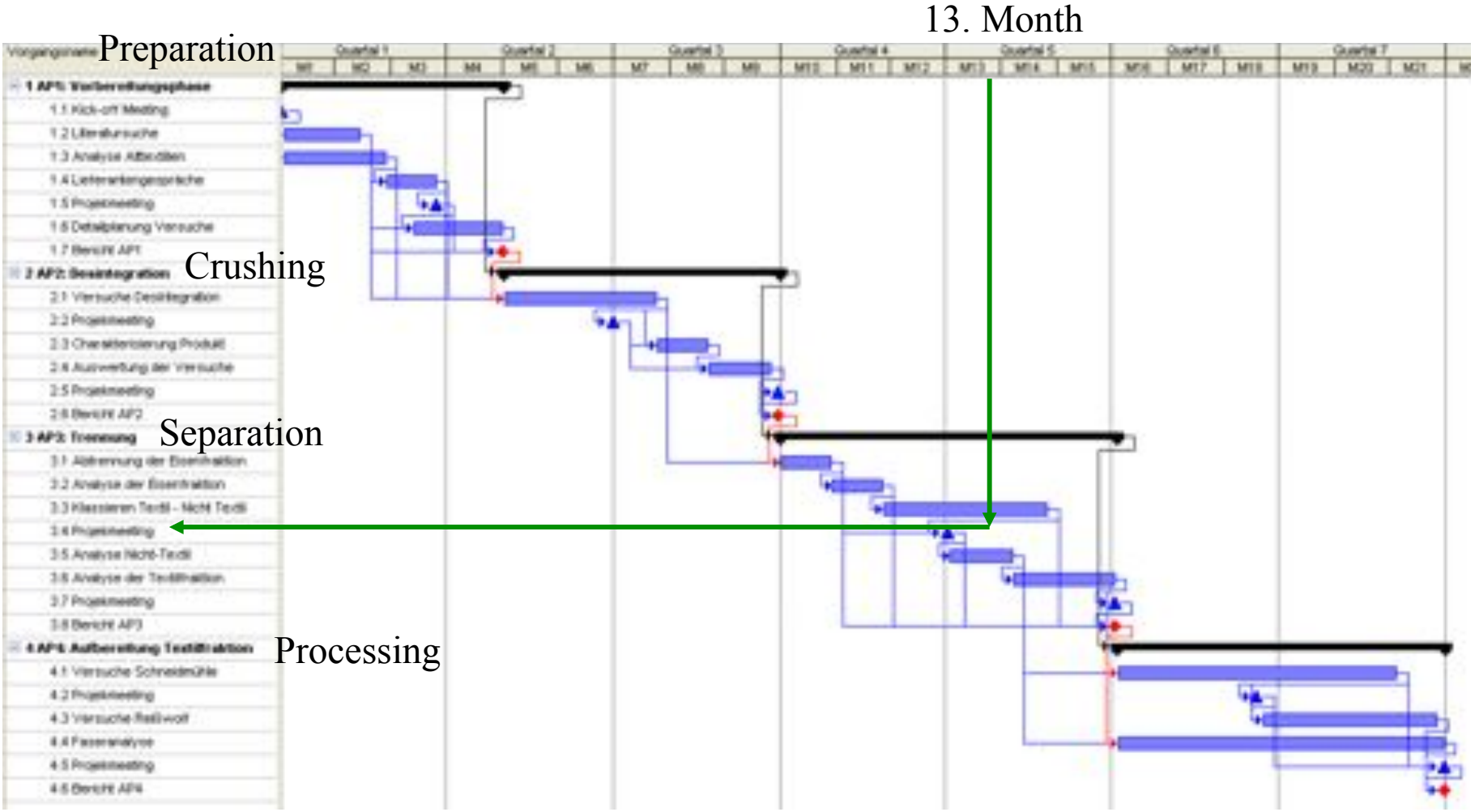
Project Name:
Stoffliche Verwertung der Textilen Restfraktion

Work Package 2 / 3:
Crushing and Separation of Textile Waste

Prepared by: A.Sebnem Haner

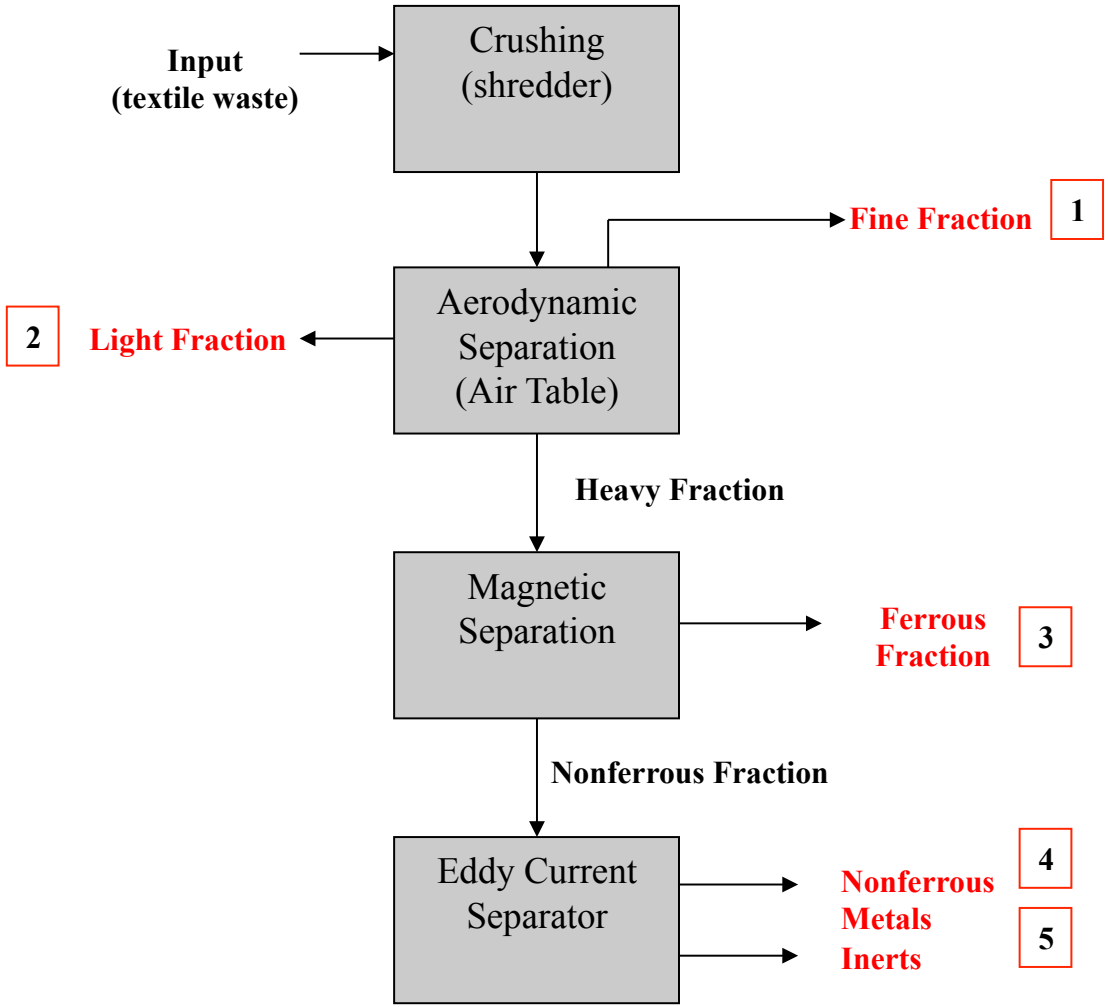
Project Meeting; September 22, 2009

Project Time Plan

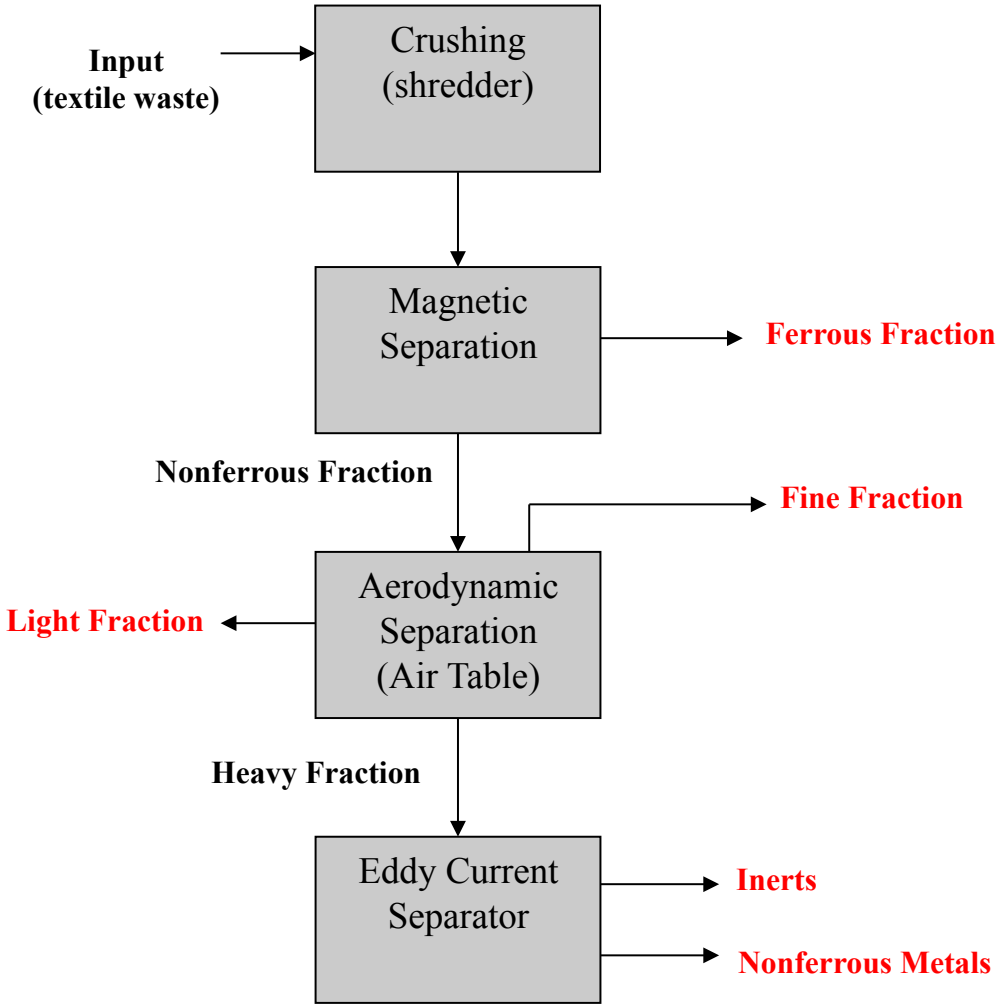


Introduction

Processing of Textile Waste (1)

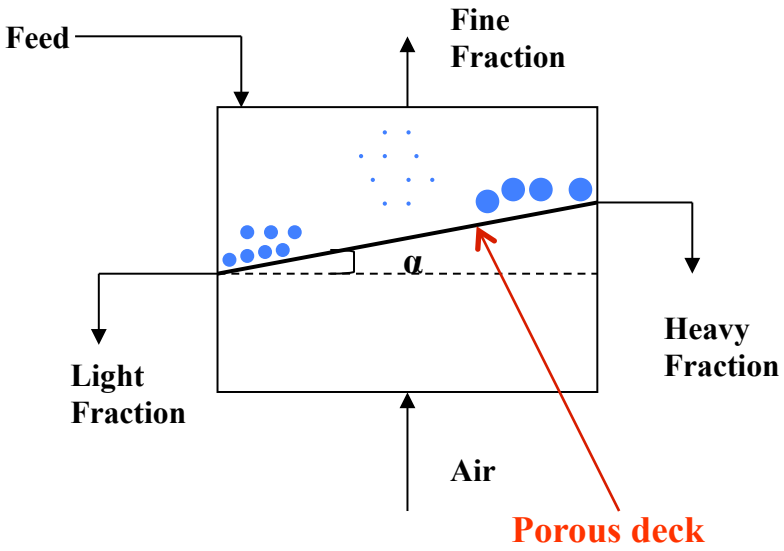


Processing of Textile Waste (2)



Low Efficiency in magnetic separation since iron materials are covered by textile material (light fraction).

Principles of Air Table



Parameters adjusted:

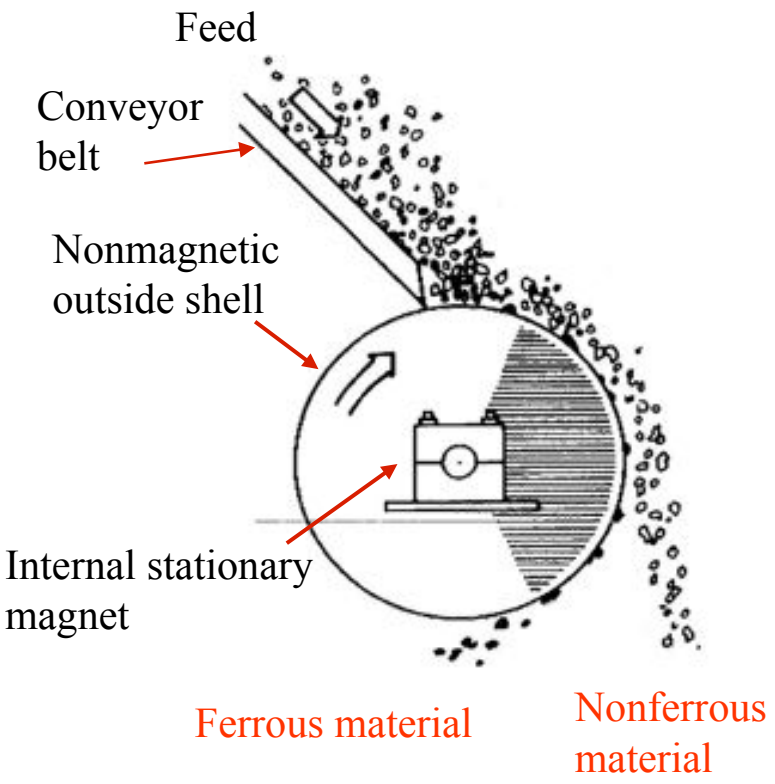
- velocity of air
- inclination of porous deck
- vibration frequency of porous deck

Advantages:

- dry method
- no chemical pre-treatment
- less energy

The size of the mesh of the deck is smaller than the size of the smallest particle in the mixture, disallowing particle falling through.

Principles of Magnetic Separation



Ferrous materials are magnetic.

Hence, they can be removed with magnetic separation technologies;

- to purify streams of granular material,
- to protect grinders, crushers, and other processing equipment against tramp iron damage.

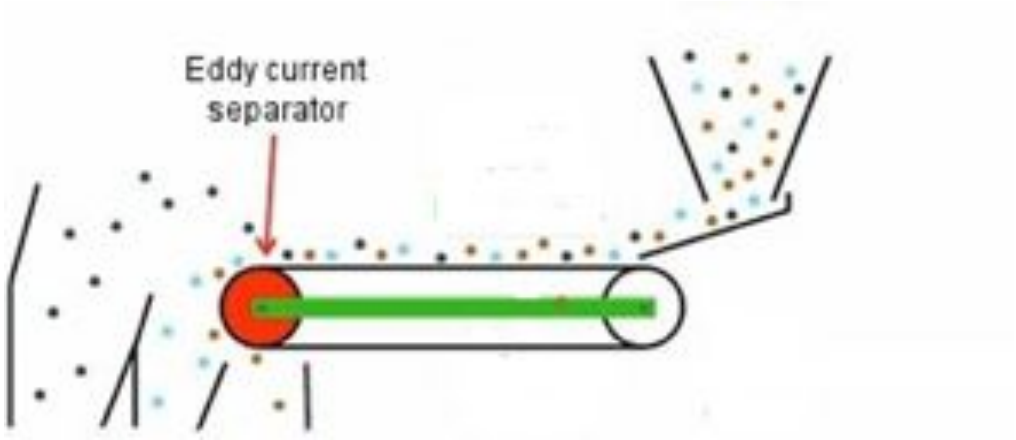
Due to the magnetic field in the drum:

- **non-ferrous metals** are repelled,
- **iron** is attracted.

Principles of Eddy Current Separator

• separates non ferrous metals (like aluminium, copper, brass, etc.) from inert materials (glass, stones, plastic, wood, etc.).

• eliminates the smallest parts of the ferrous metals left from the sorting with magnetic separator.



Non-ferrous metals Inerts Iron

Due to the magnetic field in the head:

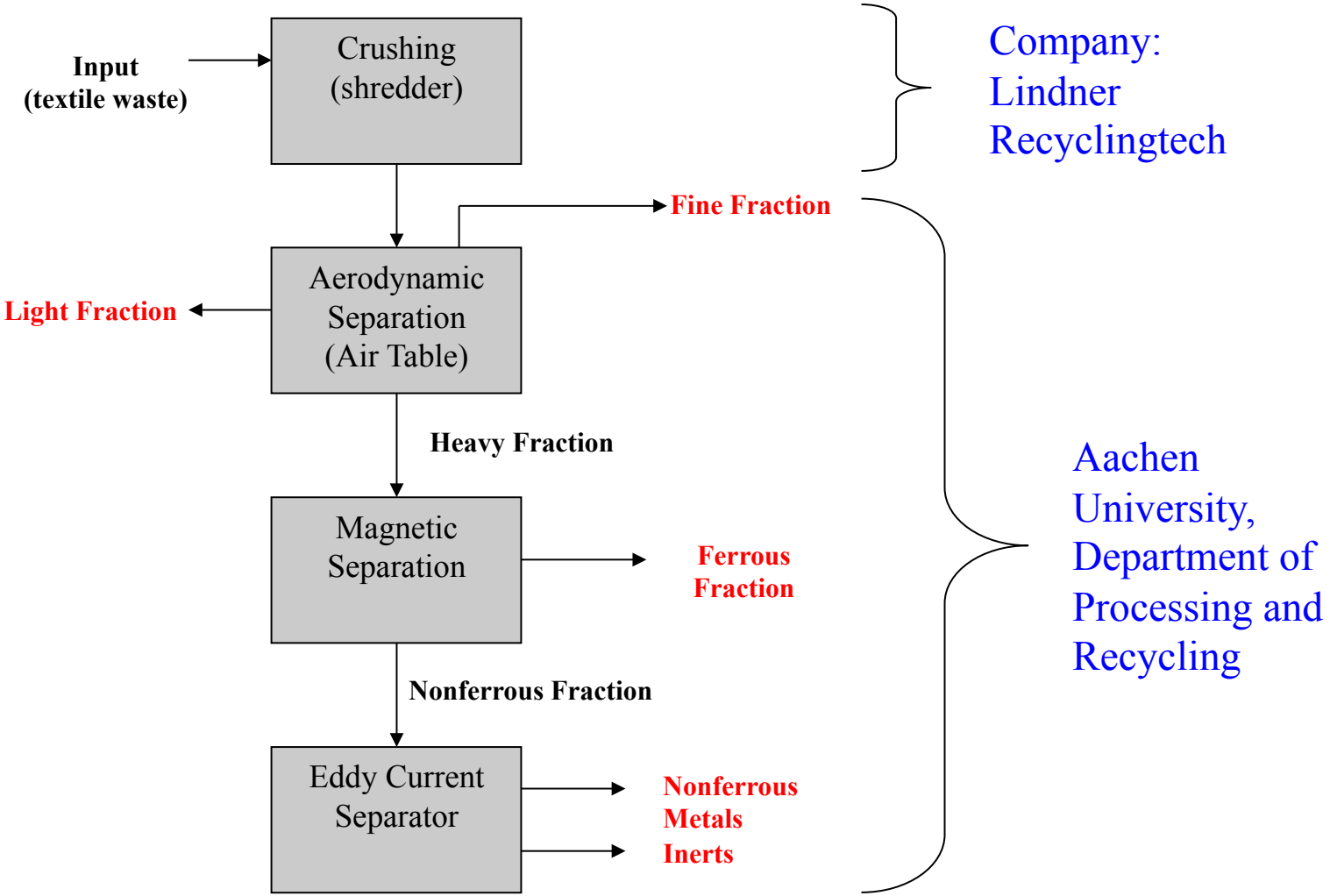
• **non-ferrous metals** are repelled,

• the **inert materials** freely fall down,

• **iron** is attracted.

Experimental Work

Processing of Textile Waste



Crushing: Samples

Waste

1. One bale of general textile **waste**
2. One bale of **apparel** from second-hand shops
3. One bale of **home-textiles**

Apparel

Home-textiles

Crushing

collection

product

Feeding of bales

crusher

Screens

Blades

Crushing: Processing Parameters

Three bales of textile waste have been crushed with a shredder having a power of 160 kW.

•Processing of the first bale (general textile waste):

m = 450 kg

size of screens = 20 mm

time = 20 min

$$power = \frac{160kW * (20/60)h}{0.450t} \cong 120\,kWh/t$$

•Processing of the second bale (apparel):

m = 427 kg

size of screens = 20 mm

time = 20 min

$$power = \frac{160kW * (20/60)h}{0.427t} \cong 120\,kWh/t$$

•Processing of the third bale (home-textiles):

m = 328 kg

size of screens = 35 mm

time = 6 min

$$power = \frac{160kW * (6/60)h}{0.328t} \cong 50\,kWh/t$$

Separation process: Samples

The same bales have been used in the separation process,
but labels of the bags are lost during the transport,
and following new names are given to the samples:

- Bag 1 (20 mm sieves)
- Bag 2 (20 mm sieves)
- Bag 3 (35 mm sieves, hometextiles)

Air Table

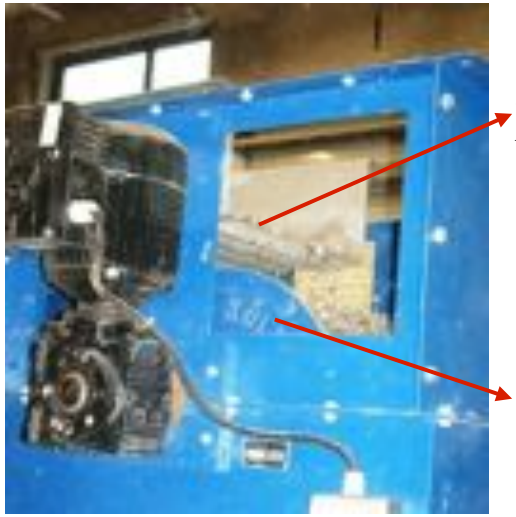
Fine fraction

Feed

Light fraction

Heavy fraction

Magnetic Separation



Conveyor belt

Magnetic Drum

Ferrous material

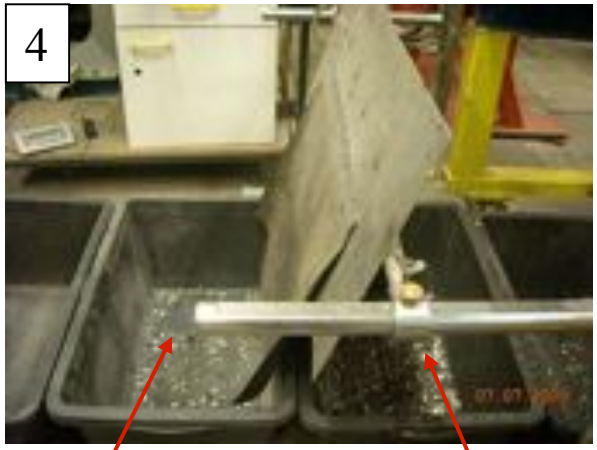
Nonferrous material

Eddy Current Separator

Conveyor tape

Feed

Head, the area of magnetic field



Nonferrous metals

Inerts

Results and Discussion

Mass Balance for the Separation Process

Fractions	Bag 1 (20 mm sieve)		Bag 2 (20 mm sieve)		Bag 3 (35 mm sieve)	
	Mass (kg)	Percentage (%)	Mass (kg)	Percentage (%)	Mass (kg)	Percentage (%)
Fine Fraction	21.4	7.2	19.0	7.8	17.7	7.7
Light Fraction	262.0	88.6	222.0	91.1	177	76.6
Ferrous Fraction	2.9	1.0	1.5	0.6	3.5	1.5
Nonferrous Metals	1.8	0.6	0.8	0.3	1.5	0.6
Inerts	7.7	2.6	0.4	0.2	31.4	13.6
Total	295.8	100	243.6	100	231.1	100

Fibre Contents of Samples After Crushing Process

			Apparel	Waste	Home-textiles	Mill Consumption*	World Production+
Man-made fibers	Cellulosics	Viscose	2.5	0.0	3.6	11.7	4.9
		Acetate	4.7 (10.1)	3.7 (4.6)	5.6 (10.2)		
		Triacetate	2.9	0.9	1.0		
	Synthetics	Polyamide	2.6	3.4	4.8	2.6	5.3
		Polyester	11.4	8.9	9.6	27.6	42.5
		Acrylic	9.5	8.9	7.2	5.5	3.3
		Polypropylene	3.6	6.1	6.2	18.5	5.6
		Polyethylene				-	
		Elastane	2.9	2.2	5.2	-	-
		Others #	-	-	-	0.5	0.9
Natural fibers		Cotton	27.1	46.4	27.4	22.4	35.7
		Wool	12.9	5.6	10.0	11.3	1.7
		Silk	14.1	9.0	13.4	-	-
		Insoluble	5.8	5.7	6.0	-	-

* Mill consumption according to end-uses in Western Europe in 2005 (CIRFS, 2008).
\+ World production in 2007 (CIRFS, 2008).
\- No data available.
\# Others include aramid, elastane, PVA/PVC.

Fibre Contents of Samples After Air Table (Light fraction)

			Bag 1	Bag 2	Bag 3 (Home-textiles)	Mill Consumption*	World Production+
Man-made fibers	Cellulosics	Viscose	6.6	17.7	9.1	11.7	4.9
		Acetate	3.8 + 10.4	1.0 + 20.7	3.3 + 13.0		
		Triacetate	0	2.0	0.6		
	Synthetics	Polyamide	4.0	6.1	4.9	2.6	5.3
		Polyester	8.1	3.9	8.4	27.6	42.5
		Acrylic	4.7	3.6	3.5	5.5	3.3
		Polypropylene	4.3	3.9	6.4	18.5	5.6
		Polyethylene				-	
		Elastane	2.8	4.6	3.6	-	-
		Others #	-	-	-	0.5	0.9
Natural fibers		Cotton	50.1	33.8	42.0	22.4	35.7
		Wool	8.6	9.6	9.9	11.3	1.7
		Silk	1.9	0.6	3.6	-	-
		Insoluble	5.8	13.1	4.7	-	-

* Mill consumption according to end-uses in Western Europe in 2005 (CIRFS, 2008).
\+ World production in 2007 (CIRFS, 2008).
\- No data available.
\# Others include aramid, elastane, PVA/PVC.

Conclusions

- Separation of textile waste has been performed and 5 fractions have been obtained.

  - Textile fibres are separated from ferrous materials, non ferrous metals and inert materials successfully.

- Textile waste contains 90% of reusable fibres, being cotton the predominant fibre (up to 50%).

- In the crushing process,

  - 20 mm sieves should be preferred instead of 35 mm sieves,

  - while 35 mm sieves result in 15 % loss of fibre material,

  - which is still being attached to inert material such as plastic buttons.

Outlook

- Processing of light fraction using cutting mill to obtain different lengths.
- Fine fraction: Directly application?
- Nonferrous metals and ferrous fraction: Recycling?
- Inerts: Further processing ?