

# Disruptive Technologies and Innovative Additives for PET Recycling

**Dr. Carl-Jürgen Wefelmeier (Gneuss):**  
**Post Consumer Tray Recycling**

**Dr. Axel Hannemann (Gneuss):**  
**Use of Post Consumer PET in Bottle und Fibre Production**

**Alessandra Funcia (Sukano):**  
**Ensure Productivity and High Quality Processability of the Final RPET Application  
with Sukano Masterbatches**

# Company History

## Development of Factory Site in Bad Oeynhausen



### Foundation 1983

Auf den Köppen, Bad Oeynhausen



### 1st Expansion 1996

Enlargement of production, engineering and administration departments



### 3rd Expansion 2015

Adding a further floor to the office building, new hall construction and complete restoration, doubling the number of employees since 2010.



### Move 1989

Mönichhusen, Bad Oeynhausen



### 2nd Expansion 2010

New hall construction for production & technical center



### 4th Expansion 2018

Second technical center for trials



- + **Made in Germany**
- + 200 employees worldwide
- + Worldwide distribution with **55 Sales & Service Locations**
- + Subsidiary Gneuss Inc. **USA**
- + Gneuss centers in **Brazil** and **China**
- + 36 years of successful development

## **Gneuss at a glance** **Who we are**

**Dr. Axel Hannemann**  
Disruptive Recycling Technologies







**Extrusion  
Technology**



**Filtration  
Technology**

**Measurement  
Technology**



**Turnkey  
Solutions**



# Technical Center

## Lab lines for your trials



- + Product demonstrations
- + Sample production for evaluation
- + Trials for determining the optimum equipment specification
- + Trials for customer product development projects



# Gneuss PET Recycling Lines

## Post Consumer Tray Recycling



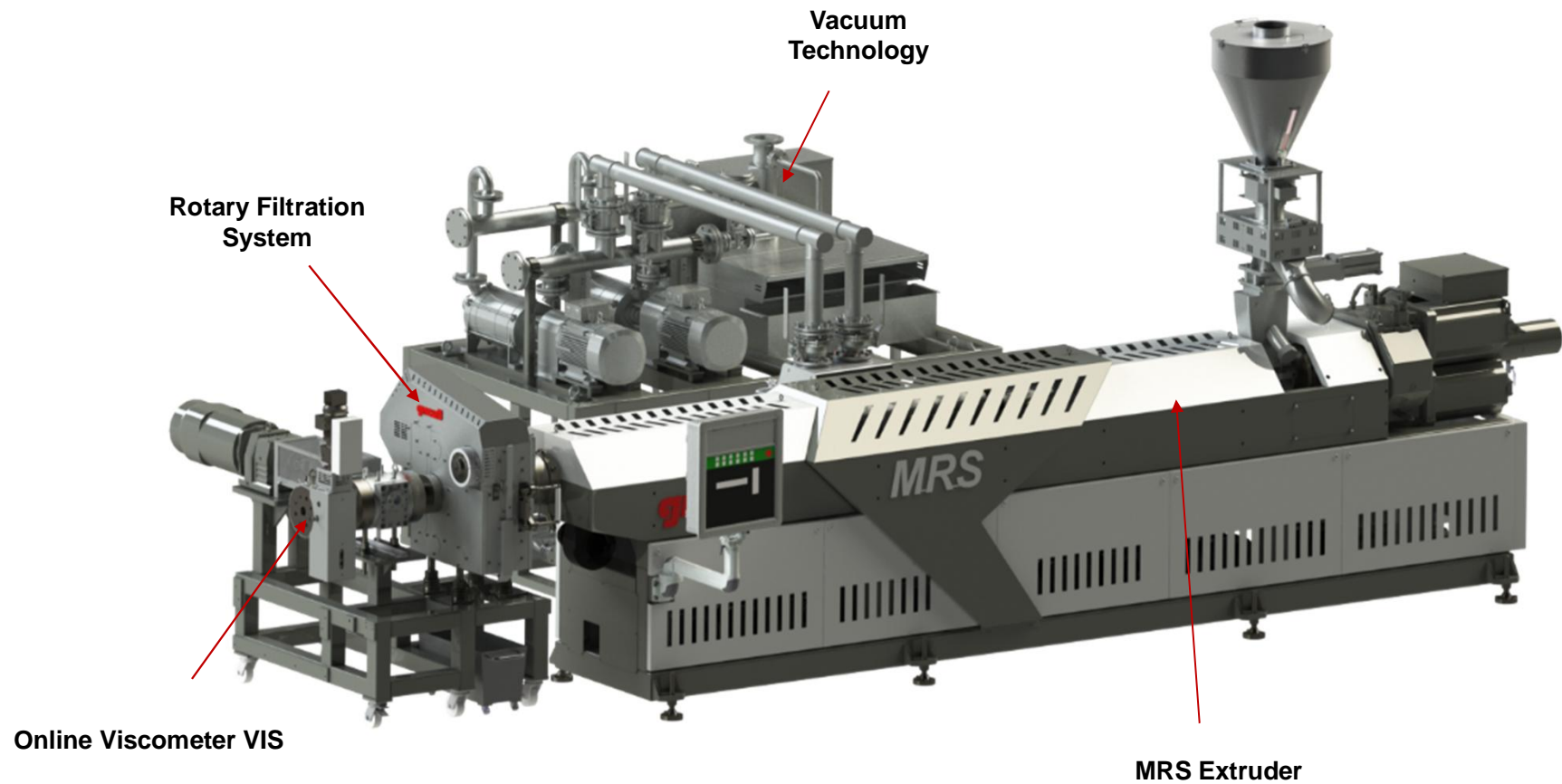
Dr. Carl-Jürgen Wefelmeier  
PET Recycling Lines

## Content

- + Bottle to Tray - MRS Extrusion
- + Recycling Filtration - RSF*genius*
- + Recycling Viscometer - VIS
- + Tray to Tray - MRS*jump* Extrusion

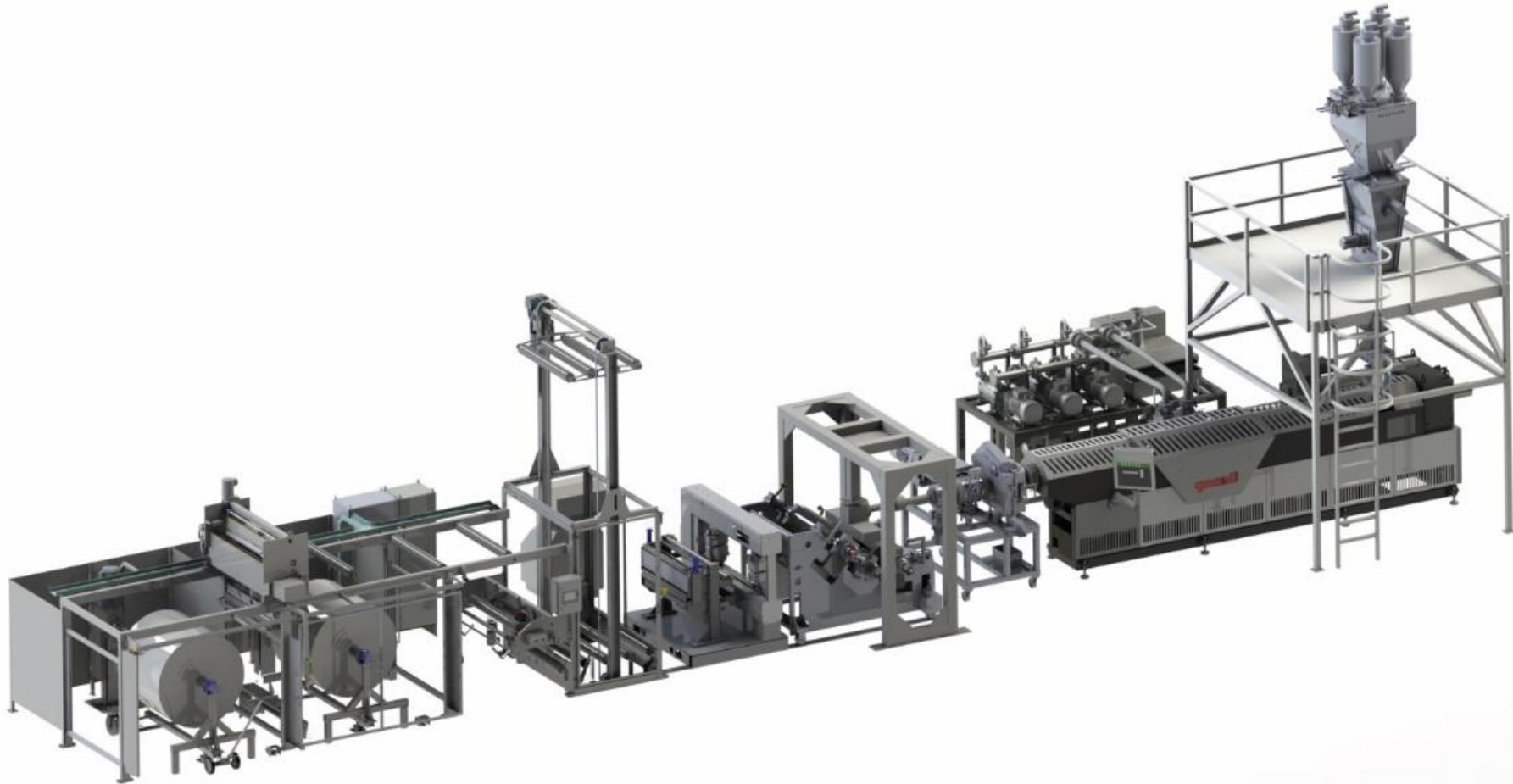
# Bottle to Tray – Multi Rotation System / MRS Extruder

## Gneuss Processing Unit GPU



Dr. Carl-Jürgen Wefelmeier  
MRS Extruder

# Standard Sheet Extrusion Line – Bottle to Sheet / Tray



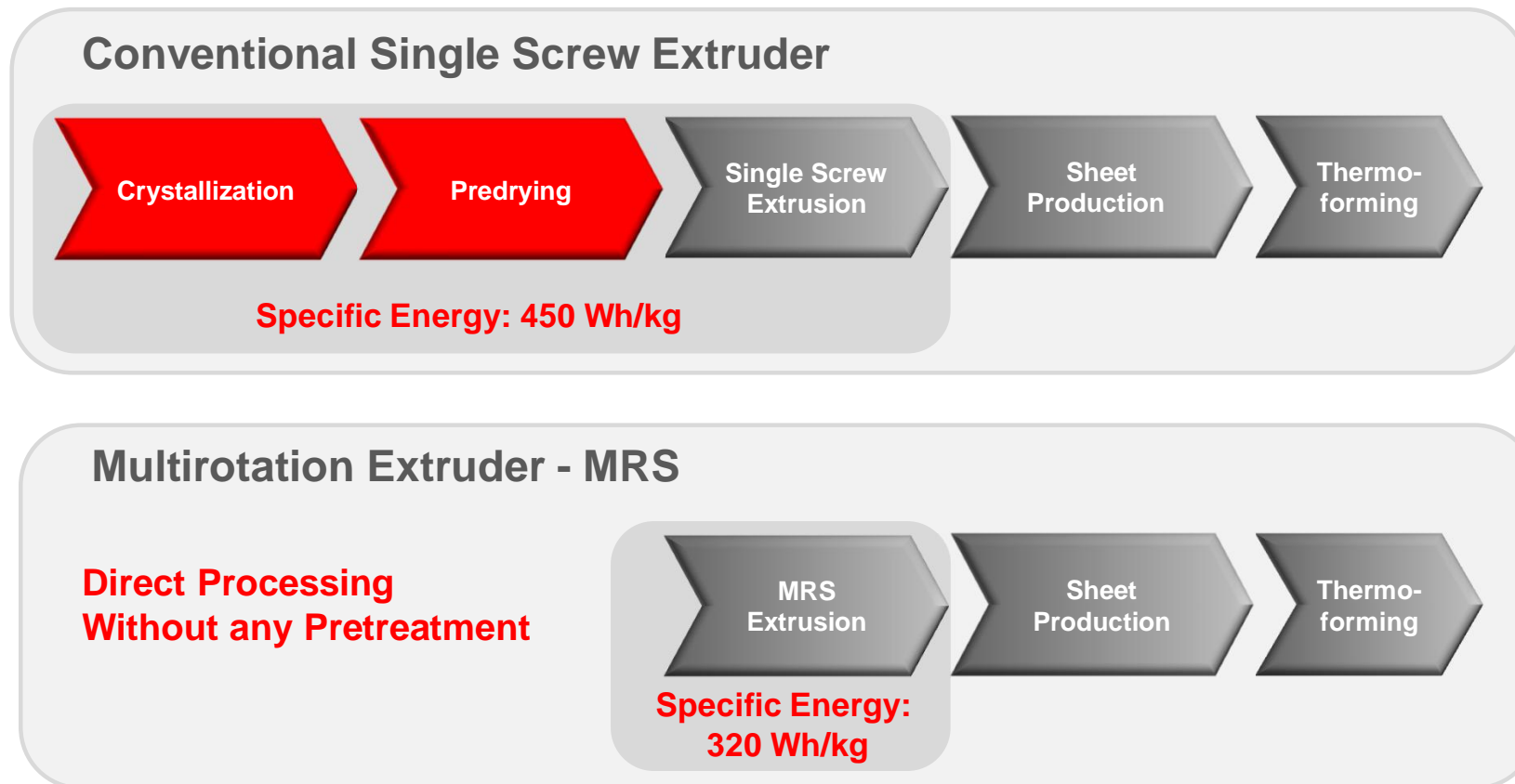
Dr. Carl-Jürgen Wefelmeier  
MRS Extruder

**gncuB**



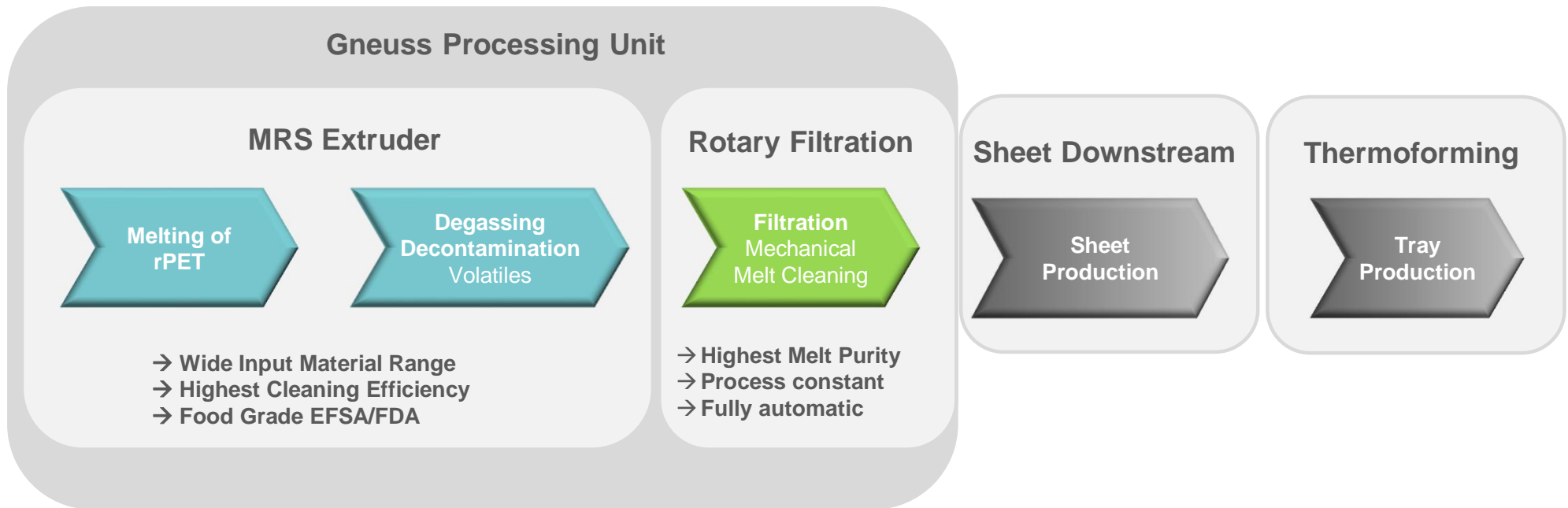
# Direct rPET Processing → Sheet → Tray

Conventional Single Screw Extruder vs. MRS Extruder



# From rPET to a Food Grade Tray

## MRS Extrusion Process Steps



# MRS Extruder

## Design of the MRS Technology



- + Single screw technology with a special, multiple screw section
- + No pre-treatment of the material prior to extrusion
- + Efficient distributive mixing
- + Specifically developed for polyester and recycling applications
- + Efficient devolatilization and decontamination

Dr. Carl-Jürgen Wefelmeier  
MRS Extruder

**gneuß**



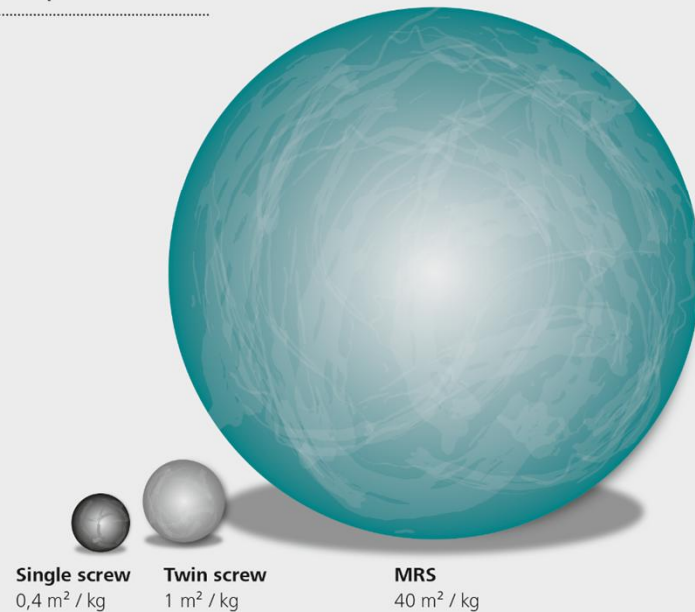


MRS Extrusion System

# MRS Extruder

## Performance and advantages

Surface area exchange in comparison



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MRS Extruder

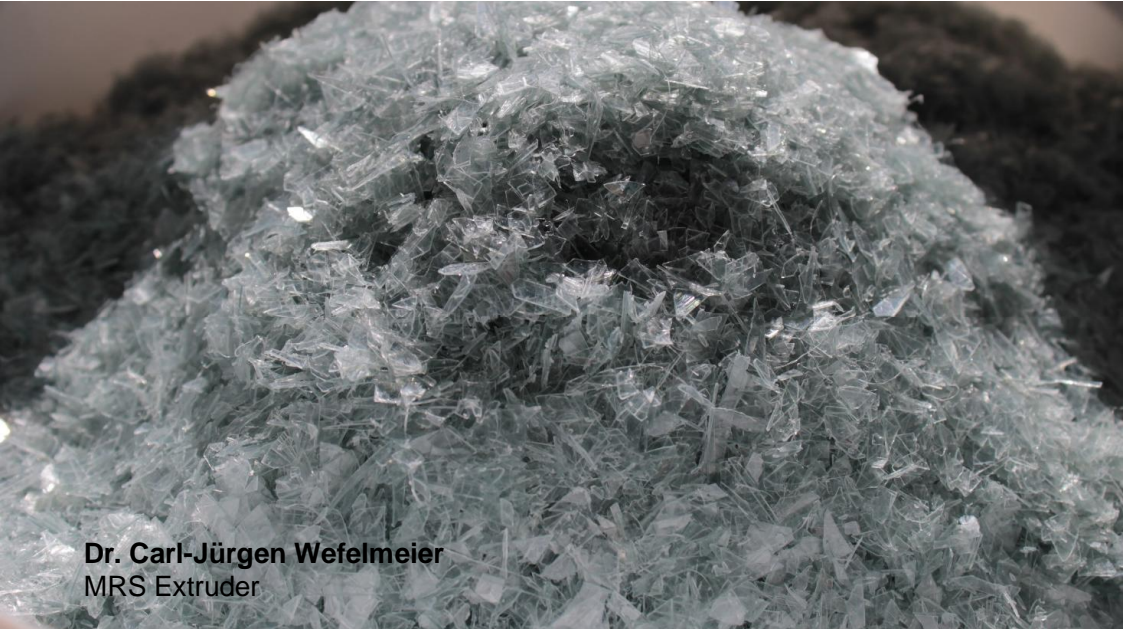
- + Single screw technology with special, multiple screw section
- + No pre-treatment of the material prior to extrusion: no crystallization or pre-drying of hygroscopic polymers
- + Efficient distributive mixing
- + Specifically developed for polyester and recycling applications
- + Efficient devolatilization and decontamination
- + Reduction of energy and space requirement
- + Low thermal stress level
- + Short process chain
- + Excellent transparency, brilliance of final product, extremely low „yellow-value“.

# MRS Extruder

## Food approvals



Large number of approvals for processing up to 100 % post-consumer and industrial polymer waste to food contact products.



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MRS Extruder



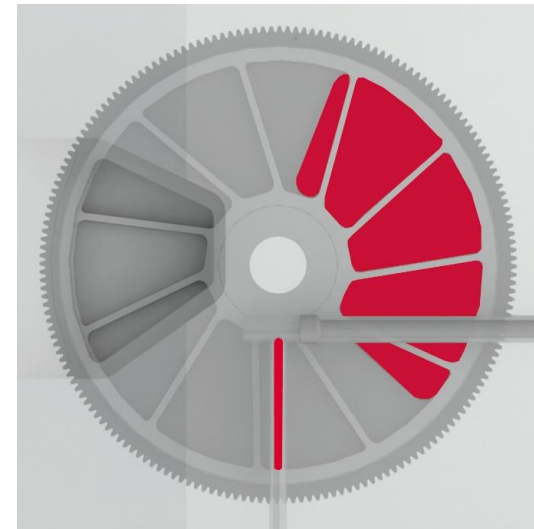




**Filtration in Recycling Applications**  
**Rotary Filtration Systems RSF*genius***

Dr. Carl-Jürgen Wefelmeier  
RSF*genius* Filtration

**gneuß**



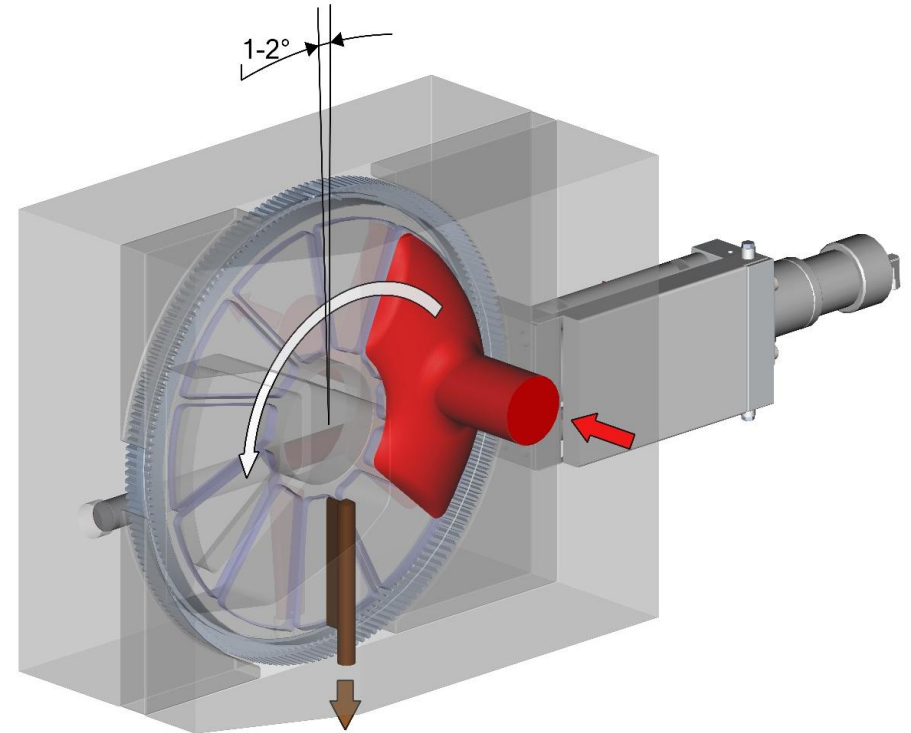
## **RSF*genius*** **Features**

**Dr. Carl-Jürgen Wefelmeier**  
RSF*genius* Filtration

- + Process and pressure constant
- + Integrated backflushing system
- + Encapsulated design
- + Pinion drive
- + Fully automatic
- + Screens in kidney or trapezoidal form

# RSF*genius* Filtration

Fully-automatic, pressure- and process constant



Dr. Carl-Jürgen Wefelmeier  
RSF*genius* Filtration

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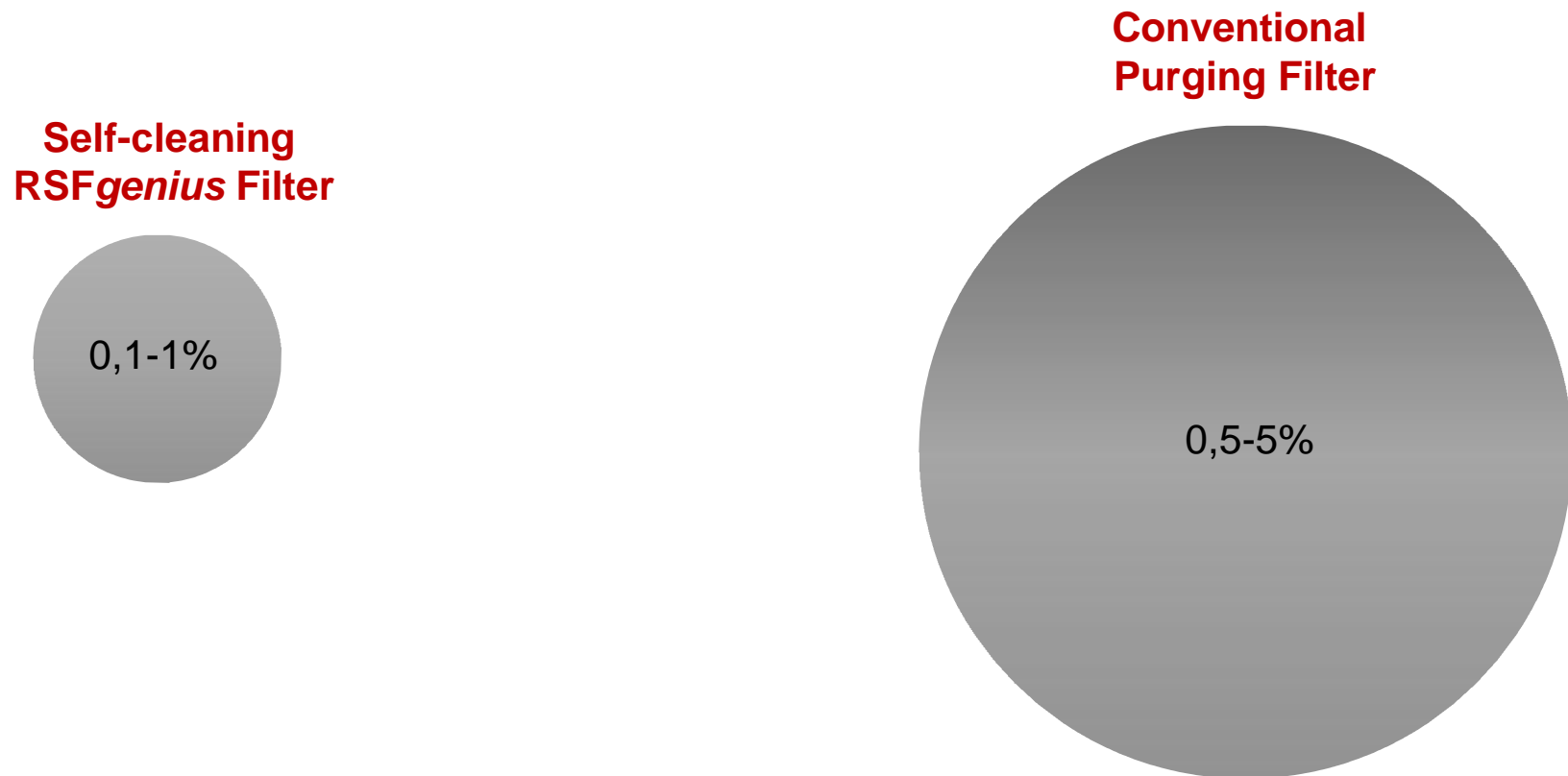


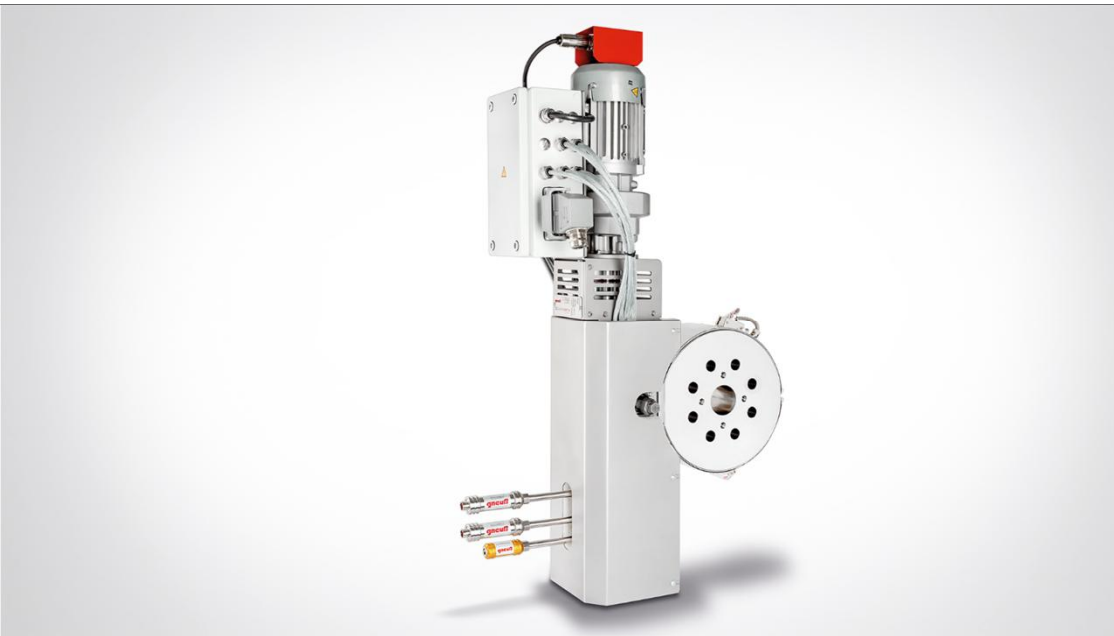


Filtration System  
RSF*genius*

## Typical Purging Losses

### Rotary Filter RSF*genius* vs. conventional purging filter

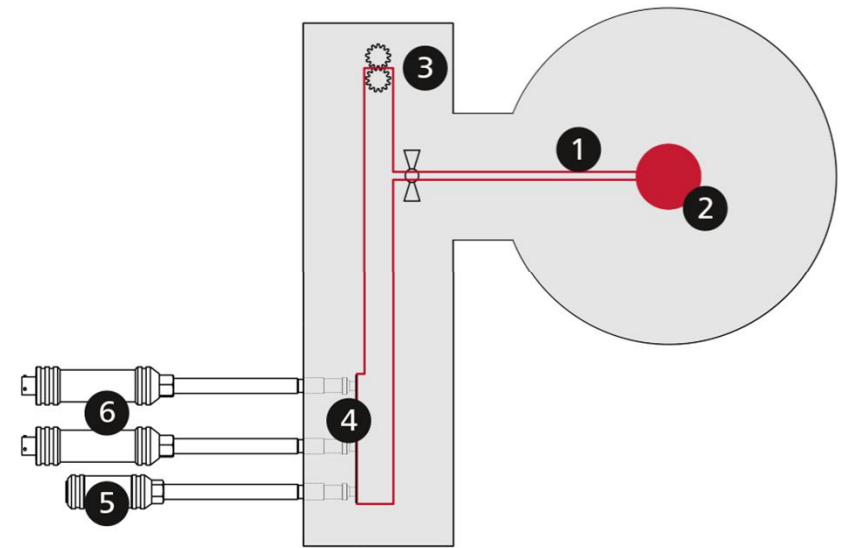




## Online Viscometer VIS

### Monitoring of rheological parameters

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Viscometer



- 1 Bypass
- 2 Main melt flow
- 3 Gear pump
- 4 Measuring capillary
- 5 Temperature sensor
- 6 Pressure transducers

# MRS Extrusion

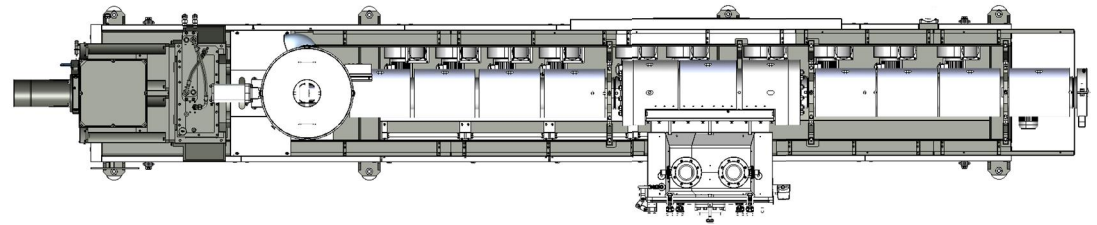
## MRSjump

- How to improve the MRS process and melt properties significantly?
- To increase the melt i.V. a process needs to provide:
  - LOW vacuum
  - LONG residence time
  - HIGH melt surface exchange



➤ Further development of MRS section

$$\frac{\Delta n}{\Delta t} = - D \cdot F \frac{dc}{dx}$$



25 mbara

1 mbara



# **MRSjump**

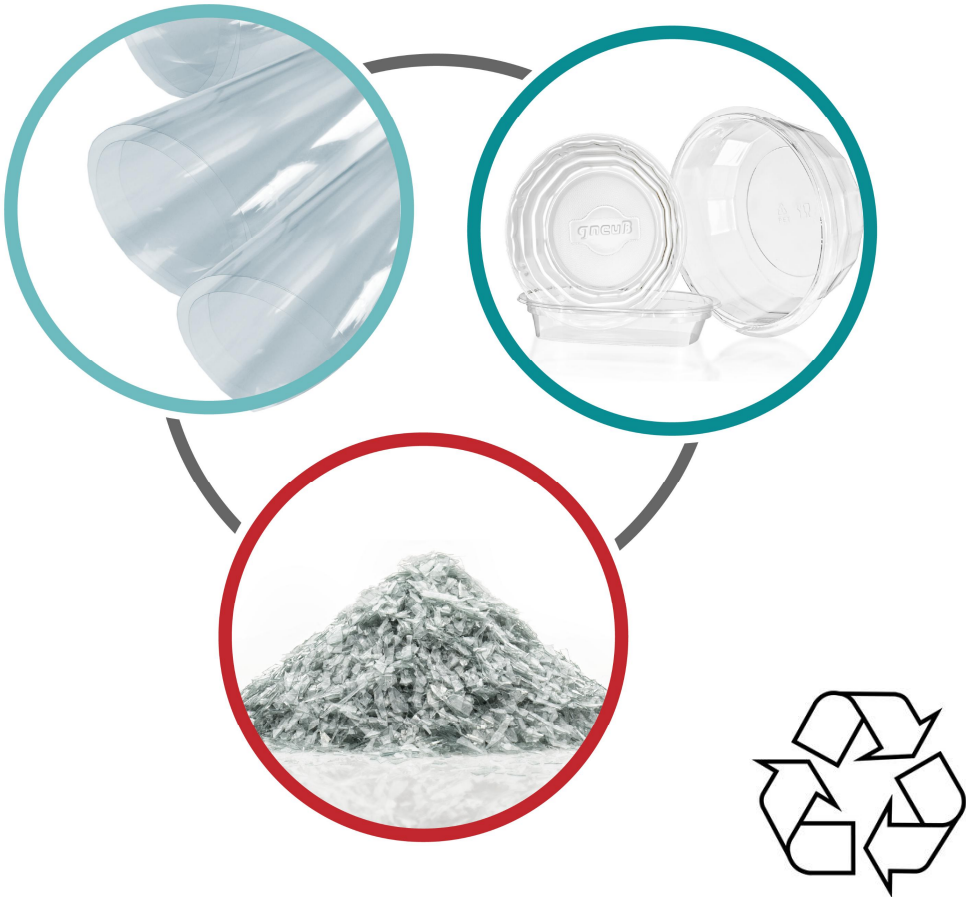
**IV stabilization on at least the same level**



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MRSjump

# Tray-to-Tray Recycling

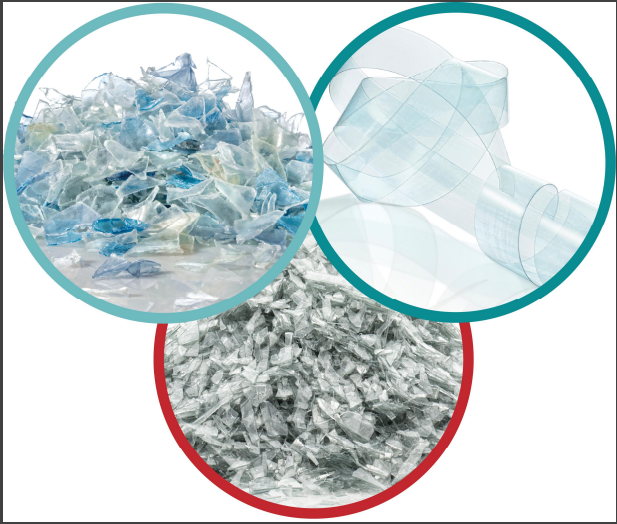
IV increase / stabilization on same level



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MRSjump



**MRSjump Extruder**



**gneuß**

# Use of Post Consumer PET in Bottle und Fibre Production

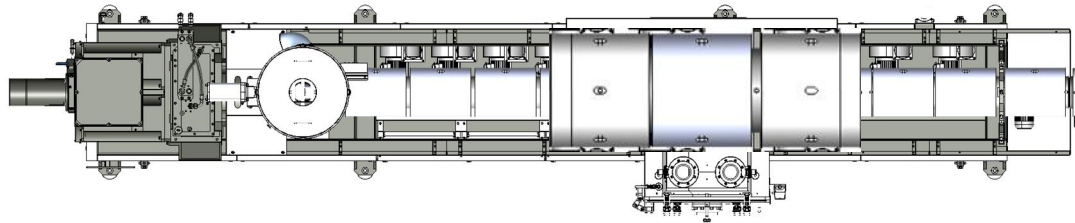


**Dr. Axel Hannemann**  
Post Consumer PET in Bottle und Fibre Production

## Content

1. Technologies:
  - + Jump Polycondensation
2. Recycling Solutions
  - + Fiber Recycling
  - + Textile Recycling
  - + Bottle to Bottle Recycling

# Polyreactor Jump IV boost to another level



25 mbara

$$\frac{\Delta n}{\Delta t} = -D \cdot F \frac{dc}{dx}$$

1 mbara



# Polyreactor JUMP

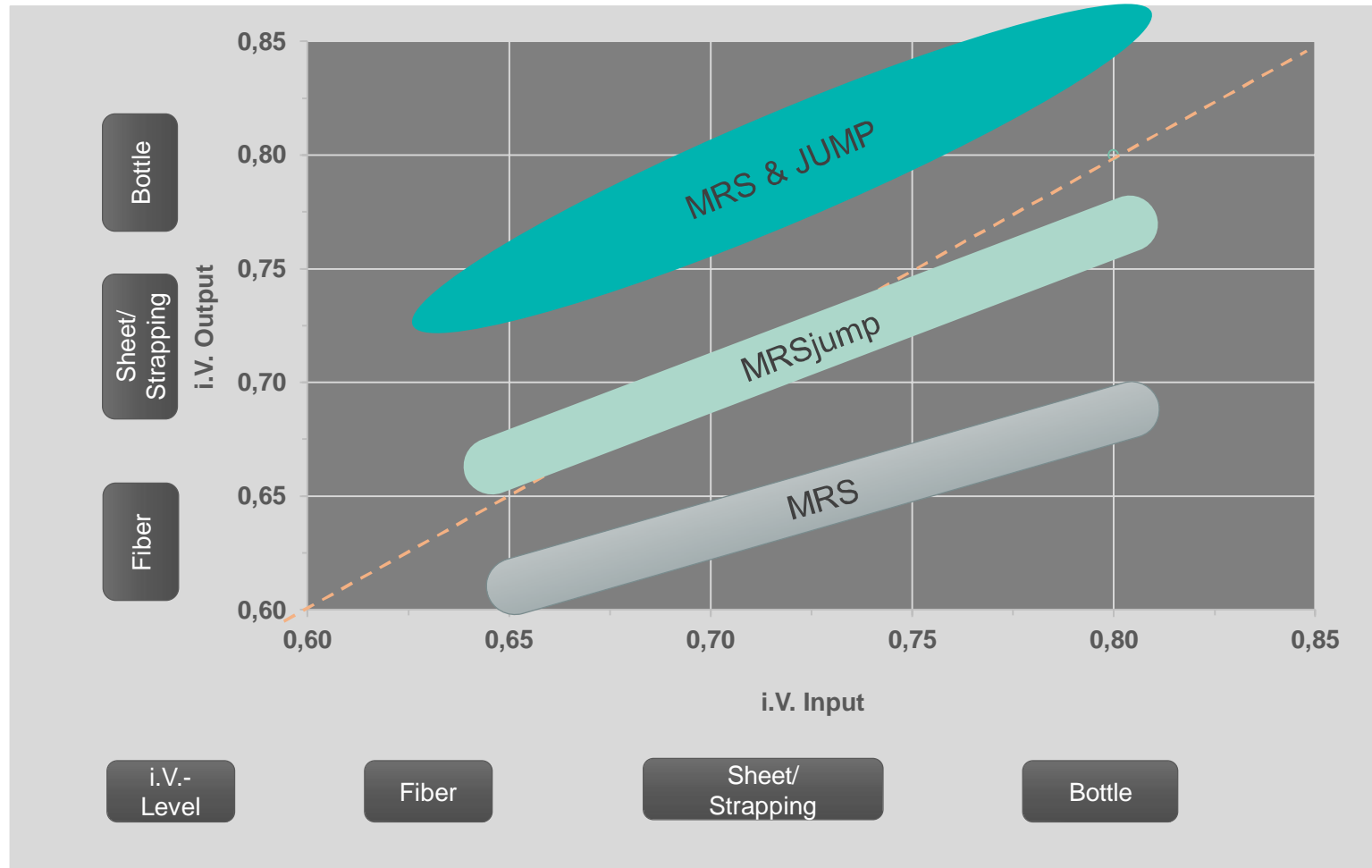
## Precise viscosity boost

- + Very fast IV increase in the melt phase
- + Minimum energy consumption
- + Minimum space requirement
- + Easy to operate and maintain
- + Can be used in pellet processing or direct recycling (e.g. fibre or strapping tape production)

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Post Consumer PET in Bottle und Fibre Production



# MRS, MRS<sub>jump</sub> and Jump Performance



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# Fibre Production With Bottle Flakes

- + **Bottle to Staple Fibre**
- + **Bottle to Nonwovens**
- + **Bottle to BCF (carpet yarn)**
- + **Bottle to POY, DTY**

Well proven process,  
state of the art with MRS system,  
IV loss is accepted

**Bottle Flake IV ~ 0,78 dl/g**

**Fibre IV ~ 0,62 – 0,7 dl/g**

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Post Consumer PET in Bottle und Fibre Production

## **BUT**

Bottle flakes are becoming rare and expensive

Need to use bottles in bottle production again  
Europe: 25 % till 2025 and 30 % till 2030

So there will be a more and more closed loop  
in the B2B processes, most will be returned to  
big bottlers like Coke, Pepsi, Danone, ...

Leftovers are poor quality and expensive

As a consequence, other sources are needed

# Fibre Waste: Headache or Goldmine?

## Fibre waste (industrial waste):

- is typically 1 % of production
- occurs in different forms in different parts of the fibre spinning process
- can have different IV depending on type of fiber manufactured
- spin finish oils and water make recycling difficult

➔ Fibre waste has a very low commercial value!

But:

**can it be used to replace virgin material?**

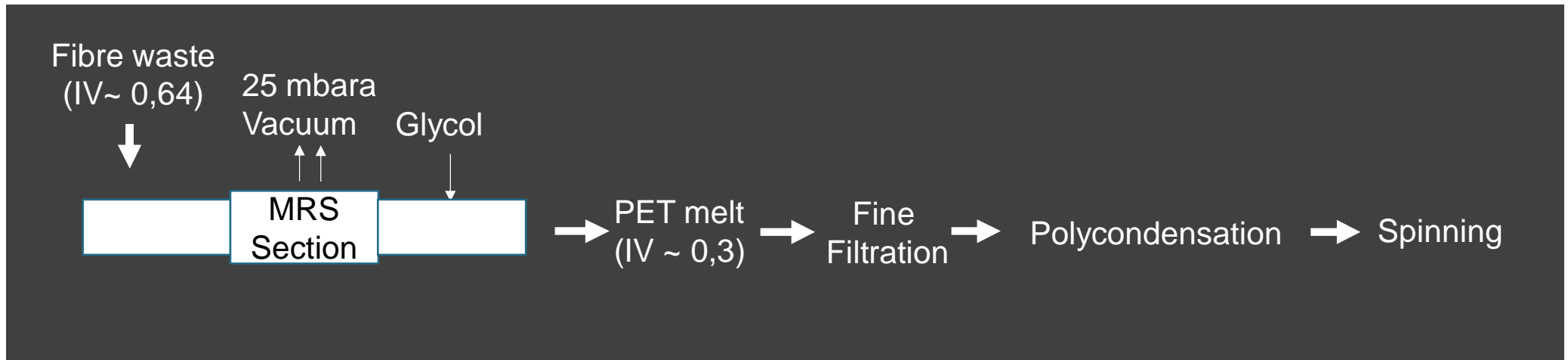
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# Solutions for Fibre Recycling I

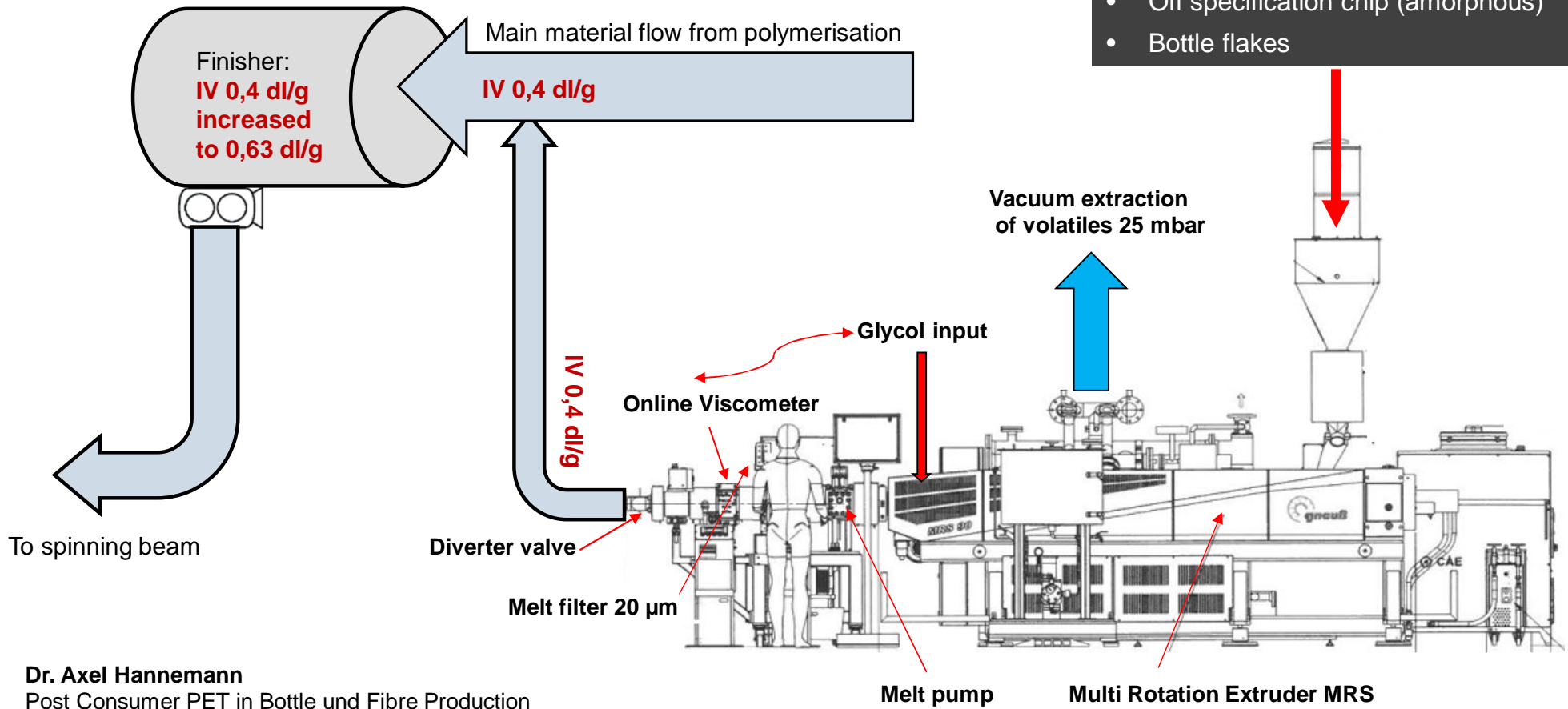
## Glycolysis for existing polycondensation spinning



# Solutions for Fibre Recycling I

## Direct Recycling Fibre to Fibre

Polycondensation:  
Mixture of main material flow with recycled content



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# Solutions for Fibre Recycling I

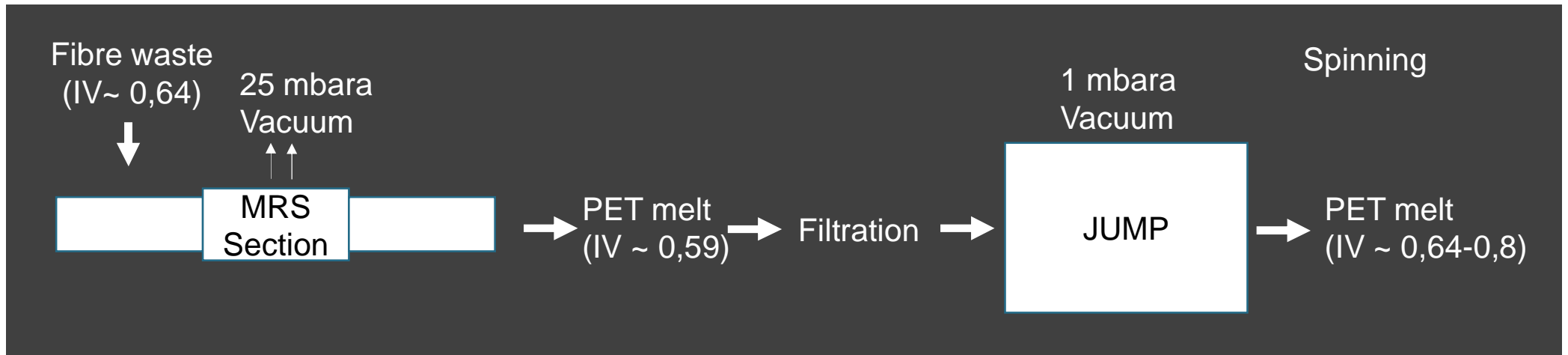


Mogilevkhimvolokno, Belarus

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# Solutions for Fibre Recycling II

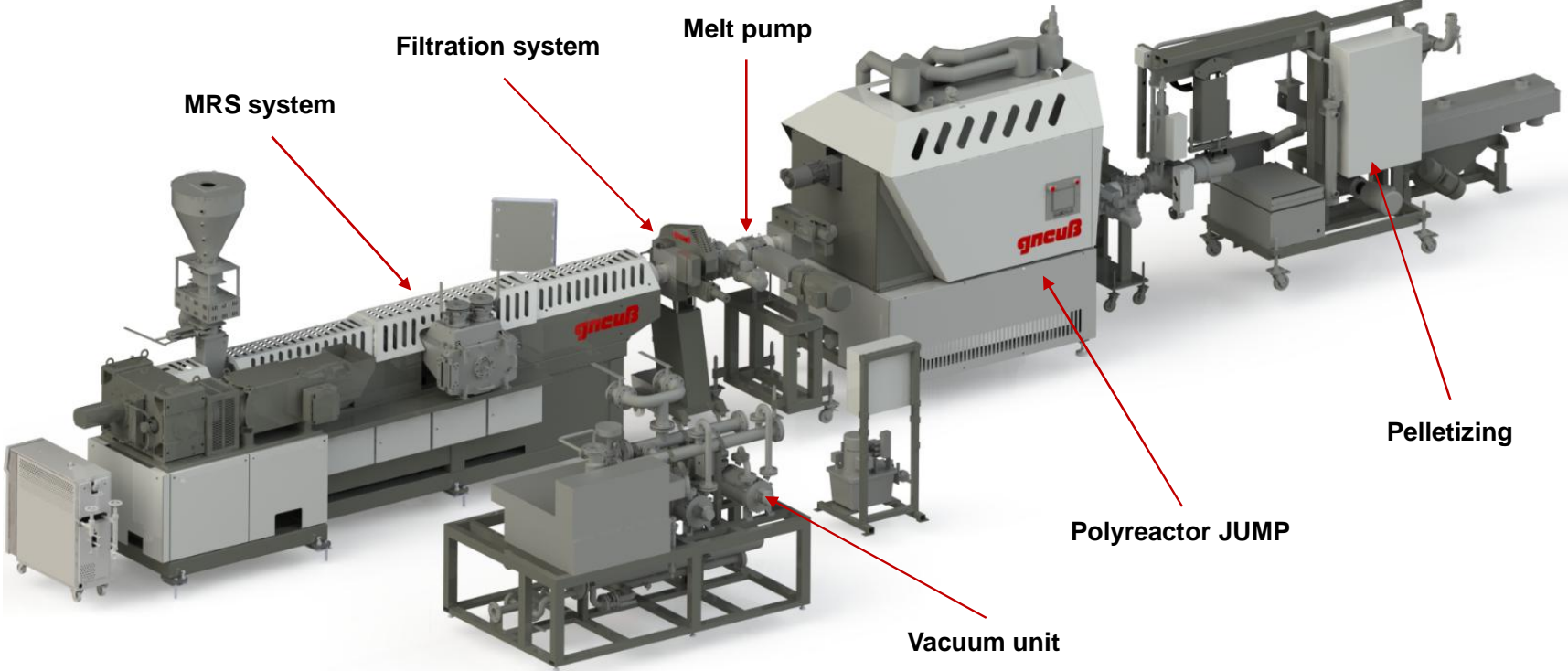
## For existing (extrusion) spinning





# Waste to Pellets (high IV)

## Pellets for high viscosity applications



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# Pelletizing Applications

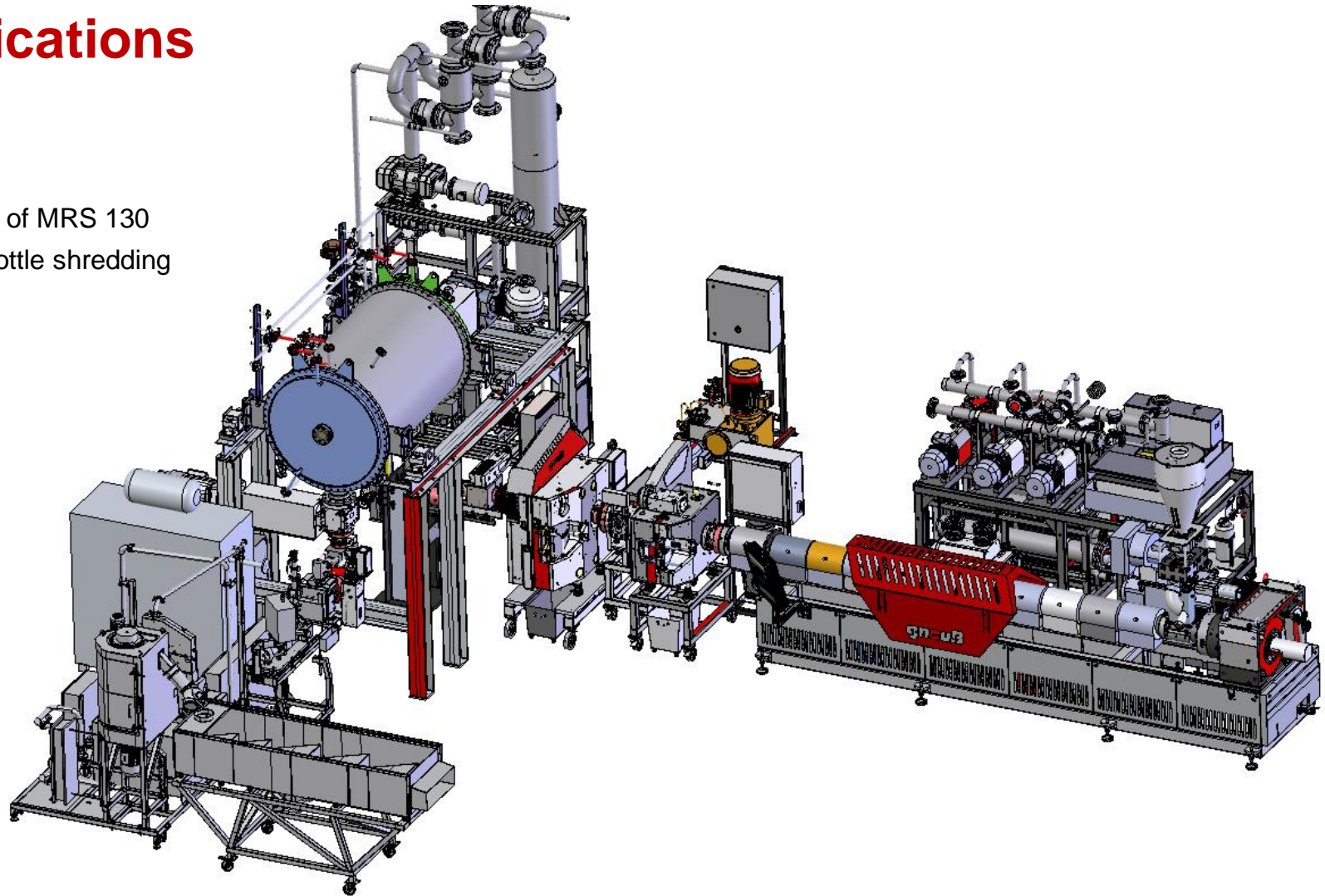
## Example 1

Jump V2000 Reactor downstream of MRS 130  
1.000 kg/h (800 kg/h) fines from bottle shredding

IV in ~ 0,64 dl/g

IV extruder 0,58 dl/g

IV out ~ 0,64 dl/g



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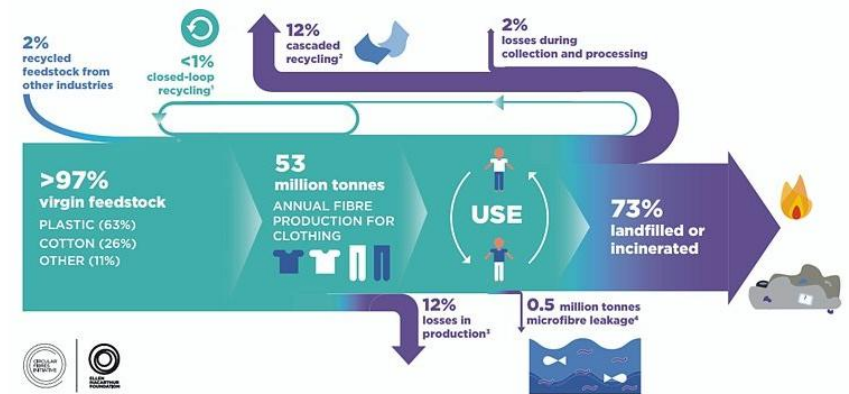
Post Consumer PET in Bottle und Fibre Production

# Textile Waste: Headache or Goldmine?

## Fibre waste (Post consumer waste):

- Production and use is far away
- Lots of different fibers are mixed (cotton)
- Buttons and zippers
- Design and ingredients needed to be changed (uniforms out of 100 % PET)
- Chemical recycling can do this, but really expensive and not industrially proven so far

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gncub

# Pellets Applications

## Bottle to bottle

### Requirements:

- IV ~ 0,8 dl/g
- Low AA (Acetaldehyde) content ~ 1ppm
- Low b\* value (color)

### Topics:

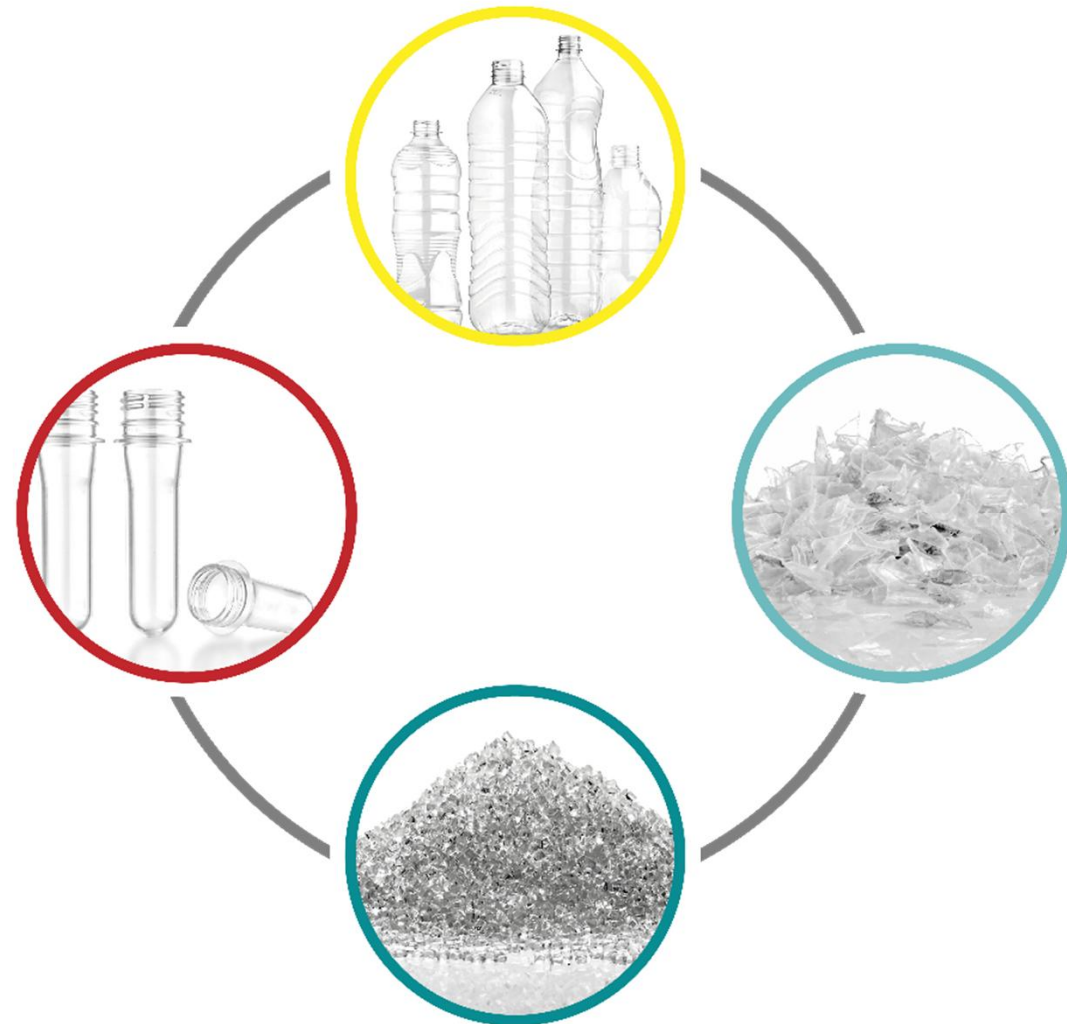
- Temperatures above melting point will create AA – additional process step (diffusion below  $T_m$ )
- Additive or short storage under heat

### Solutions:

- MRS + SSP in normal applications
- MRS*jump* + “de-aldehyd” for **clean** bottle flakes

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Post Consumer PET in Bottle und Fibre Production



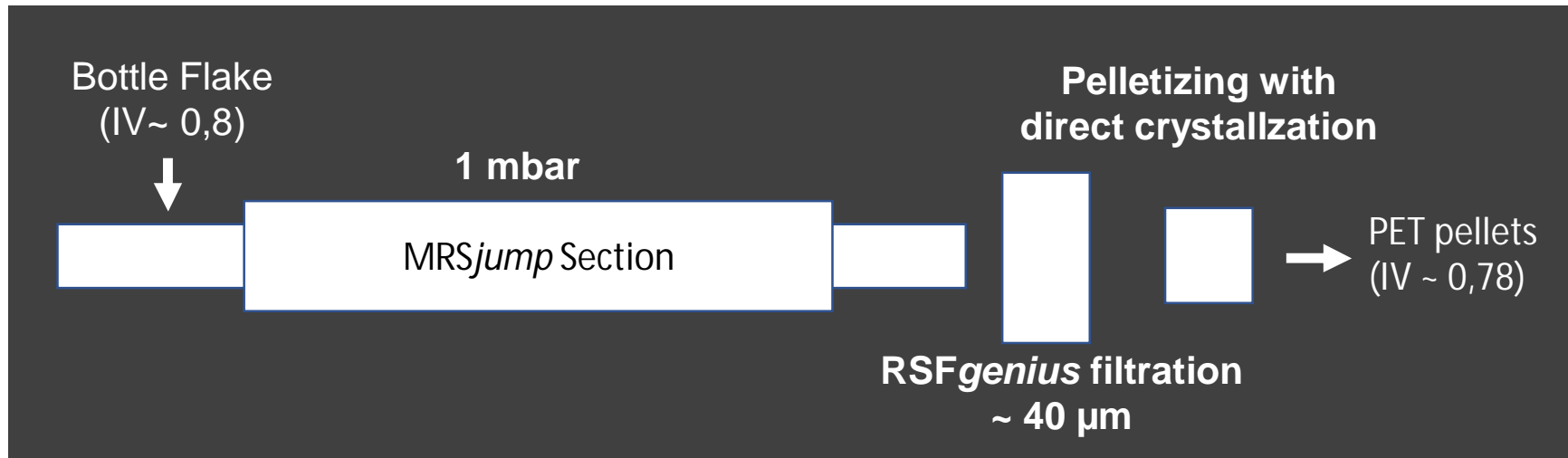


# MRS Extruder

## Food approvals



100 % bottle flake (food container) use







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