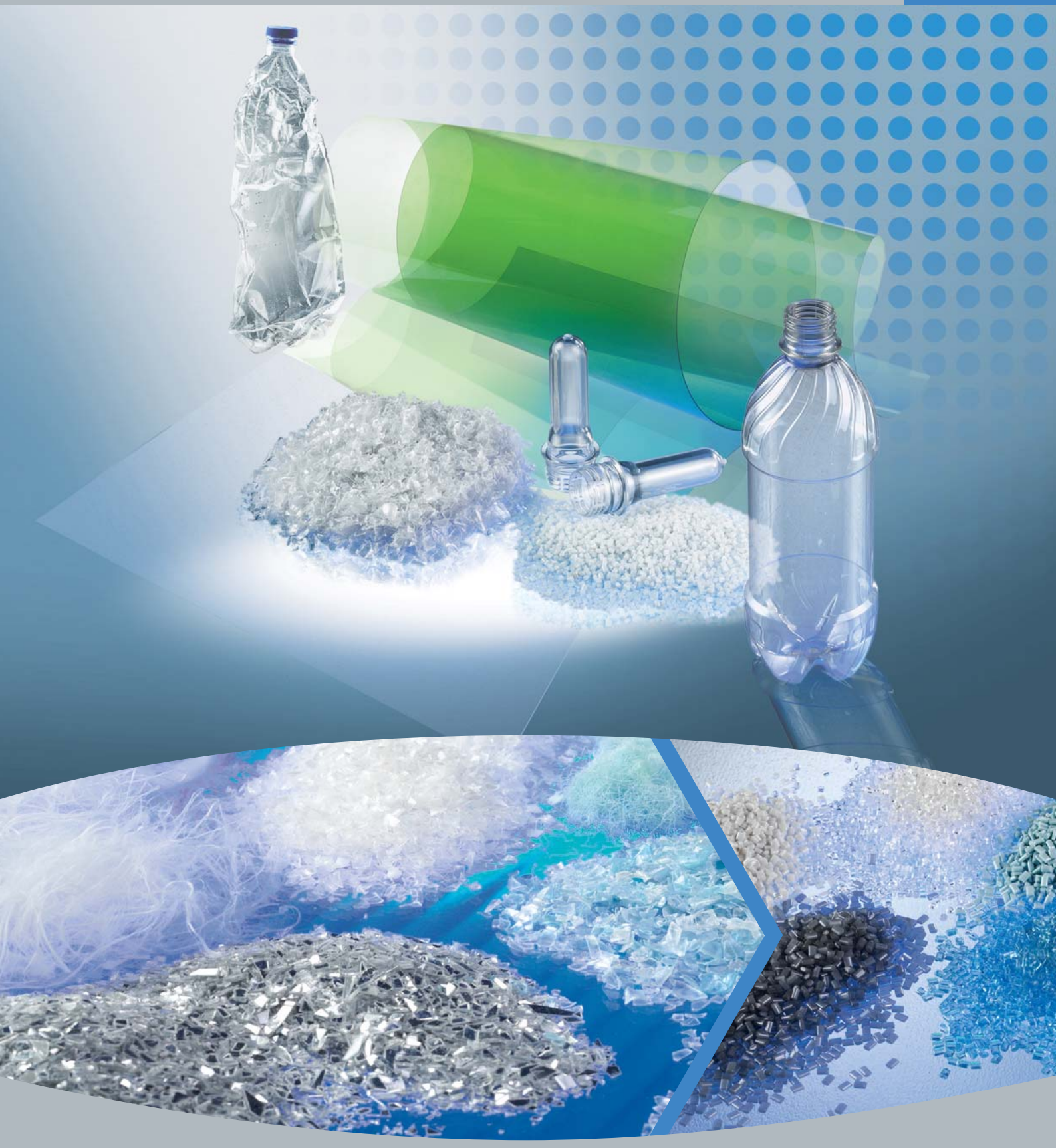
PET Extrusion System

VACUREMA

DIN ISO 9001



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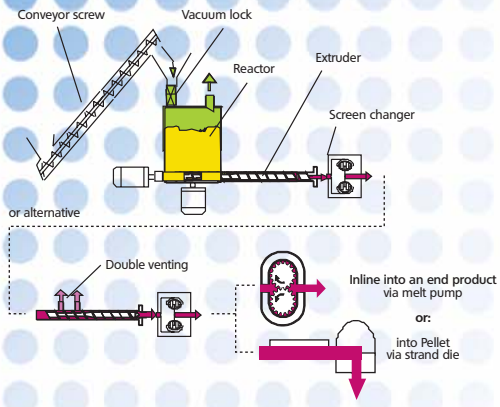
The Erema VACUREMA technology for PET processing and PET recycling

This unique, well proven and extremely flexible technology can process PET materials and any blends of materials coming along in the form of virgin pellets, post consumer bottle flakes, preground preform flake, preground cut out frames from thermoforming, precut fibre waste, and others,
- without external upstream crystallisation and without upstream predrying,
- in various bulk densities,
- into melt filtrated, virgin-like pellets or directly into end products such as sheet, fibre or strapping.

Different plant concepts can be configured depending on customers' individual requirements regarding required IV and required degree of decontamination.

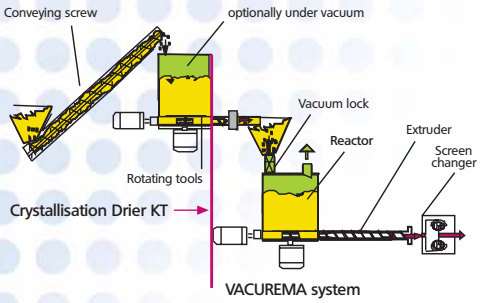


Picture: "Basic VACUREMA technology"

The basic VACUREMA technology

... works with a (patented) single reactor under vacuum directly feeding a sturdy, insensitive single screw extruder system. Suitable for applications such as PET fibre processing and inline thermoforming sheet extrusion. Product FDA approved.

Beginning with e.g. bottle flakes the material is brought into the VACUREMA reactor/extruder combination via vacuum lock. Appropriate holding time in very high vacuum/high temperature atmosphere effectively removes contamination (volatile matter) from the PET flake, and minimises residual moisture and IV-loss. The PET flake is continuously fed, still under vacuum, directly to the extruder. In the extruder the PET material is plasticised and homogenised and then fed to a fine filter with integrated, automatic self-cleaning system. In the filter residual solid contamination down to very small particle size is separated from the PET melt. The continuous extrusion process enables optionally continuous online IV monitoring/recording of the processed PET melt.
The result is clean, food-contact grade, optionally crystallised pellets with high IV levels that can be reused directly to produce high quality products.
FDA category "C" approved.



Picture: "Double Step VACUREMA technology"

VACUREMA technology with upstream crystallisation dryer: "Double Step VACUREMA technology"

This process technology uses a crystallisation dryer with or without vacuum admission upstream of the VACUREMA-reactor. Suitable for Bottle-to-Bottle recycling applications, where a modest IV increase (crystallisation dryer without vacuum admission) or a considerable IV increase up to five points (crystallisation dryer with vacuum admission) is required.
FDA category "C" approved. PepsiCo approved.
Degree of possible IV increase depends on input flake quality.

VACUREMA technology in combination with downstream SSP Process

Suitable for "Very high IV-increase" recycling applications. Virtually any required IV increase can be achieved. Produces high quality, crystallized and melt filtrated pellet. Due to VACUREMA process upstream of SSP, SSP process can, depending on individual targets, increase throughput or can be designed smaller (reduced investment).
FDA category "C" approved.
PepsiCo approved.

Bottle-to-Bottle Application

In the VACUREMA PET extrusion process washed polyester bottle flake from post-consumer waste collection is transformed into high-quality pellets. These pellets are confirmed as 100% suitable to be reused as raw material to produce PET bottles again. Two factors are decisive here:

- Erema to increase the viscosity of the PET in the process
- Extensive tests have confirmed that the reclaim, as produced with the Erema VACUREMA-technology, meets food packaging cleanness requirements.

PET bottle to PET bottle

By combining the VACUREMA extrusion system with the Erema crystallisation drier, used PET bottle flakes can be turned into top quality food-contact grade PET pellets with increased IV, - ***at low cost*** -, suitable to be used 100% to make new bottles. A conventional solid state process may not be required to meet this target.

BTB: key parameters for classification of end product (pellet):

Safety related parameters

- Whether they can be met depends only on the cleaning effect (ability) of the system and not on the input flake quality ✓**met by VACUREMA**
- Cleaning effect of system normally checked only by means of challenge test ✓**met by VACUREMA**

Physical parameters

IV, AA, colour, pellet shape, filtration fineness: ✓**met by VACUREMA**

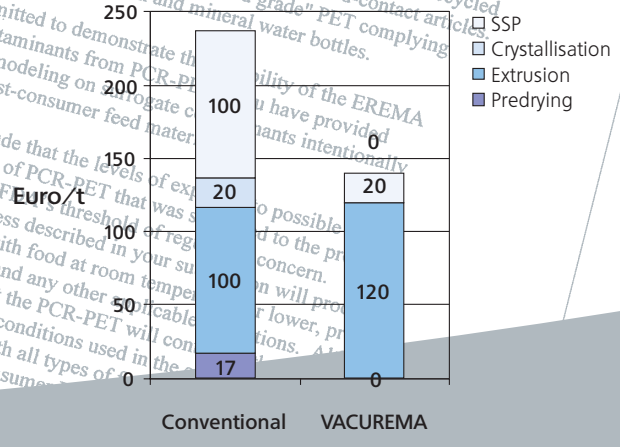
- Normally not checked by local government/authorities
- Result achieved and quality of pellets depend mainly on the (input) flake quality and the type of process used.

Key Advantages

- ✓ VACUREMA-technology = "state-of-the-art" with a long reference list
- ✓ Minimal production costs – 10 to 15 €cent/kg
- ✓ FDA approved process, various other national approvals received
- ✓ Same IV or increased IV (up to 0.05) in one extrusion step without solid state reactor - only one heat-up process, low maintenance.
- ✓ Produces melt filtrated pellet
- ✓ Simple, continuous process - "Compact production"
- ✓ Insensitive to input moisture variations.

Comparison: total transformation cost for BTB*

Example from practice, without engagement, numbers may vary.

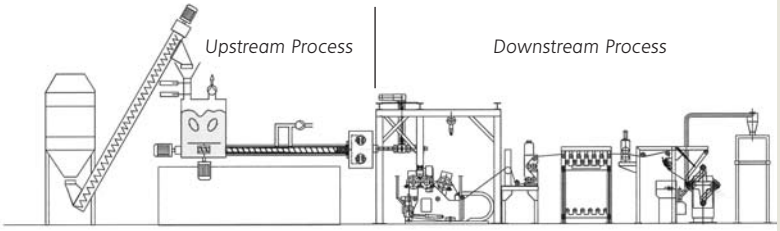


*incl. labour, energy, interest, space and other cost

Inline Application:
(for example direct sheet production)

For the direct route from PET waste (bottle flake, virgin/flake blends, inhouse sheet waste, ...) back to PET sheet or fibre Erema successfully realises "inline" processing by placing the die right behind the VACUREMA extrusion system to make thermoforming sheet, spun fibres or other products; without the detours of prior repelletising, predrying and external pre-crystallisation. This reduces production cost and logistics – and decisively increases the value added to the product produced.

The upstream process:
Material is fed into the plant automatically (via silo and conveyor screw). It passes a vacuum slide into the reactor. In the reactor the material fed in is mixed, heated, dried and crystallised at the same time in one working step. Thanks to an appropriate dwell time at high vacuum and high temperature, residual moisture is removed very efficiently and quickly. This is essential for minimal IV loss. In particular no external predrying is necessary. In addition to this, rotating tools provide the force for efficient and continuous filling of the tangentially and directly connected single screw extruder.
The extruder screw takes the material, plastifies, homogenises and degasses it and directs it to a downstream large area fine mesh filter system with integrated automatic self cleaning system.



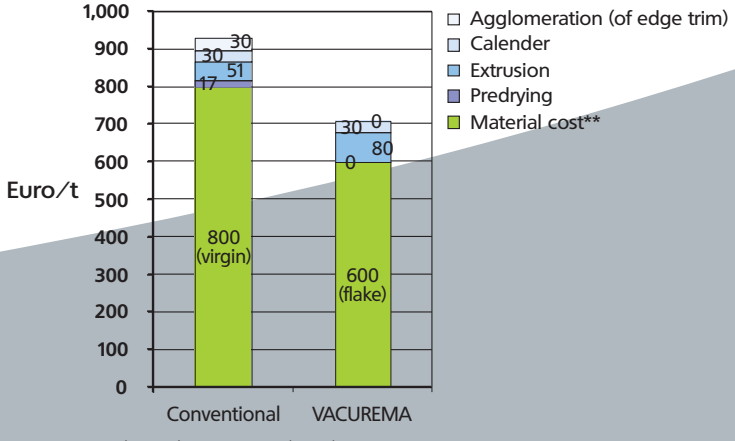
(Basic Layout)

The downstream process for sheet production
... consists of e.g. a melt pump, manual die, 3-roll-stack, gauging system, antiblock, film accumulator, edge trimming station, edge trimming granulator and turret winder (supplied for example by Erema´s partner SML).

In short ... and this may be very interesting to you: sheet extrusion by using the VACUREMA extrusion systems means/is:

- ✓ Very high flexibility regarding different input material and mixtures of materials
- ✓ Insensitive to moisture variations of input material
- ✓ Insensitive to solid contamination (aluminium, wood, etc.)
- ✓ Excellent self-cleaning filter system for processing of post consumer flakes - stable and proven! No melt pump required before filter system
- ✓ Minimal production costs
- ✓ Colour dosing possible

Comparison: Production cost for sheet (in €/ton)
Example from practice, without engagement, numbers may vary.



***... can vary, depending on actual market prices.*

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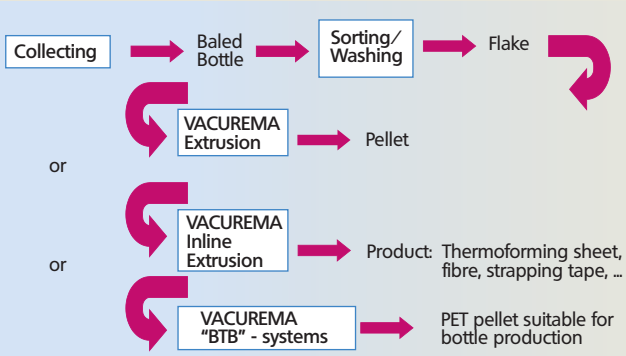
PET Recycling: Required processing steps and main applications



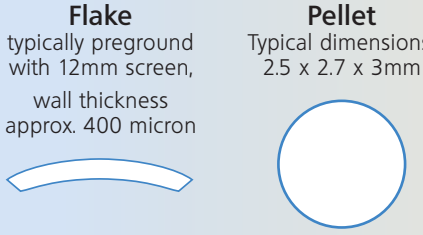
Picture: Main Steps in PET bottle recycling

When looking at classic PET bottle recycling, several "key steps" (see picture) are required for finally receiving quality secondary raw material, suitable for making high-quality products again.

By using the Erema VACUREMA technology, different high-quality products can be produced. Two main applications have stood out from the rest in the past years:

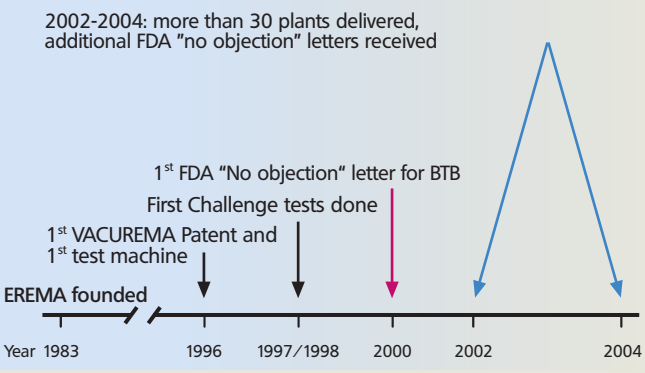
- **BTB:** Bottle-to-Bottle Recycling by using the "Double Step"-VACUREMA technology
- **Inline Extrusion:** Direct production (via extrusion) of products (sheet, strapping, fibre) from bottle flake, without detour of pelletising, by using the basic VACUREMA technology

In comparisn to conventional PET processing systems treating pellets *after the extrusion*, the patented VACUREMA process offers the following key advantages:

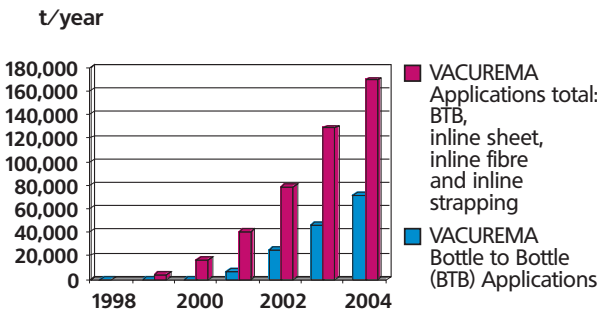


- **Quicker and less energy-intensive IV increase** by treating *flake* in comparisn with concepts treating pellet, since the infeed material into the VACUREMA reactor in the form of (typical) bottle flake has much thinner wall thickness compared to pellet and therefore a much larger surface.
- For the same reason as above, **decontamination efficiency is higher** and decontamination takes place quicker at a time.
- Due to the very effective predrying under vacuum **IV** of produced pellet is more stable and **less sensitive to input flake moisture variations.**

VACUREMA history, the first years: 1996 to 2003



VACUREMA-worldwide capacity



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Plant Sizes
VACUREMA Extrusion Systems for processing of PET

Type	Output (kg/h) depending on application and required IV
VACUREMA 906	120 - 200
VACUREMA 1000	150 - 300
VACUREMA 1100	250 - 400
VACUREMA 1109	300 - 500
VACUREMA 1300	400 - 600
VACUREMA 1500	550 - 800
VACUREMA 1514	700 - 1000
VACUREMA 1700	1000 - 1500
VACUREMA 1701	1200 - 1800
VACUREMA 1702	1700 - 2500

Use our wide range of experience in PET processing !

Our experts are at your disposal to discuss
your PET extrusion or recycling project with you.

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