

New Recycling Technologies by Gneuss: Efficient Circular Recycling of PET Fibre Waste to High Quality Fibres

格诺斯先进的回收技术：
高效循环回收，将PET纤维废料制成高品质纤维

New Technologies for Circular PET Fibre Recycling

PET纤维循环回收的最新技术



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2. Technologies:
 - + MRS Extrusion
 - + MRS*jump* Extrusion
 - + Jump Polycondensation
3. Recycling Solutions

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 - + Jump 增粘反应釜
3. 回收循环解决方案



Andreas Hunold
Efficient Circular Recycling
Andreas Hunold

Gneuss at a glance

Who we are

- + Made in Germany
- + 200 employees worldwide
- + Worldwide distribution with 55 Sales & Service Locations
- + Subsidiary Gneuss Inc. USA
- + Gneuss centers in Brazil and China
- + 38 years of successful development

格诺斯全球团队

- + 总部位于德国
- + 全球雇员超过200名
- + 世界范围内超过55家销售和服务办事处
- + 美国设立子公司
- + 巴西和中国设立销售技术中心
- + 超过38年的高速发展

Technical Center

Lab lines for your trials

试验技术中心
为客户提供试验



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

- + 产品实况演示
- + 试样生产评估
- + 为确定更合适的设备规格而进行试验
- + 为客户提供产品开发项目而进行试验

Polymer Processing

MRS Extrusion Technology

Rotary Filtration Technology

Online Viscosity Measurement

Polyreaction with JUMP / MRSjump

模块化的聚合物加工设备

MRS挤出机

全自动旋转熔体过滤器

在线粘度计

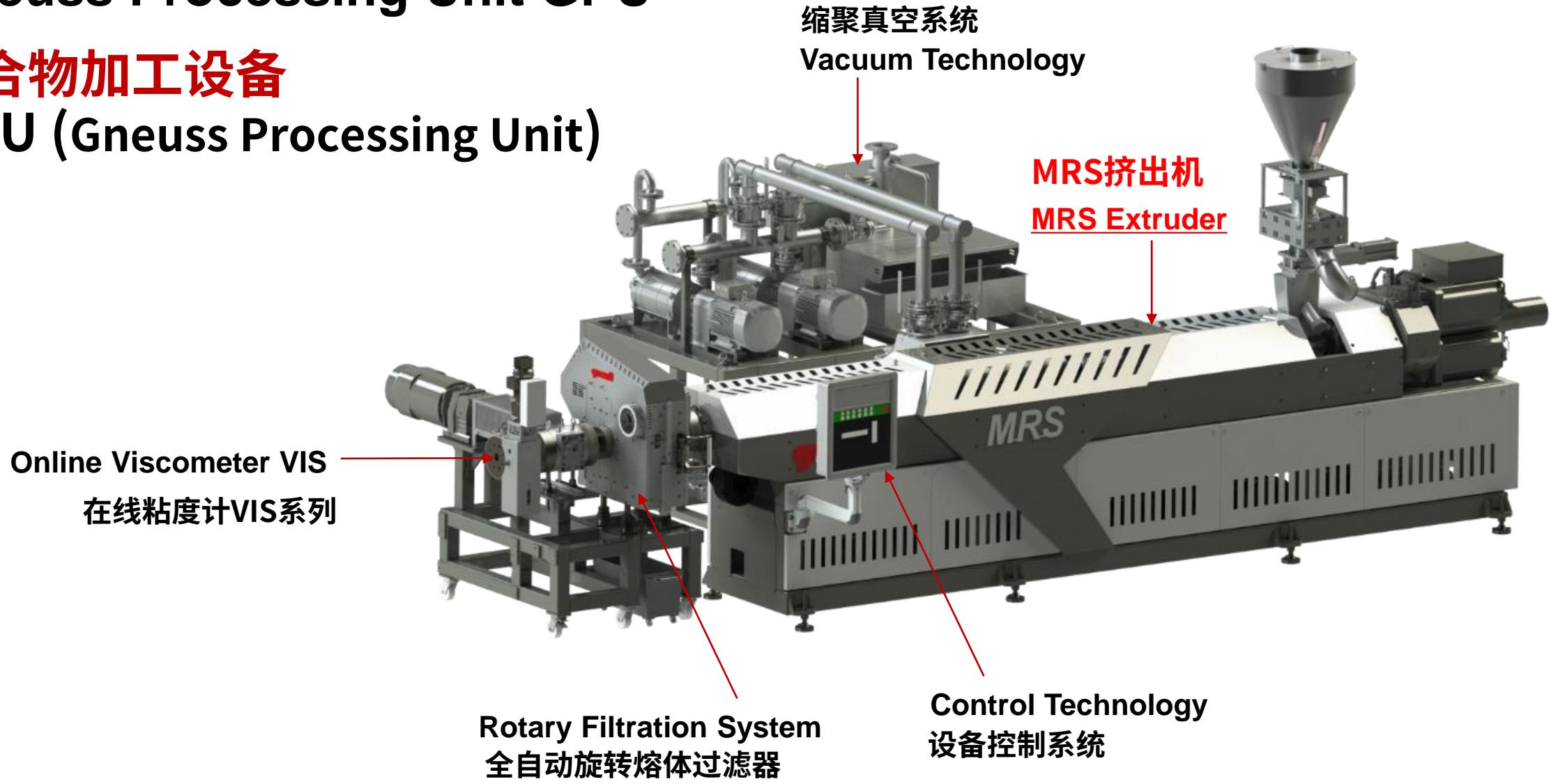
JUMP增粘反应釜 / MRSjump 挤出机

Polymer Technology

Gneuss Processing Unit GPU

聚合物加工设备

GPU (Gneuss Processing Unit)



MRS Extrusion

Diffusion process

扩散过程原理

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

n: transferred quantity of material

D: material constant, diffusion coefficient

F: polymer surface

c: concentration differential / vacuum depth / accessibility

x: polymer layer thickness

t: residence time

n: 物料转移量

D: 材料常数, 扩散系数

F: 聚合物表面积

c: 浓度差/真空深度/可及性

x: 聚合物层的厚度

t: 停留时间

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Efficient Circular Recycling

PET degassing

PET 排气脱挥



Can be water, spinfinish oil, toxics, monomers

能够去除水份、纺丝油、有毒物质、单体等等



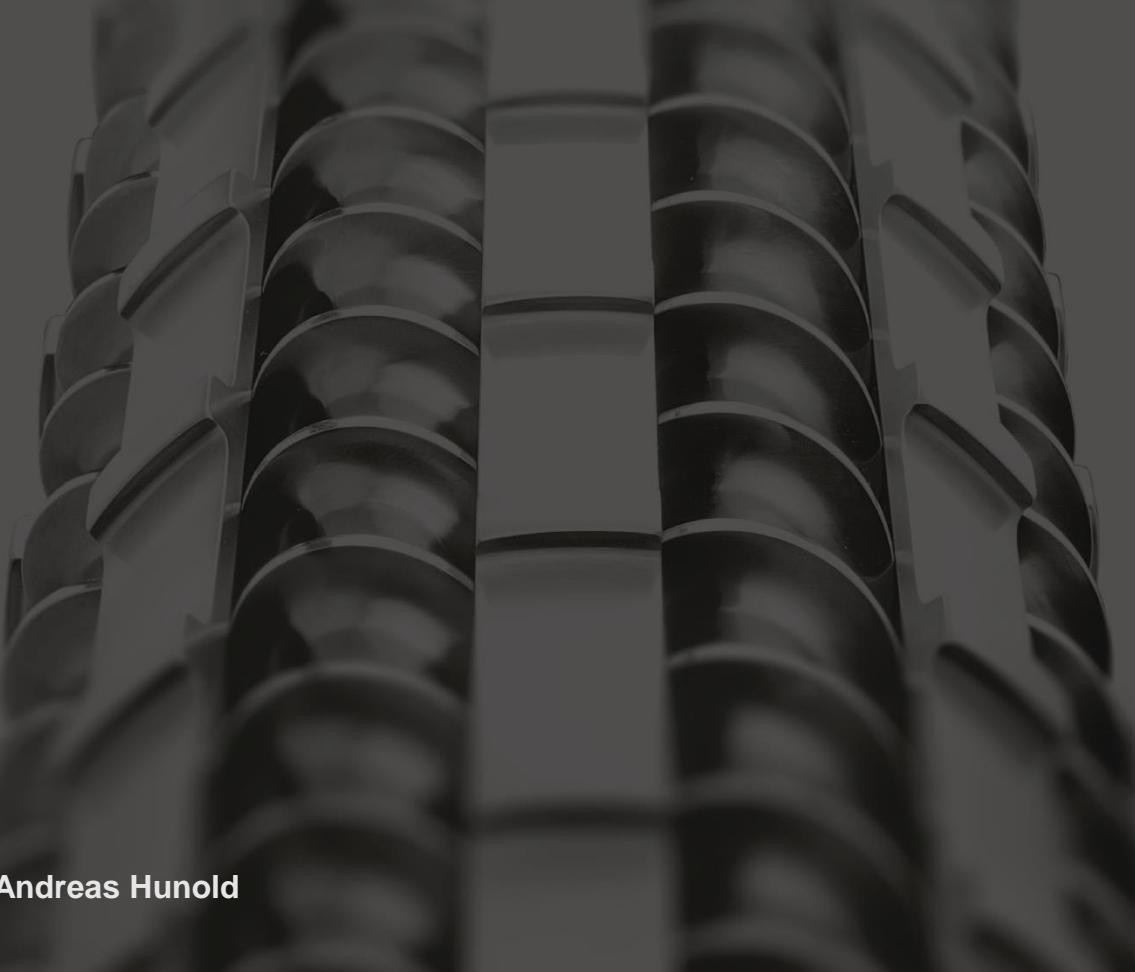
polymer molecule 聚合物分子

• molecules to be removed 被去除掉分子

MRS Extrusion

Design of the MRS Technology

MRS挤出机的设计理念



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- + 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

- + 采用特殊单螺杆技术结合部分多螺杆段
- + 挤出前，材料不需要预处理
- + 更高效的共混过程
- + 专门为聚酯和回收应用开发
- + 更高效的脱挥、去污



MRS Extrusion System

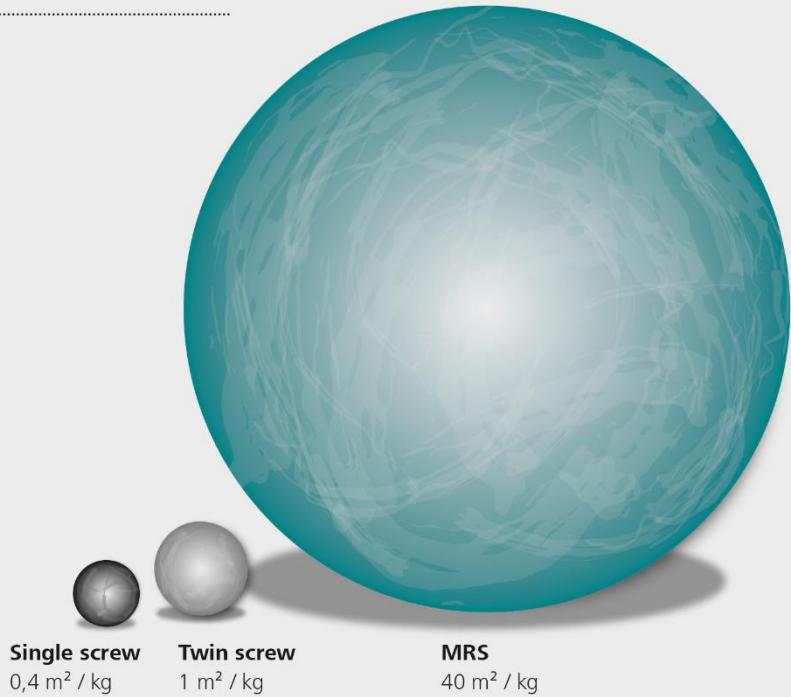
gneuB

MRS Extrusion

Performance and advantages

MRS挤出机的性能和优势

Surface area exchange in comparison



- + 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“.

- + 专利的单螺杆技术，即多螺杆分段技术
- + 无需在挤出前进行材料处理：如预干燥或结晶
- + 更高效的共混
- + 特别为PET聚酯和回收应用开发
- + 高效地脱挥、去污能力
- + 降低能耗，减少空间需求
- + 更低热应力水平
- + 更简洁紧凑的加工过程
- + 成品透明性好，光泽度高，“黄值”极低。

MRS Extruder Food approvals

食品级认证



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

以100%回收料为原料，
生产食品级的塑料包装材料。



European Food Safety Authority



Instituto Nacional de Vigilancia de Medicamentos y Alimentos.



SERVICIO NACIONAL DE SANIDAD
Y CALIDAD AGROALIMENTARIA

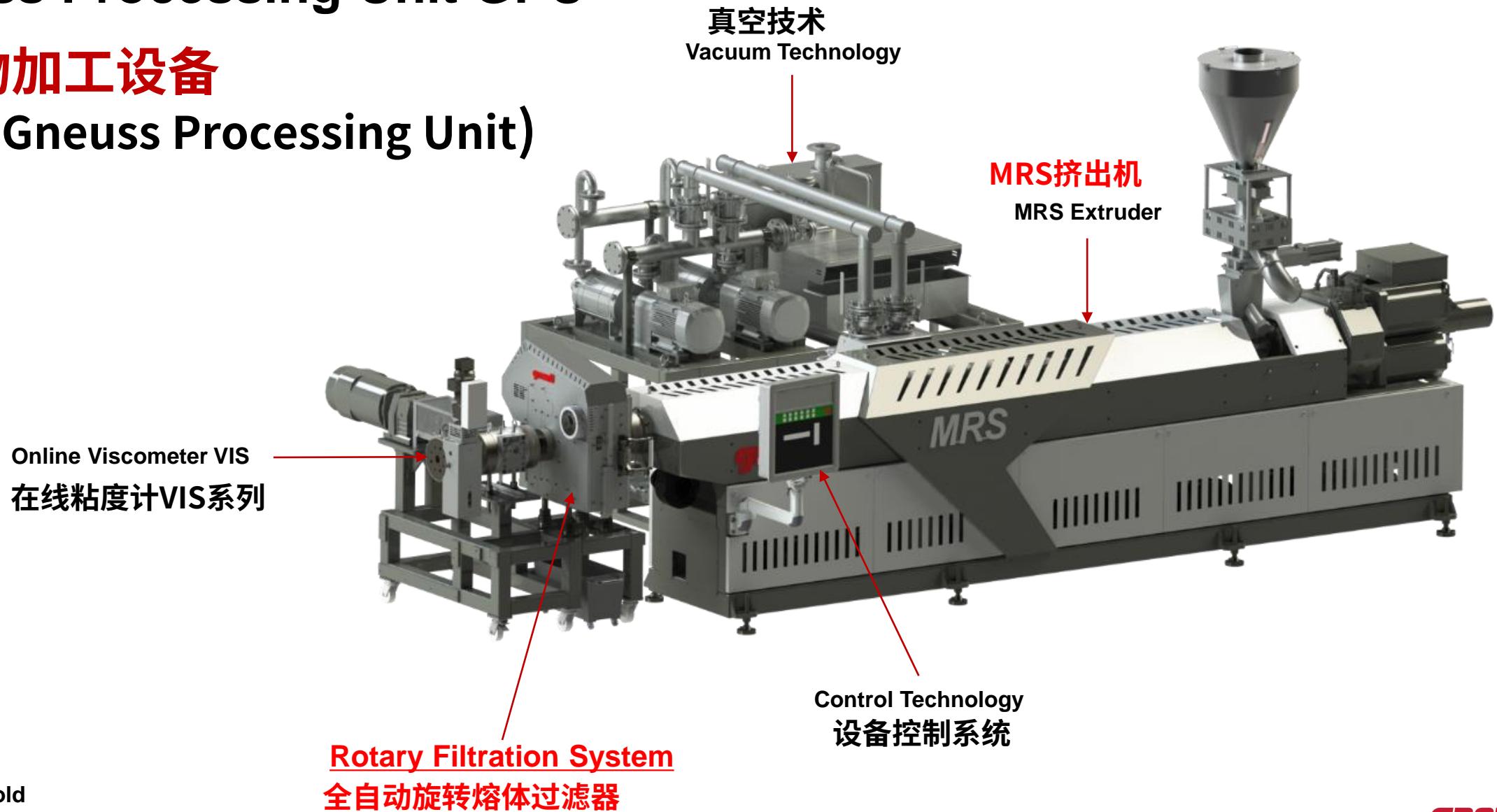


Polymer Technology

Gneuss Processing Unit GPU

聚合物加工设备

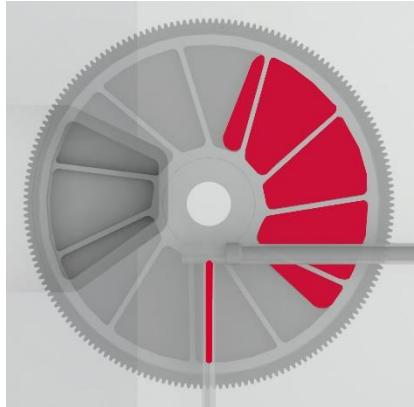
GPU (Gneuss Processing Unit)



Rotary Filter 全自动旋转熔体过滤器

Fully automatic, process and pressure constant filtration.

全自动的，压力恒定的，熔体过滤器



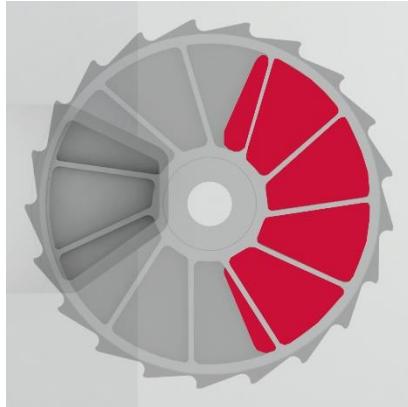
RSFgenius

Process and pressure constant filtration with integrated backflushing system for demanding applications.

RSF系列

过滤时保持工艺和压力恒定，集成反冲洗系统，适用于苛刻条件下的应用。

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SFXmagnus

Process and pressure constant filtration for high quality end products.

SFX系列

过滤时保持工艺和压力恒定，适用于高质量的终端产品的生产。

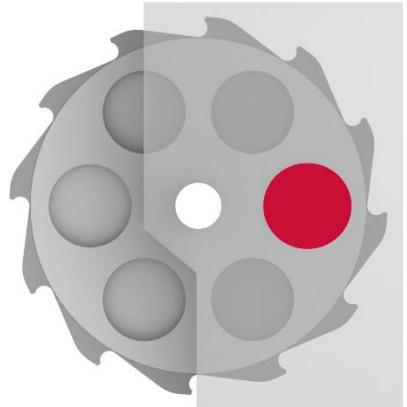


SFneos

Process and pressure constant filtration for thermally sensitive materials (e.g. PVC).

SF系列

热敏性材料的工艺和恒压过滤（如，PVC）

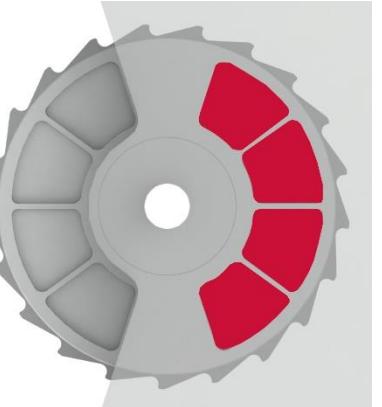


KSF

Continuous and process constant filtration for applications with high pressure or frequent changes.

KSF系列

过滤过程连续，且压力恒定，适用于于高压或频繁变化。



CSFprimus

Continuous filtration for with large active screen area for safety or pre-filtration.

CSF系列

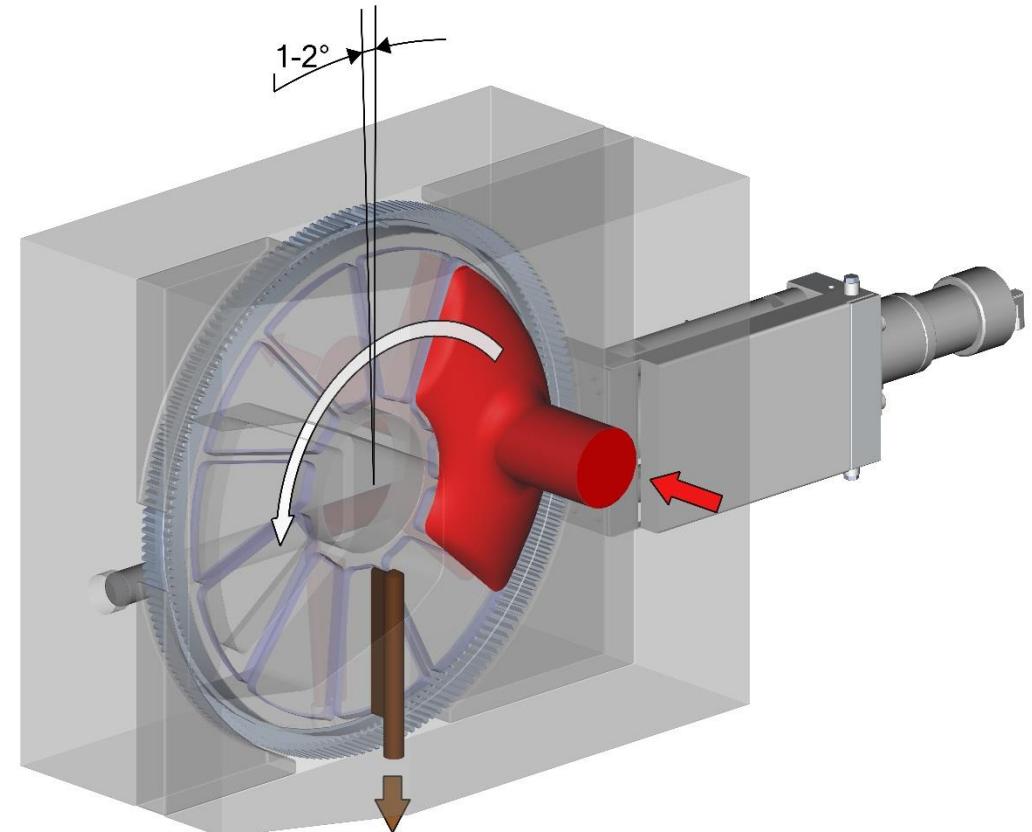
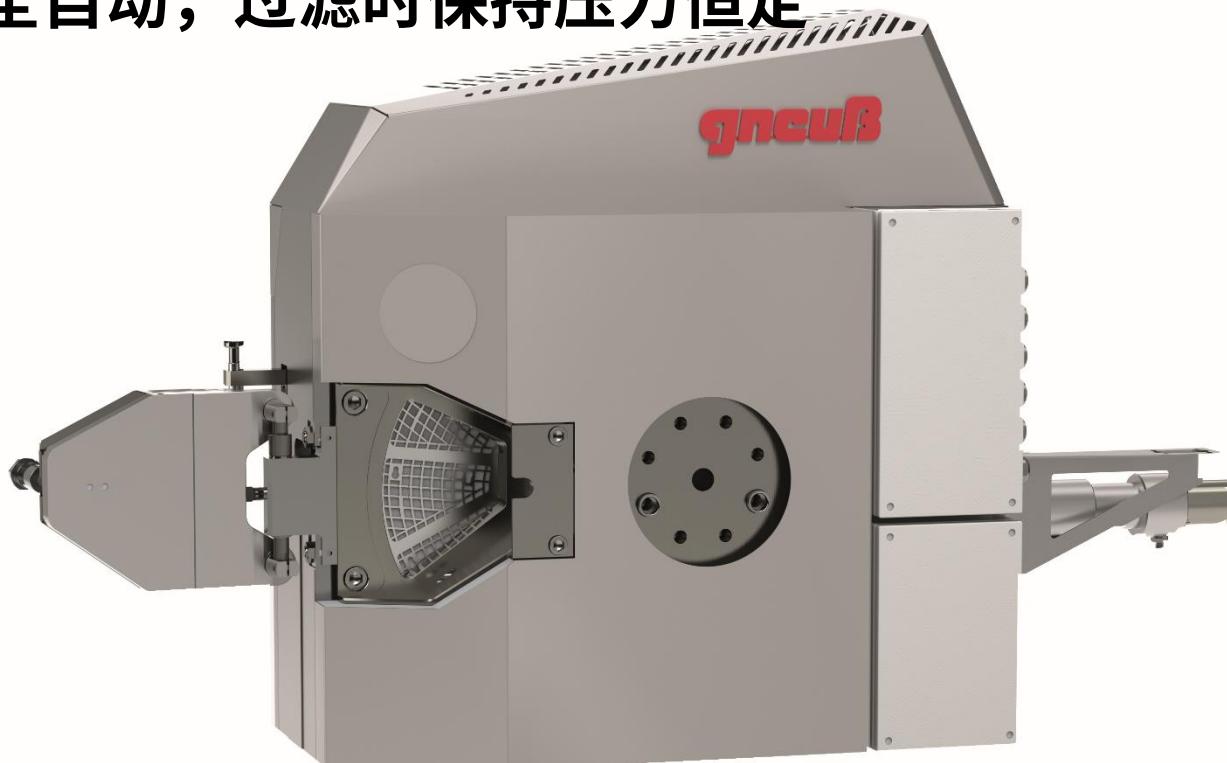
连续过滤，更大面积的滤网，适用于安全地预过滤。

RSFgenius Filtration

Fully-automatic, pressure- and process constant

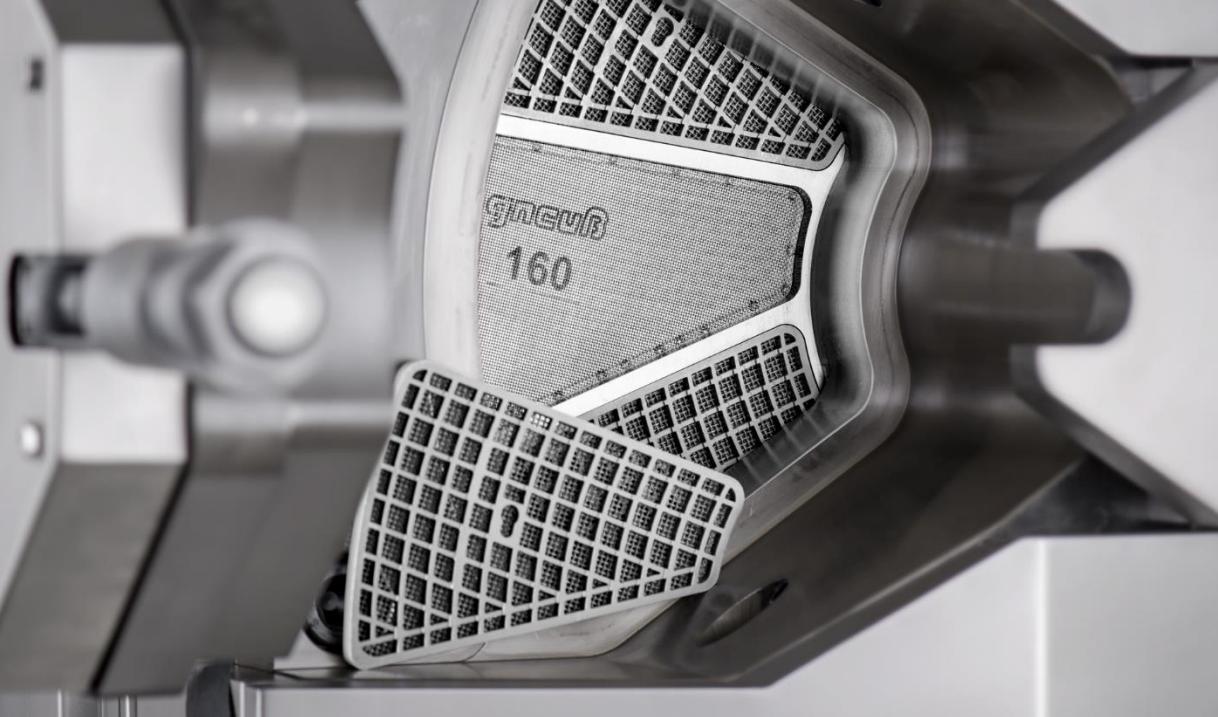
RSF系列 全自动旋转熔体过滤器

全自动，过滤时保持压力恒定





Filtration System
RSFgenius



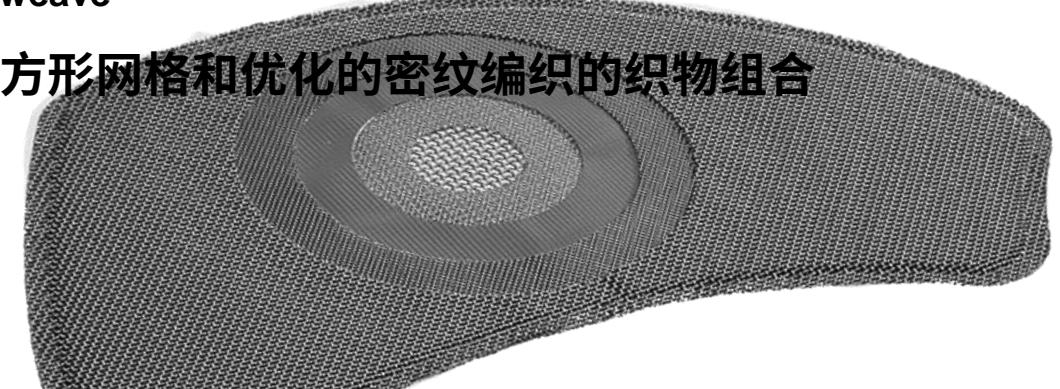
Screens / Filter elements

Consistently high melt
and product purity

滤网 / 过滤器配件
持续高效，经济耐用

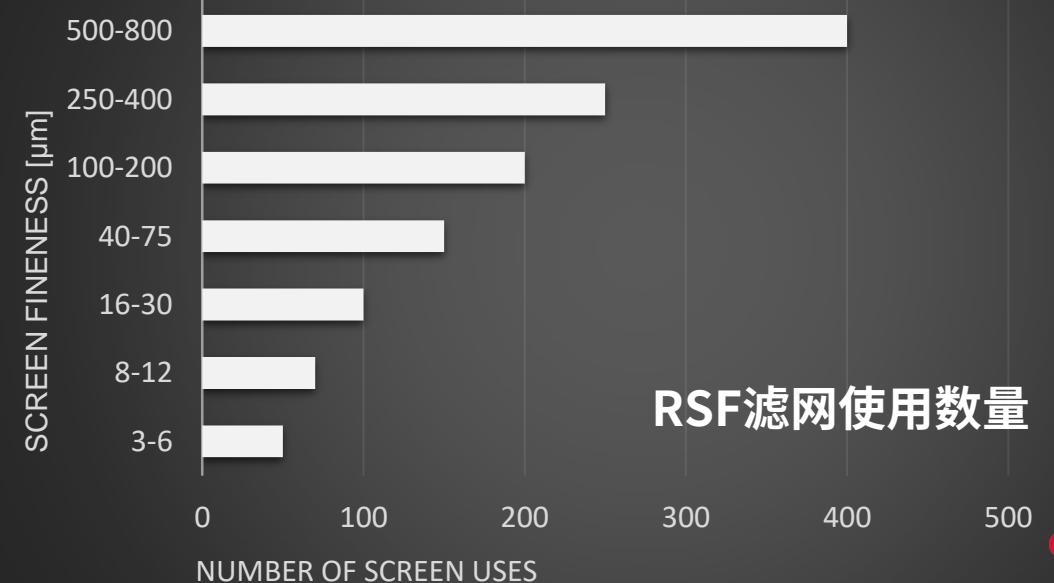
Fabric combination of square meshes and optimized dutch weave

方形网格和优化的密纹编织的织物组合



- 最好的反冲洗属性
- 更精细的过滤
- 更高的产量
- 更少的换网频率
- best back-flushing properties
- fine filtration
- high throughputs
- rare screen changes

Number of screen uses RSFgenius

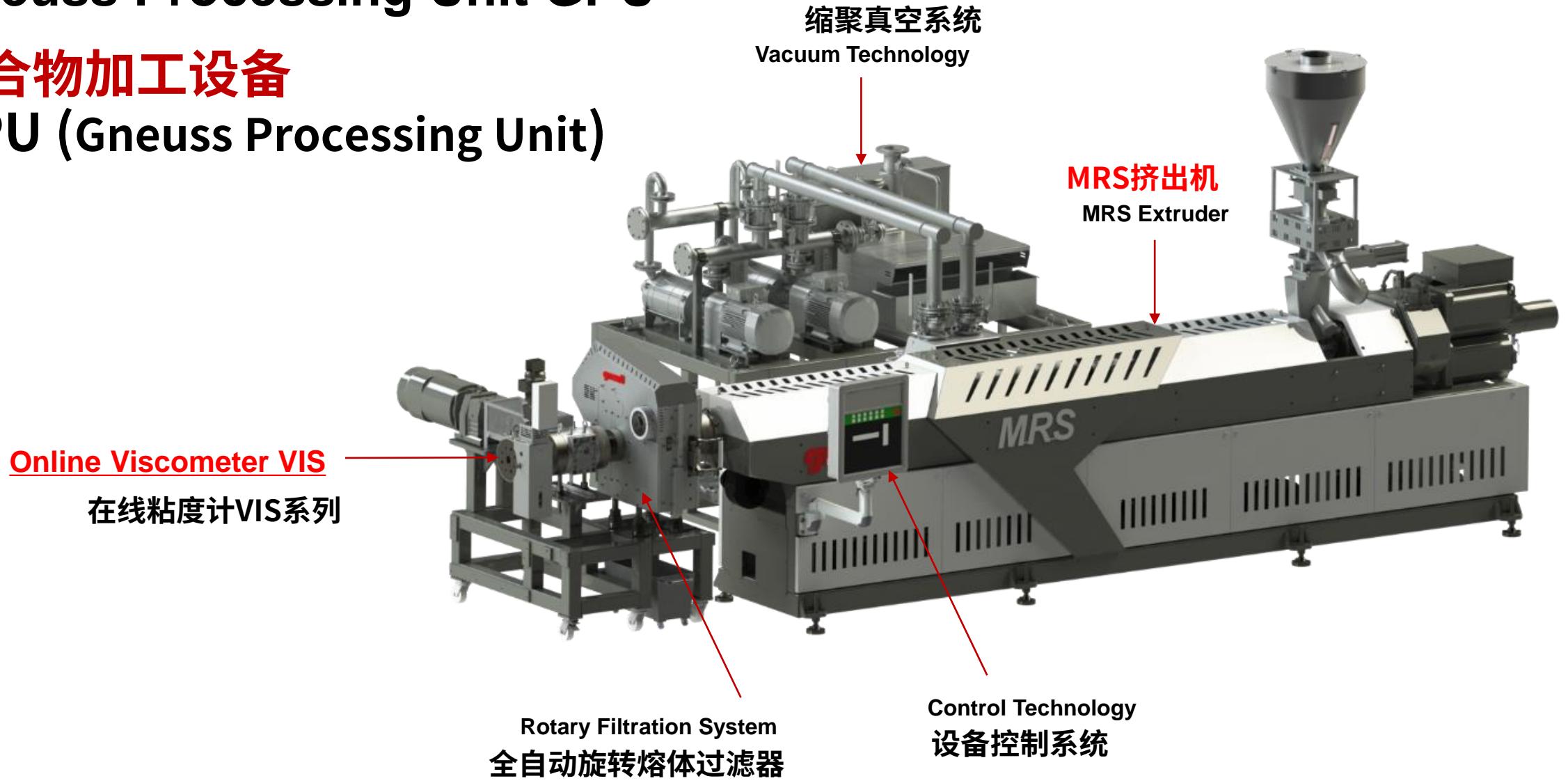


Polymer Technology

Gneuss Processing Unit GPU

聚合物加工设备

GPU (Gneuss Processing Unit)



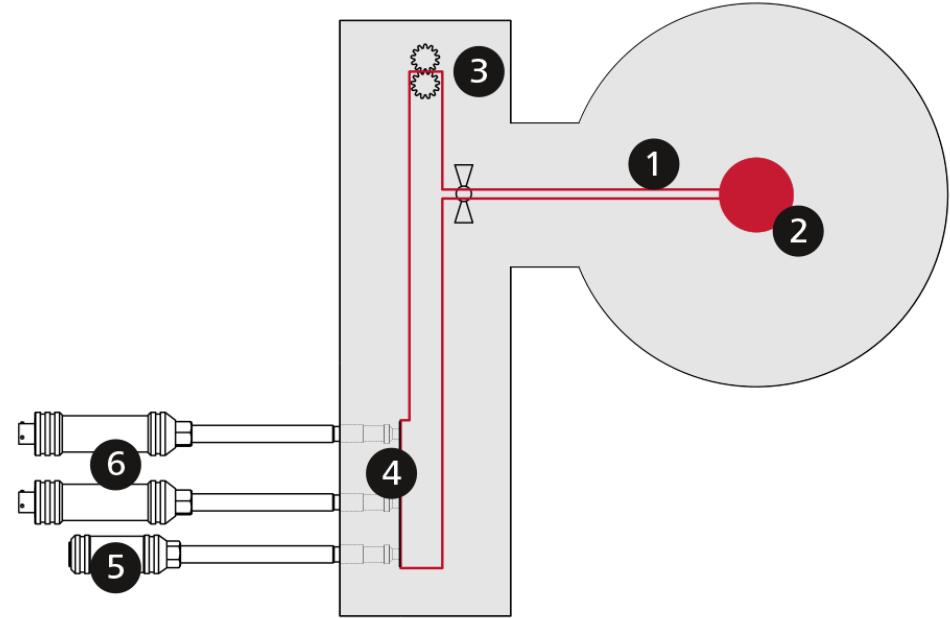


Online Viscometer VIS

Monitoring of rheological parameters

在线粘度计VIS
实时监控流变参数

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- | | | | |
|---|----------------------|---|---------|
| 1 | Bypass | 1 | 旁路 |
| 2 | Main melt flow | 2 | 熔体流动主通道 |
| 3 | Gear pump | 3 | 齿轮泵 |
| 4 | Measuring capillary | 4 | 测量毛细管 |
| 5 | Temperature sensor | 5 | 温度传感器 |
| 6 | Pressure transducers | 6 | 压力传感器 |

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 :MRS section

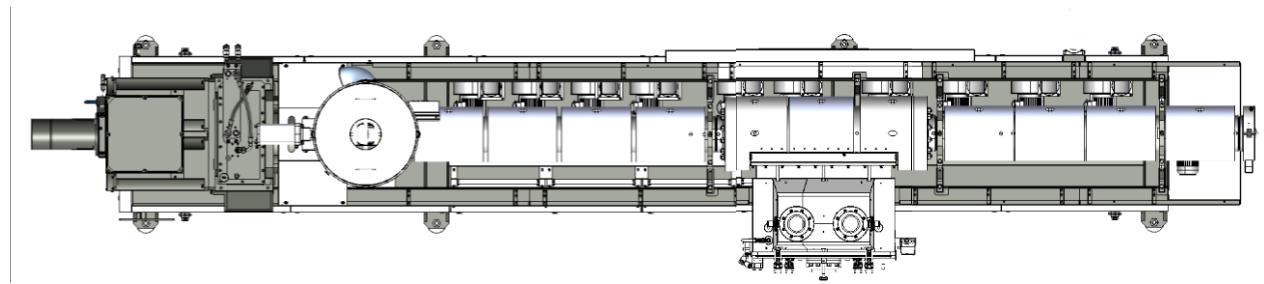
MRSjump 挤出机

- 如何显著改善MRS的挤出工艺和熔体性能?
- 提高熔体的 i.V. 值，加工过程中需要：
 - 更低的真空 ☀️
 - 更长的停留时间 ⏳
 - 更高的熔体表面交换率 ↗

❖ 设备升级：MRS挤出单元

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



25 mbara



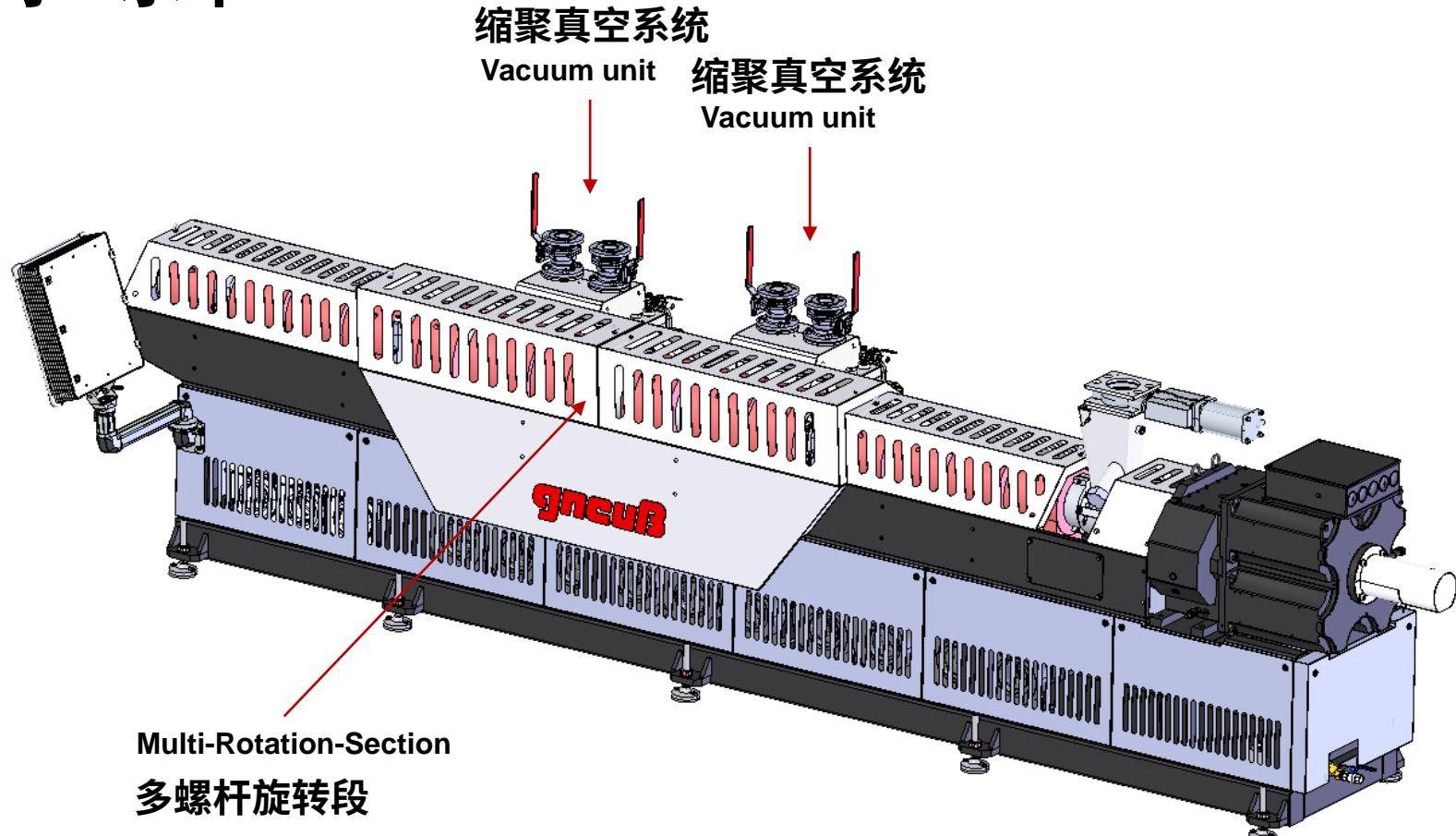
1 mbara

MRSjump

IV stabilization on at least the same level

MRSjump挤出机

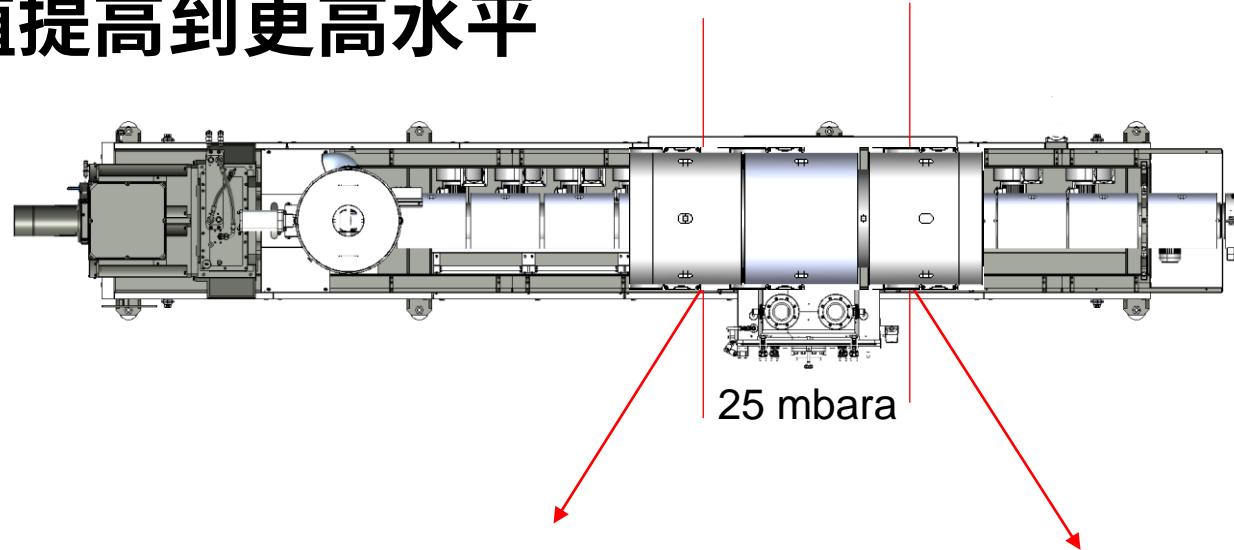
IV值稳定在同一水平



Polyreactor Jump

IV boost to another level

Jump挤出机增粘反应釜
将IV值提高到更高水平



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

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. fiber or strapping tape production)

Jump增粘反应釜

精确的粘度增加

- + 在熔融阶段非常快速地提高IV值
- + 最低的能源消耗
- + 最小的占地面积
- + 易于操作和维护
- + 可用于颗粒加工或直接回收(如纤维或胶带生产)



Liquid-heated double jacket
双套管接入加热的液体

Melt input
熔体输入



Vacuum
连接真空装置

Melt discharge
熔体输出

真空装置

Vacuum unit

Glycol
Spinning oil
water, toxins

乙二醇
纺丝油
水、有毒物



Polyreactor JUMP Polymer surface renewal under vacuum

Jump 增粘反应釜
在真空环境中实现聚合物表面
更新

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Efficient Circular Recycling

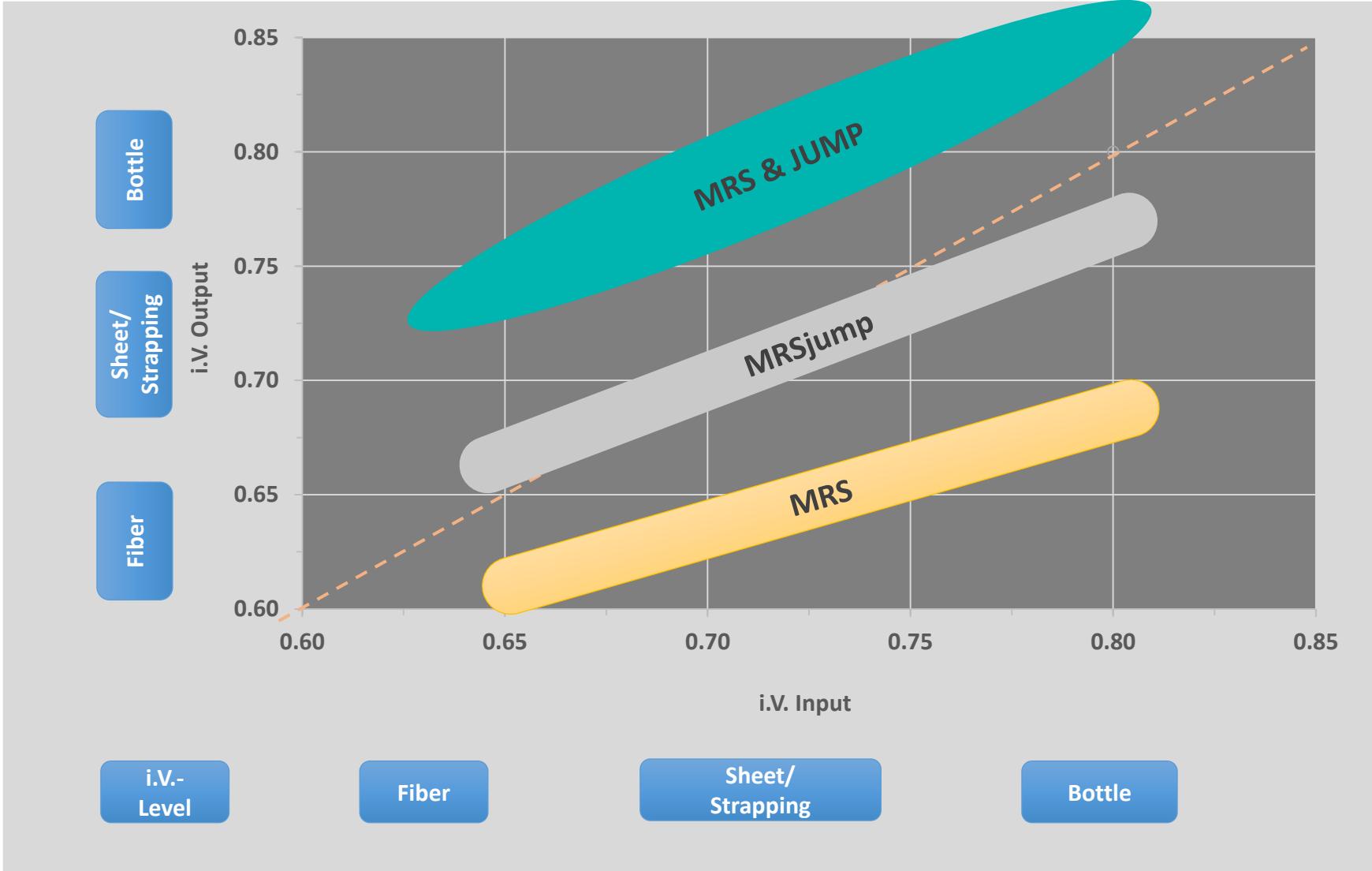


*Depending on input IV level

** POLYESTER BOTTLE RESINS, Production, Processing, Properties and Recycling" Ulrich Thiele,
Heidelberg Business Media GmbH, 2007

gncuβ

MRS, MRS*jump* and Jump Performance 三种设备的性能对比





New Technologies for Circular Fibre Recycling

Content

1. Company Gneuss
2. Technologies:
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 - + MRS*jump* Extrusion
 - + Jump Polycondensation
3. Recycling Solutions

纤维回收循环利用的新技术

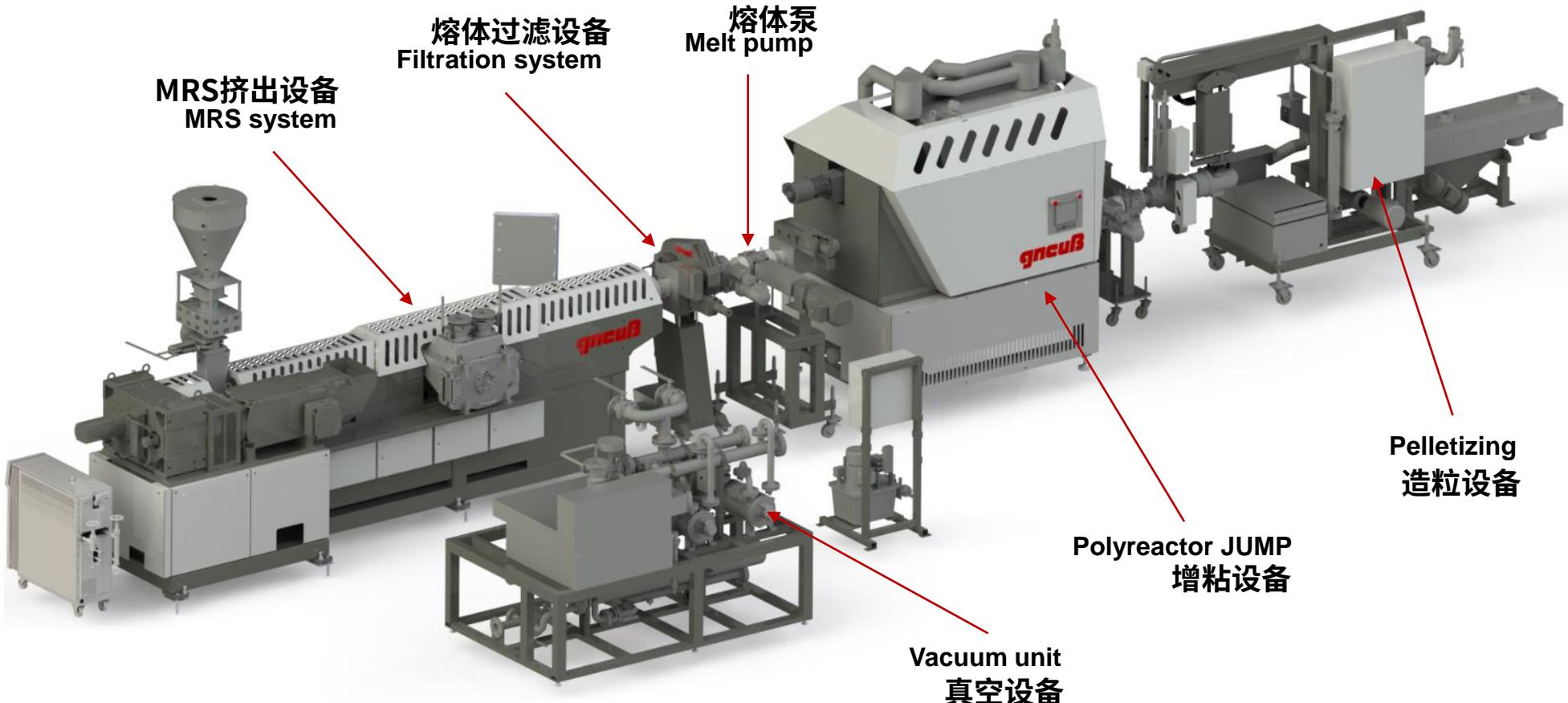
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3. 回收循环解决方案

Waste to Pellets (high IV) Pellets for high viscosity applications

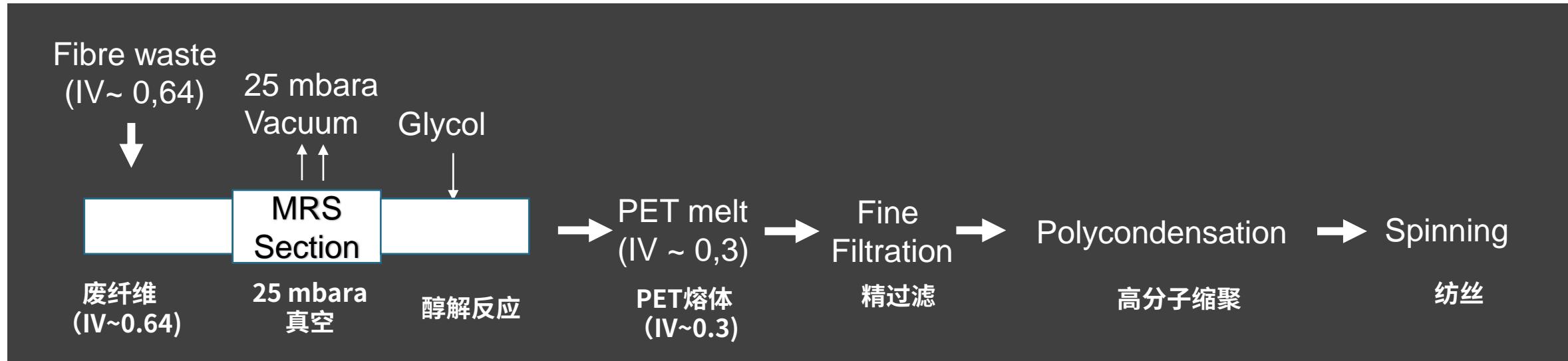
从废料到（高IV值）颗粒
高粘度造粒解决方案



Solutions for fibre recycling

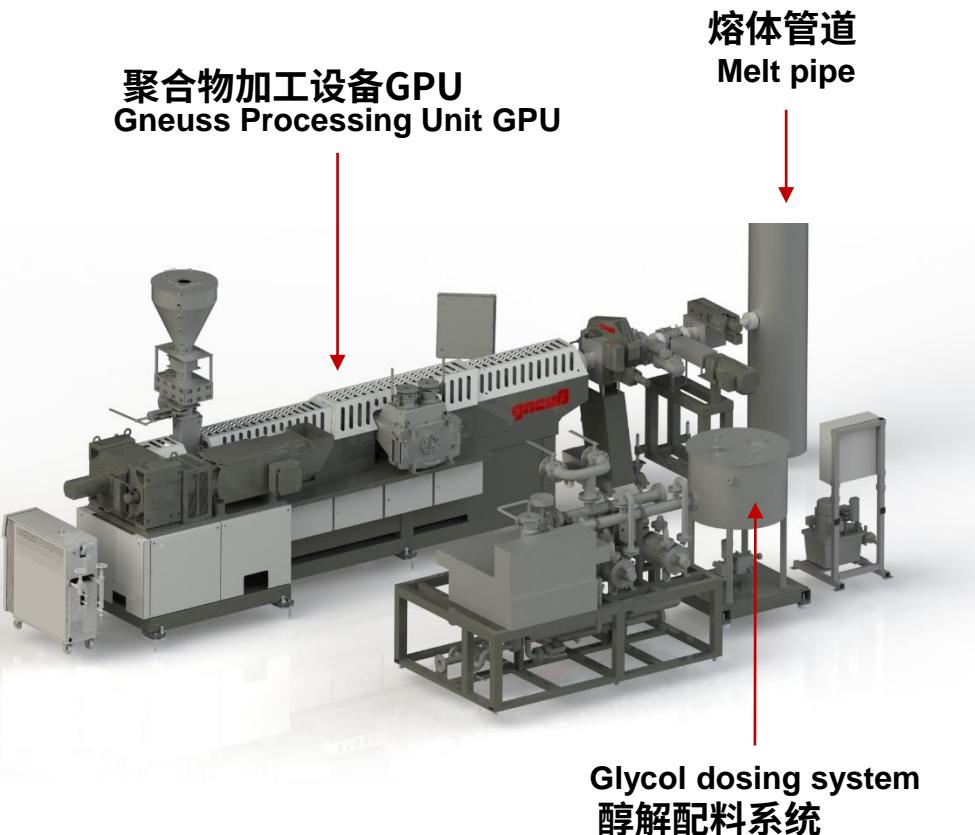
Glycolysis for existing polycondensation spinning

废纤维回收循环解决方案
现有缩聚纺丝的醇解反应



Direct spinning process

Material introduction upstream of the finisher



直接纺丝加工生产线

上游物料输入



Technical options:

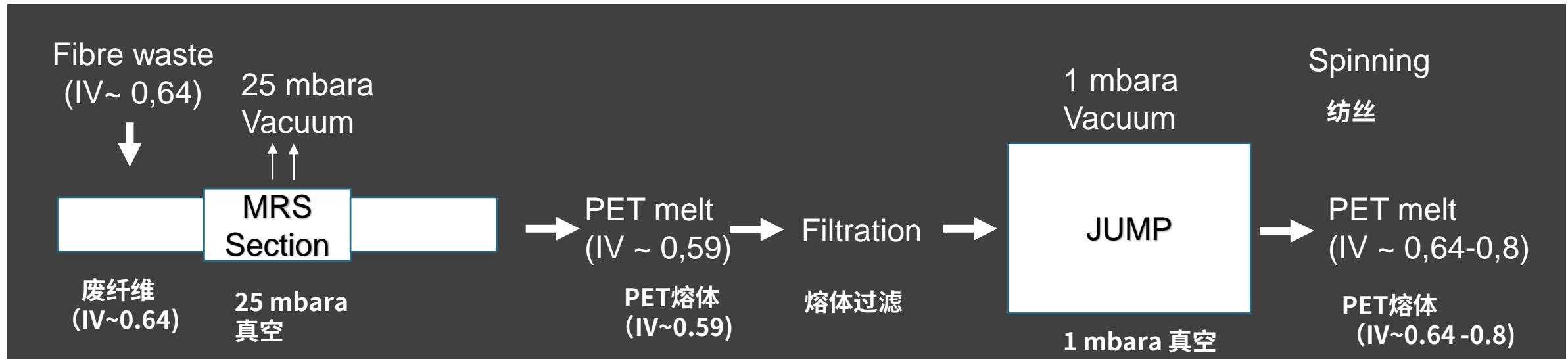
- + Glycolysis
- + Hydrolysis
- + IV boost

技术要点：

- + 醇解反应
- + 水解作用
- + IV值提高

Solutions for fibre recycling for existing spinning

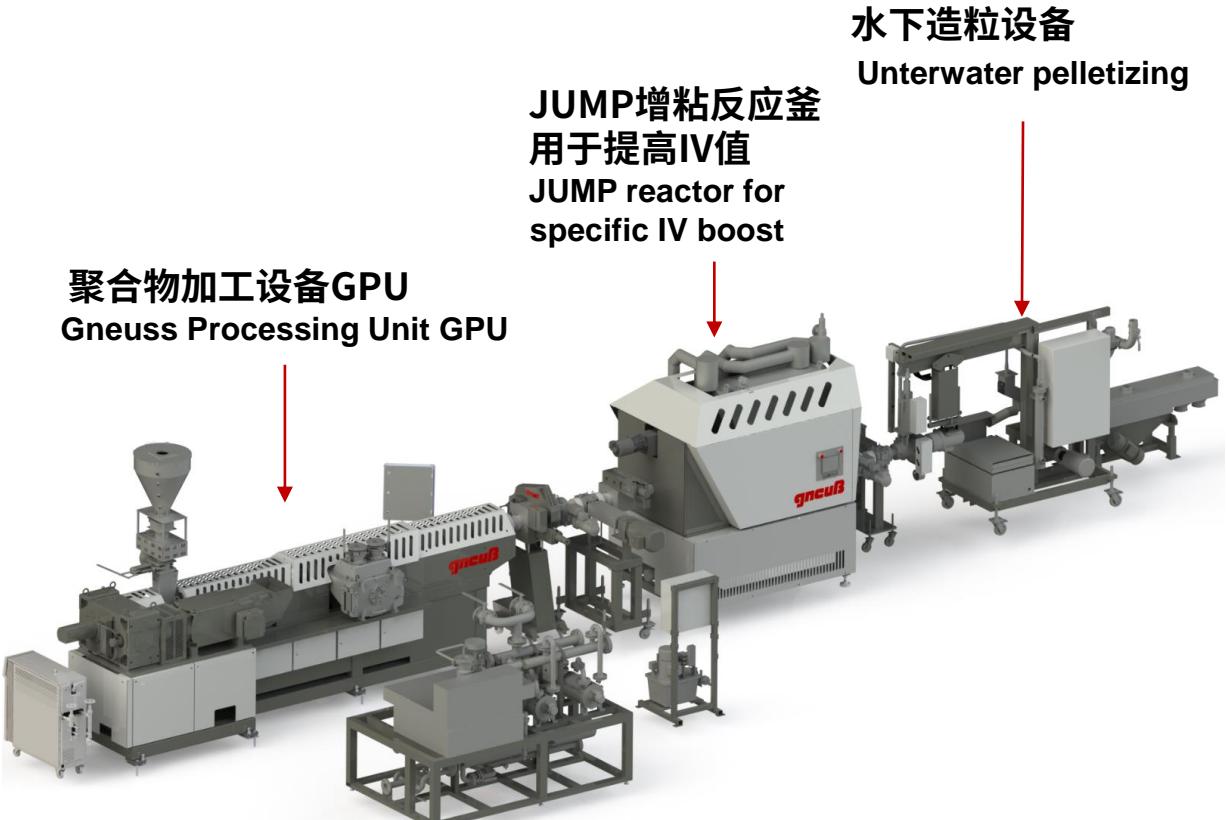
废纤维回收循环解决方案 现有纺丝生产的纤维回收



Pelletizing Lines

High Viscosity Applications

Input = Production waste from fiber, film and start- up lumps



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造粒生产线

高粘度的应用方案

输入料=纤维或薄膜生产以及试料生产的废料



Technical options:

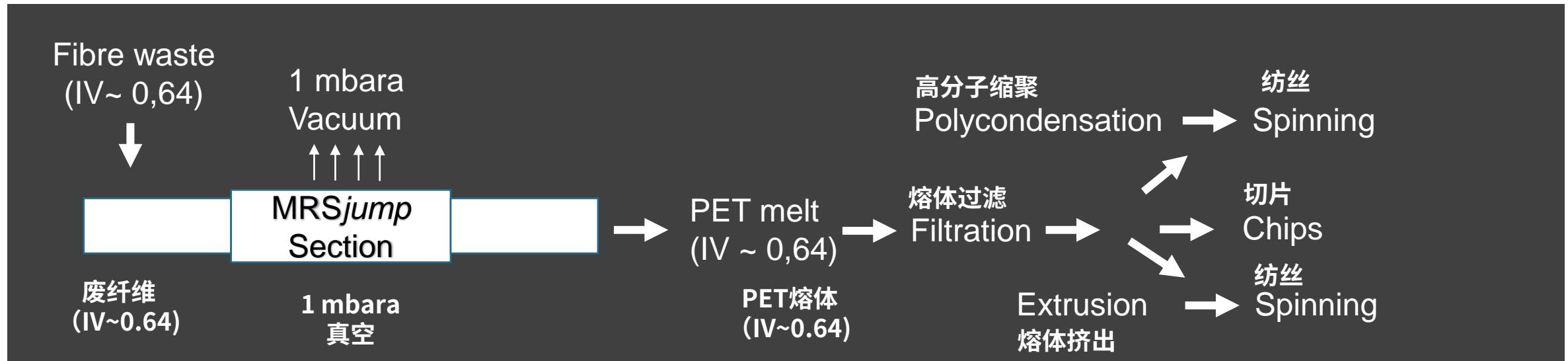
- + Underwater, underwater strand or strand pelletizing
- + Direct crystallization
- + Targeted IV setup

技术要点:

- + 水下切粒、线料切粒
- + 直接结晶
- + 设定目标IV值

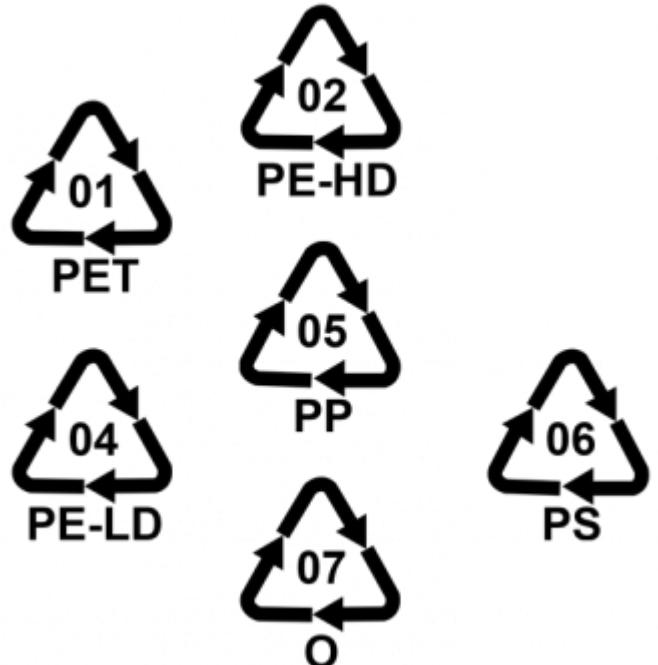
Solutions for fibre recycling for existing extrusion and polycondensation spinning

废纤维回收循环解决方案 现有挤出和缩聚纺丝加工



Degassing / Decontamination Spectrum of MRS Technology

脱气 / 去污
MRS技术应用范围广阔



Recycling

- + Closed recycling loop for PET / rPET
Bottle to Bottle / Tray to Tray
including food applications



- + Recycling of PS with FDA LNO, EFSA
- + Fibre waste recycling (textiles)
- + Odour neutralization, e.g. in the recycling of LDPE fish films
- + Purification of polymer melt

循环回收

- + PET / rPET 的闭环再利用，包括，
瓶子 - 瓶子，托盘 - 托盘 等食品安全级应用
- + PS的循环利用，具备美国 FDA LNO, 欧盟EFSA认证
- + 纤维废料的循环利用
- + 消除异味。比如循环利用LDPE的鱼膜
- + 净化聚合物熔体

Efficient Recycling Technologies for PET Fibre Waste

格诺斯先进的回收技术：高效循环回收，将
PET纤维废料制成高品质纤维



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