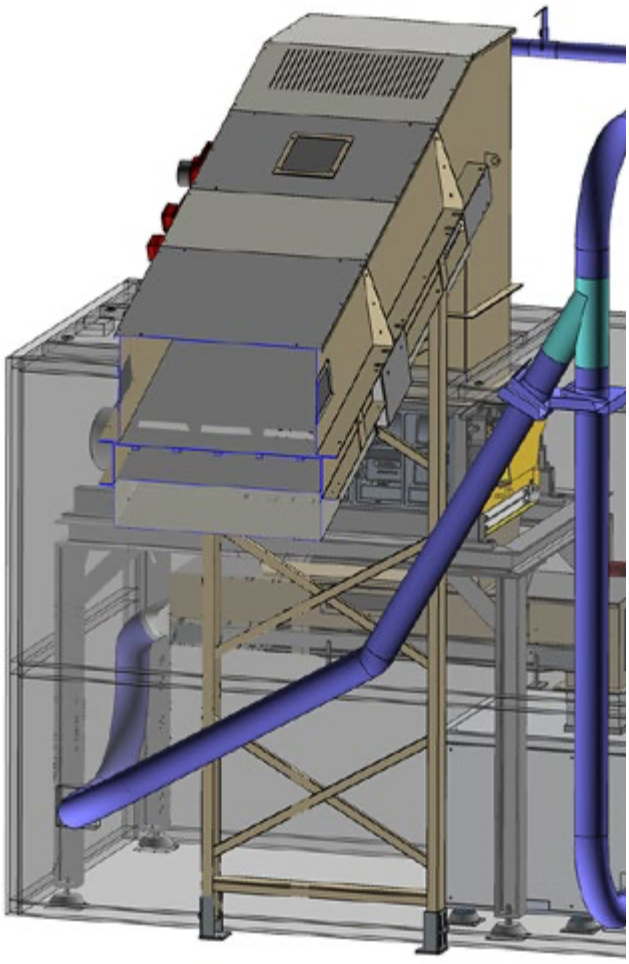
- Mixed substrate strategy requires a parallel shredding system / process to enable recycling.
- Polymer substrate needs a high level of purity for a correct recycling approach.
- A sequential destruction should only be considered if the banknote shreds cannot be recycled

OPTION 3: 100% POLYMER SUBSTRATE IN CIRCULATION

In this case a dedicated destruction line meets the shredding demand. As briquetting is not possible for polymer material the destruction lines are usually equipped with a big bag or stationary press with an exchangeable container solution (in case of larger destruction volume).

Polymer tends to get stuck in various places in the system during the destruction process due to the static charge. The design of the destruction process should comprise of:

- antistatic belt at the conveyor belt
- scraper on conveyor belt
- non-painted inner and clamping surfaces at shafts
- antistatic filter bags
- temperature sensor in the granulator due to the low melting properties of the polymer material



3. SHREDDING

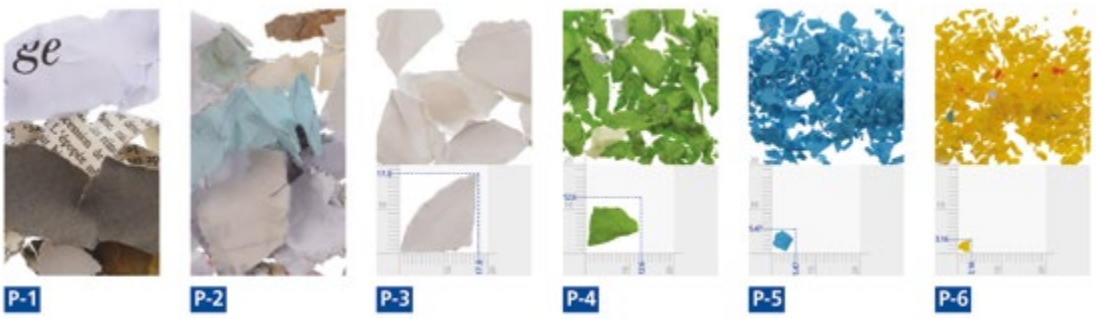
Now we come to the key destruction and we need to differentiate between either a (a) one-stage or (b) two-stage destruction system.

For a "one-stage" destruction system, the shredder chops up the banknotes to the required particle size. Based on the general security level for the destruction of unfit banknotes, a minimum security level of P4 (P5 for lower volumes) conforming to the DIN-66399 is required, while a security level 4 and lower are used e.g. for unprinted banknote sheets.

At the "two-stage" destruction process higher security levels Level 4+ can be achieved with a post granulator with its long-lasting shredder blades. This shredding process is required e.g. for unfit banknotes out of circulation or finished printed banknote sheets at the printing premises which do not match specifications.

Reduction from a two-stage to a one-stage destruction process can cause savings of thousands of Euros p.a. as one shredder aggregate requires up to 25 kW/h less consumption compared to a granulator (two stage process).

The Hunkeler control and workflow manager is continuously monitoring the entire disposal process during the production time. All the relevant information is being stored and displayed in a central control station. The interface allows a transparent view of the actual production as well as of the history data. The workflow software shows transparently to the supervisor in real time the status of the destruction line and the summary of the production data's within a day or a week. The visualization tool is an extension of the HCM PVS17 software and can be adapted to the customer host via XML, CSV interfaces.



LONGEVITY OF SHREDDING KNIVES

It is recommended to pay attention on the longevity of shredding as this reduces maintenance costs and can result in saving of a solid four-digit Euro value per year.

4. FILTRATION

Banknote shreds and other production waste all interfere with production when aiming at higher levels of economic efficiency. The dust-loaden transport air is cleaned in the jet-filter and is either returned to the production rooms or exhausted outside the building; this is the base of saving energy with conditioned (warm / cold) air treatment.

5. BRIQUETTING/COMPACTING

The shredded particles then are sent into a briquetting system or a bagging system.

Main target at the Briquetting/Compacting step is the volume reduction by a factor of up to 12 times. A specific pressing force of 1700kg/cm^2 is the minimum requirement to keep a solid compact shape of the briquettes.

Feasibility of briquetting depends on the substrate type and we need to differentiate between:

a. polymer substrates
b. cotton based substrates inclusive composite

Cotton-based and composite (cotton/polyester) banknotes of up to a 30% polymer/plastic proportion have excellent briquetting properties. The density of pure cotton-based banknotes is significantly higher than composite based banknote shreds.

As for polymer banknotes, briquetting is not feasible, and alternative solutions for shred transportation must be considered (‚Big Bag' solutions for small to medium volume amount or Stationary press /exchangeable containers for large scale destruction volumes).

Key findings
The quality of briquetting is a driver for:

- better transport possibilities
- reduced CO2 footprint
- better burning properties
- easier handling for further processes
- lower disposal costs
- increased cleanliness at the workplace

6. STORAGE/ HANDLING

It is necessary to store the shredded banknotes in an easy-to handle and compact form. Briquetting / compacting of shredded banknotes supports the storage capacity of shredded banknote material:

Calculation example:

- ≈ 100'000'000 shredded banknotes
- ≈100'000 kg
- ≈1000 m3 shredded notes (not compacted / loose)
- ≈100 m3 cotton briquettes

7. TRANSPORT

The transport routes must be taken into consideration when evaluating the most sustainable approach. The following parameters need to be put into consideration:

- volume of shredded banknotes until a full truck can be loaded
- recycling option for shredded banknotes vs distance of transportation

It can be more sustainable to avoid long transport routes for recycling and to incinerate the waste in a controlled manner next to the central bank destruction location.

Lets have a look at a calculation scheme: Transportation of 100 tons shredded cotton banknotes will require several times the total amount of tours if shredded banknotes are not briquetted /compacted: Uncompacted storage and transport leads to unnecessary environmental impact.

8. DISPOSAL / RECYCLING

To learn more about it, please see the recent published 'Sustainability & Destruction Technology' page 10ff

www.banknote-industry-news.com/recycling-report

CLICK OR SCAN

ENERGY SAVING WITH THE GREENLINE CONCEPT

The Greenline Concept from Hunkeler Systeme AG is an energy & cost saving system based on the following parameters:

1. **Automatic switch-off assistant (ASA)**
   A suction system consumes energy at a steady level, whether it is transporting material or not. With the ASA, the suction system is only operating when suction is required, otherwise it is automatically switching off.
2. **Energy saving system (ESS)**
   The energy saving system regulates the energy consumption according to the actual need. With an integrated ESS, the electrical energy can be lowered by up to 40%

3. **Recovery of waste heat from a suction system.**
   A suction system is generating thermal energy when operating. The warmed air allows to heat the production rooms in the cooler months of the year.
4. **Concept and architecture**
   A state of the art concept and architecture of the system including high efficient drives and components reduces the general level of energy consumption and reduces the operating costs for the system.

HUNKELER SYSTEME AG

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TECHNICAL FACT SHEET

- The Greenline Concept increases the sustainability of your system.
- The ESS can save up to 40% of the energy consumption of the suction system
- A specific pressing force of 1700kg/cm^2 is required to produce perfectly shaped briquettes
- Recovery of the filtered process air back into the production environment saves energy for AC-units engravings.