BOOSTING THE REDUCTION OF THE ENVIRONMENTAL IMPACT OF PHARMACEUTICAL PRODUCTS THROUGHOUT THEIR ENTIRE LIFE CYCLE

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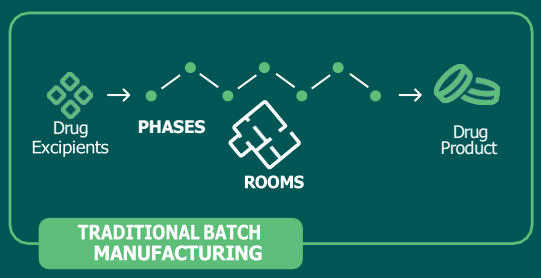
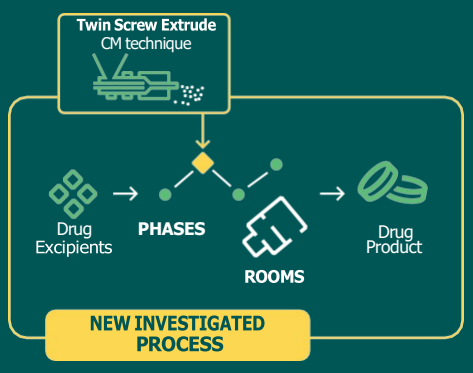


- BATCH PROCESS
- NUMEROUS PHASES AND EQUIPMENT
- MULTIPLE PRODUCTION ROOMS



- SUITABLE FOR CONTINUOUS MANUFACTURING
- SMALLER EQUIPMENT TRAIN
- MANUFACTURING STEPS AND SPACES REDUCTION
- LOWER ENERGY CONSUMPTION
- LESS RESOURSES USE

In the **past**, energy consumption and environmental impact were **not considered major factors** to be taken into account during the development of a manufacturing production line in the pharmaceuticals industry. Traditional batch manufacturing often involved **long**, **discontinuous**, **multi-phase processes** that required facilities with a considerable physical footprint and high energy consumption, due to demanding air-conditioning and environmental control requirements.

Now, as they increasingly pursue sustainability in their operations, pharmaceutical companies are seeking to adopt **innovative approaches** and technologies enabling continuous manufacture, which **improves efficiency** and **reduces environmental impact**. One technology with exciting potential for enhancing downstream, drug product formulation is **Twin screw extrusion** (TSE), a continuous technique capable of flexibly producing high-quality granular agglomerates with a range of properties. TSG can support dry, melt, or wet processes and the use of several excipients, further facilitating access to a range of final product performance profiles.

FEATURES AND ADVANTAGES

TWIN-SCREW GRANULATION

- CONTINUOUS MANUFACTURING
- OPERATIONAL FLEXIBILITY
- REDUCTION ELIMINATION OF WATER
- SMALL DIMENSION EQUIPMENT
- SHORTER PROCESSING TIMES
- INCREASED WORKER SAFETY
- DIFFERENT GRANULES PROPERTIES
- LESS RAW MATERIALS
- REAL-TIME MONITORING (PAT TOOLS)

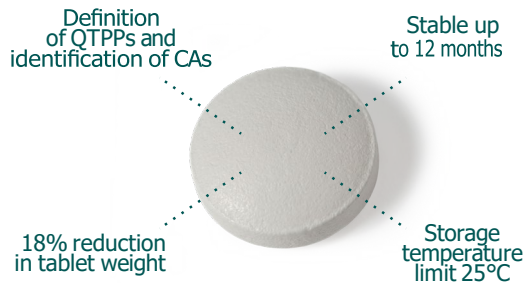
Twin-screw extrusion systems consist of a pair of co- or counter-rotating screws. The drug active and excipients are automatically fed as **solid powders** into the extruder, where the combination of mixing, kneading and controlled heating causes them to **agglomerate into granules**, suitable for further processing into the final product form.

Through **twin screw melt granulation** (TSMG), it is possible to obtain more **uniform granules** with better compressibility than is possible by conventional processing. Other advantages are:

- **Energy savings** associated with the reduced number of manufacturing steps and the space-time efficiency of the process, which reduces the requirement for energy-intensive air-conditioning.
- **Environmental impact reduction** through optimised use of raw materials and water.
- **Safer working conditions** through automation.
- **Consistent product quality** through real-time monitoring.

FLEXIBLE, EFFICIENT, EFFECTIVE AND SAFE OPERATIONS WITH A SMALL FOOTPRINT

PROTOTYPE DEFINED



PROCESS STREAMLINED

- MIXING
- TSMG
- MILLING
- BLENDING
- TABLETING

HIGH ENERGY CONSUMING STEPS REMOVED

- DRYNG COATING
- SOLUTION PREPARATION
- NO ADDED WATER
- NO THERMAL ENERGY BY NATURAL GAS

RESULTS

A **twelve-month stability study** has been carried out to confirm the chemical-physical stability and microbiological quality of the product tablets, confirming the packaging type and storage conditions. Drug release and particle size have been explored extensively during initial scale-up trials, which are being extended into further phases of development.
Continuous production methods including TSG may be used to **develop new drugs**, to target and finely tune properties like immediate/prolonged release, to improve **solubility** or to **mask taste without coating**, and to produce pharmaceuticals in a **greener way**. Thanks to automation and real-time monitoring, operator safety can be enhanced while maintaining or even improving product quality, and raw material and energy consumption can be reduced, minimising environmental impact.

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