# MicroMedia™ – Annular Mill for Nano Processing.

BÜHLER

The agitated bead mill MicroMedia™ covers an enormous spectrum of applications. It opens up new perspectives for the development and manufacturing of nano-scaled dispersions.

# Nano annular mill MicroMedia™.
# Flexible in use for a multitude of tasks.

**The MicroMedia™ is an agitated bead mill which has been specifically optimized for the use of micro beads. It is tailor-made for the development and production of high-value nano dispersions. The wide application spectrum of the MicroMedia™ comprises both the conservative treatment by soft dispersing and the true grinding in high-energy mode.**




### The superior advantages of the MicroMedia™-series:

- Development of highest quality standards for solid/liquid dispersions down to the lower nano range.
- Reliable use of micro beads Ø 20–400 µm (Ø 20–200 µm with mill sizes MicroMedia™ L).
- Extremely wide range of operating parameters from soft dispersing to high-energy grinding.
- Five mill sizes – from formulation development to mass production.
- Ideal conditions for a reliable scale-up.
- User-friendly functional elements, optimized for the use of micro beads.

### Comparison of bead size

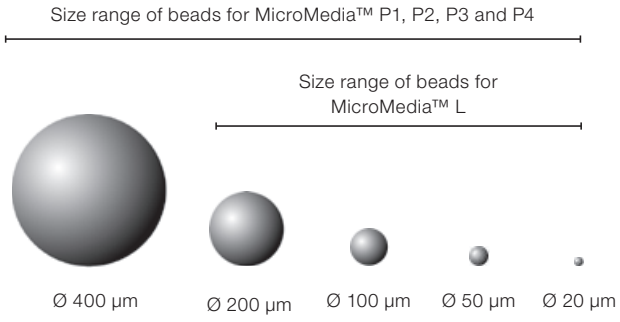


Fig. 3.1: Grinding beads – 50 × magnified.

### The benefit of micro beads

With just a fraction of the conventional bead size, micro grinding beads open up fully new possibilities in wet grinding technology. The MicroMedia™ has been designed for the use of micro beads without compromise, and it is ideally suited for novel products on the basis of nano dispersions.

### Examples of achievable particle fineness

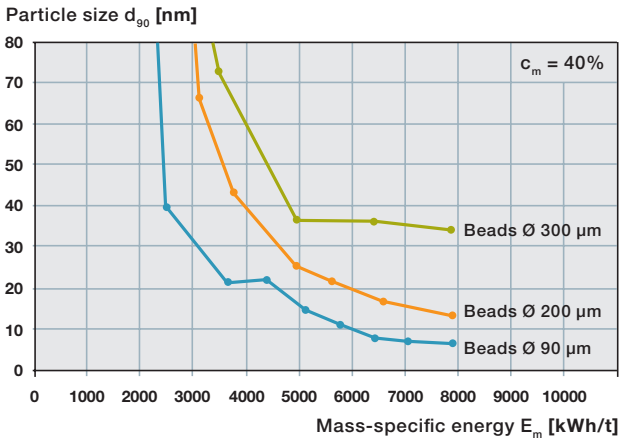


Fig. 3.2: Achievable particle fineness $d_{90}$ [nm] as function of the mass-specific energy input with reaction grinding using different bead diameters.

# Operating parameters which set standards. From soft dispersing to nano true grinding.

**The extremely wide parameter range in which the MicroMedia™ can be operated recommends this type of mill as an ideal instrument for completely different applications in nano processing.**

### Soft dispersing for sensitive material systems

With many innovative applications it is the task of the tiniest micro beads (from diameter of 20 µm) to separate agglomerated clusters of nano particles in a liquid phase and to concurrently wet the new surfaces. For this purpose, micro beads need to be perfectly moved against each other, but yet in a conservative manner. An inappropriate intensive load would result in an activation of the surfaces of the primary particles which were separated during dispersing. A negative influence on the reagglomeration behaviour up to undesired chemical or morphological conversion processes in interaction with the formulation could be the consequence.

A MicroMedia™ can be reliably operated with micro beads with a tip speed already from 4 m/s and with a mean power density below 0.1 kW/l (power per grinding chamber volume).

These are ideal prerequisites for highly efficient soft dispersing of sensitive nano systems – optionally supported by a superimposed chemical treatment of the new surfaces. The latter results in a stabilization of the dispersion.

### High-energy mode for true grinding

Depending on the grain hardness, nano particles may as well be generated by true grinding of crystalline matter. For this purpose micro beads, also with a diameter of below 100 µm, are eddied intensively with a comparatively high tip speed of the agitator. Due to the outstanding cooling efficiency of all mill sizes, the high energy milling is carried out at low milling temperatures and thus in a thermally conservative way despite a mean power density in the mill chamber of up to 4 kW/l.

### Application example: Soft dispersing

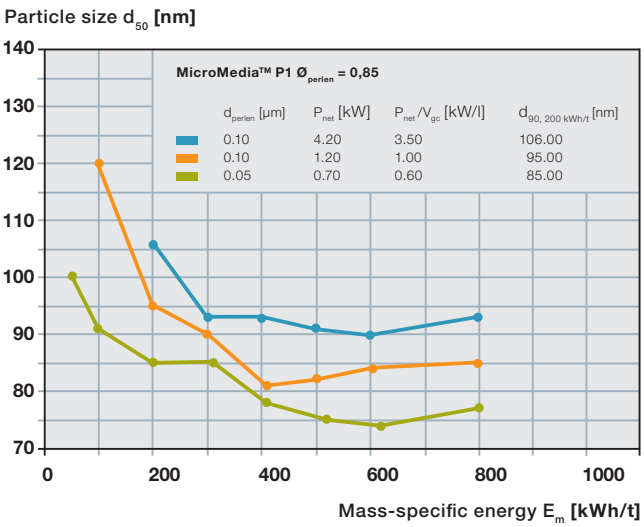


Fig. 4.1: Nano dispersing-grinding of an organic pigment formulation with different power densities, bead diameter 50 µm and 100 µm. Highest fineness with smallest beads and lowest density $P_{net}/V_{gc}$.

### Application example: Nano true grinding

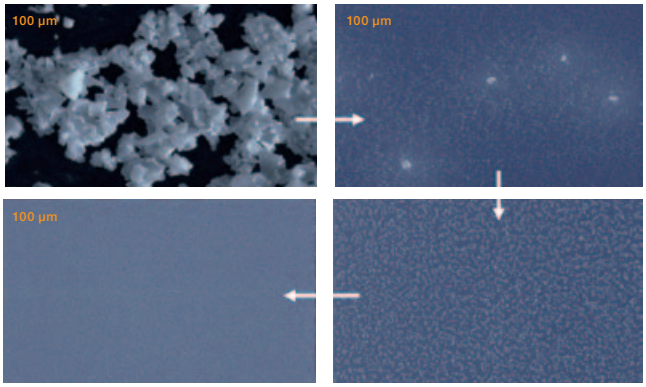


Fig. 4.2: Nano true grinding of a functional ceramic with micro beads Ø 100 µm with high power density in the process chamber of a MicroMedia™ P1.


Fig. 5.1:
MicroMedia™ P2-C in stainless steel execution, process unit completely from ceramics.

# The mill sizes at a glance.
# From lab solution to mass production.

**Innovative nano and micro dispersions usually depend on formulation and process development on micro scale. The applied wet grinding technology needs to be reliably transferable. For this purpose the MicroMedia™ series comprises five different mill sizes, which ideally fulfill the respective needs in research, development and production.**

**MicroMedia™ L –**
**Formulation development and material screening**
With an active chamber volume of only 0.07 l = 70 cm³ the MicroMedia™ L module, mountable to the universal lab Perl Mill™ PML 2, is an ideal instrument for the development lab (see Fig. 7.1). The minimized batch sizes allow for comprehensive test series also in combination with particularly high-value ingredients.

**MicroMedia™ P1 –**
**Pilot-scale and small-scale production**
The smallest size of the P series, MicroMedia™ P1 (see Fig. 7.2), is preferably used for the production of high-value small batches ranging from 3 to 50 litres or in a pilot wet milling facility to develop scale-up data for mass production with the mill sizes MicroMedia™ P2 to P4.

**MicroMedia™ P2-C –**
**Metal-free nano processing in production**
The process unit of the production mill MicroMedia™ P2-C is fully made from ceramics (see Fig. 5.1). This makes the mill ideally suited for demanding applications in nano true grinding or nano dispersing, where no contact with metal surfaces in the mill chamber would be acceptable.

**MicroMedia™ P3 and P4 –**
**Nano processing for mass production**
The process units of the large-scale mills MicroMedia™ P3 (see Fig. 7.3) and the two times larger MicroMedia™ P4 (see Fig. 7.4) with a scale-up factor of 2 are made from an extremely wear-resistant, through-hardened proprietary stainless steel. Both mill sizes are provided with a highly efficient rotor cooling (see Fig. 9.1) as standard.

# Scale-up – reliable and quality-constant.

With many other wet grinding systems, special effects and extreme operating conditions are realizable in the development lab or on pilot plant scale which are not at all or at least not reliably transferable to a larger scale.

In contrast, products developed with the MicroMedia™ series can be processed on any other MicroMedia™ mill size reliably and with identical product quality. Moreover, beginning with pilot size MicroMedia™ P1 a linear scale-up is achievable, with the active mill chamber volume as reference parameter. This ideal scale-up characteristic is based on the fact that the load conditions in the mill are in wide ranges adjustable to identical values. Because of the innovative separation of micro beads (see Fig. 8.1 and 9.1) already in the outer working annulus, flow rates are realizable which are directly proportional to the chamber volume.


Fig. 6.1: MicroMedia™ P1 – linear scale-up to all production size mills of the MicroMedia™ series.

Fig. 7.1: MicroMedia™ L (active chamber volume 0.07 l = 70 cm³) with recirculation set-up in the development lab, mounted to the universal Lab Perl Mill™ PML 2.

Fig. 7.2: MicroMedia™ P1 – ideally suited for a scale-up from the pilot plant and for the production of high-value small batches.

Fig. 7.3: MicroMedia™ P3 – production size mill (stainless steel version) for micro beads, with additional rotor cooling.

Fig. 7.4: MicroMedia™ in customer finish, nano processing in the mass production with an installed power of P = 90 kW. Cleaning of inner surface of MicroScreen during operation by means of an in-situ device.

# Functional principle of MicroMedia™. Perfect fine-tuning of all components.

The Perl Mill™ series MicroMedia™ is specifically designed and optimized for the reliable use of micro beads in the range of 20 to 200 (400) µm. The innovative concept consists of a large number of ideally fine-tuned functional elements (see Fig. 8.1 and 9.1), which allow for a high flow capability – even in combination with the use of extremely small micro beads:

- Vertical arrangement of the drive to avoid any bending moments and total relief of the double-acting mechanical seal (1) are ideal prerequisites for the reliable use of micro beads.
- The cylindrical rotor body (2) rotates in a double-walled cooled stator housing (3).
- For selected mill sizes, a double-walled cooled rotor (4) is available, made from wear-resistant metallic proprietary alloy (see Fig. 11.4).
- The rotor cylinder features a large number of axial slots (5) in the upper range, through which micro beads which may have settled during standstill can be transferred back to the actual outer process area.
- Axial annular process area, product flow from the top to the bottom (6).
- The specific arrangement* of low-clearance activation pegs (7) at the outer rotor surface results in a concentration of the beads in the outer annulus.
- In selected mill sizes, turbulence inducing pegs – TIP – (8) located at the inner surface of the outer stator result in an additional eddying of the micro beads – even with difficult rheological properties of the multi-phase system beads–mill formulation, such as e.g. dilatancy.
- The dimensioning of rotor and stator, supported by specific functional elements (7, 9, 10), facilitates the staying of the micro grinding beads in the outer annulus** (see Fig. 8.1 and 9.1).
- In the annular discharge channel (11) between the cooled inner stator (12) and the inner rotor surface (lower range), the mill dispersion which has been largely separated from the beads flows from the bottom to the top.
- Between the inner rotor surface (upper range) and the outer surface of the MicroScreen (13) a shear gap is located (14).
- The extremely large MicroScreen (13) with a particularly large free surface area (slot widths from 10 µm) is located well protected above the inner stator and within the rotor head.
- Due to the local shear thinning, the dispersion can pass through the MicroScreen with significantly reduced pressure drop.
- Isolated micro beads which might migrate into the inner discharge ducts together with the dispersion may be returned to the outer process annulus through the numerous slots in the rotor.
- The product is discharged downwards through a central exit pipe (15) downstream of the MicroScreen.

**Mechanism of bead concentration* in MicroMedia™ mill sizes L and P1:**

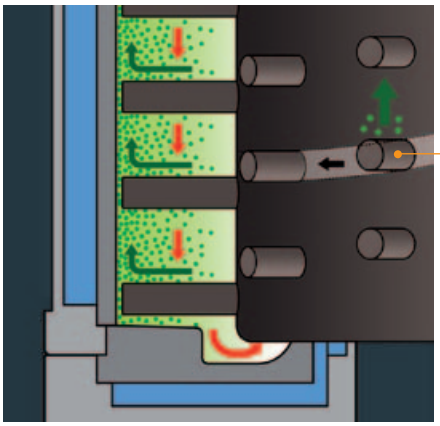


Fig. 8.1:
Product flow marked by red arrows ➡, internal bead movement marked by green arrows ➡.

*** = Internationally patented, e.g. EP 1 943 022 B1 (2010)**

# Schematic MicroMedia™ P2 to P4.
# Concentration of beads in outer annulus**.

** = Internationally patented,
e.g. EP 1 992 412 B1 (2010)

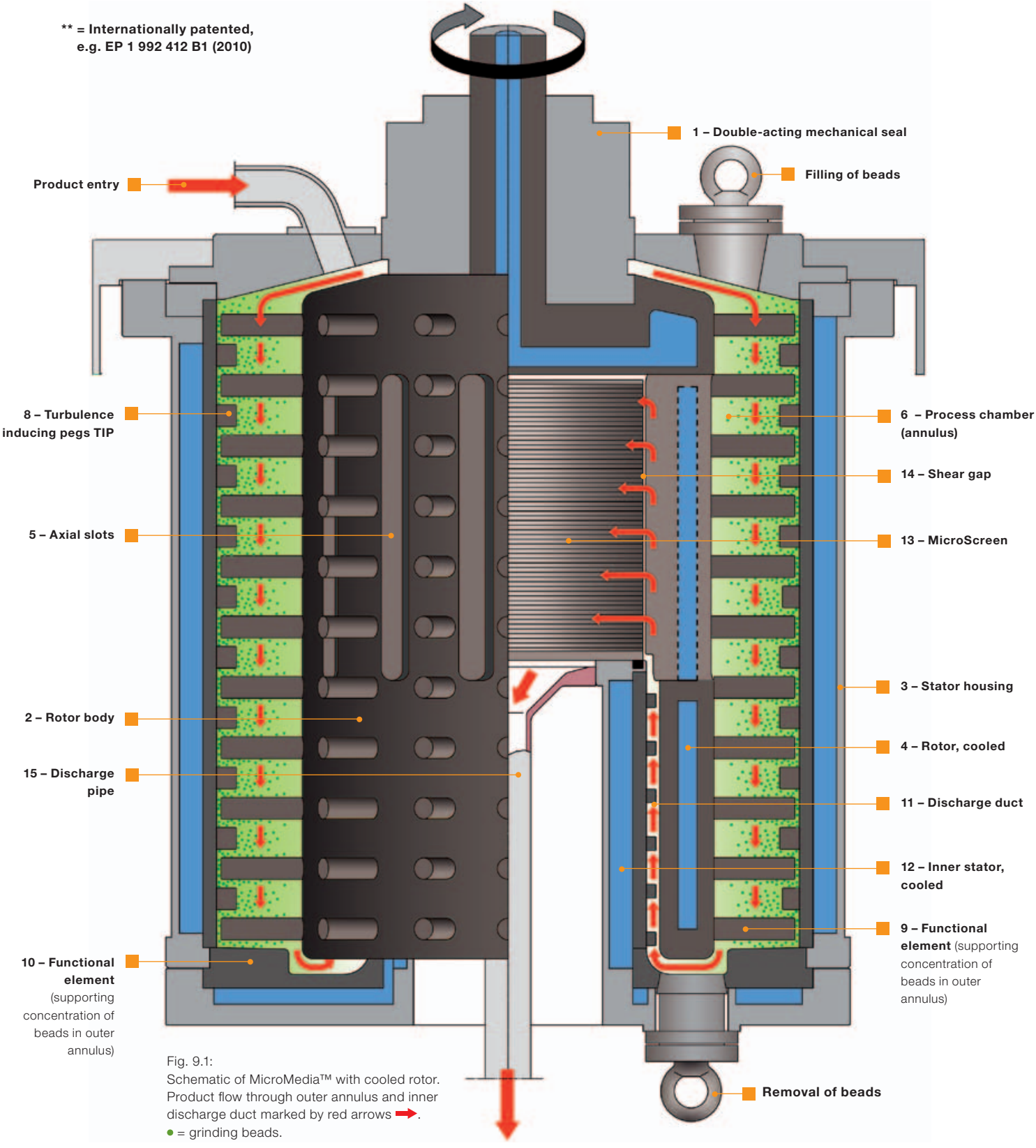


Fig. 9.1:
Schematic of MicroMedia™ with cooled rotor. Product flow through outer annulus and inner discharge duct marked by red arrows ➡.
● = grinding beads.

# Buhler automation and MicroMedia™.
# One flexible solution – for laboratory and production.

Fig. 10.1: Touchpanel HMI at MicroMedia™ L in R&D laboratory.

Fig. 10.2: MicroMedia™ P2 with control package PREMIUM for optimized automation in the production.

**The advantages at a glance**

For the precise adjustment of operating conditions which have to be varied for the development of an application such as e.g. power input, all Perl Mills™ of the MicroMedia™ series are equipped with a frequency inverter controlled variable speed drive.

Reflecting the needs of the demanding applications, all mills of the MicroMedia™ series feature as standard equipment the Buhler operation and automation package PREMIUM – in identical execution from the development lab to mass production.

**The PREMIUM package**

The operation and automation package PREMIUM fulfills the highest demands with respect to user friendliness, control and automation options as well as trending and logging of operating parameters:

- Speed control of mill rotor by frequency inverter
- Speed control of pump by frequency inverter
- PLC-based technology:
  + Software control circuits
  + Administration of set value data records
- Operating interface (HMI) as graphics-capable touch panel with LCD color display
  + Input and indication of operating parameters
  + Input of control variables (set values)
  + Basic parameter setting of the mill
- Choice of different control algorithms, resp. different possibilities of combination
- Automated processing based on different optimization strategies, e.g. in temperature, pressure, power or energy modes
- Several communication interfaces
  + Standard interface to Buhler data logging system WinTrend
  + Optional interfaces to superimposed process control systems

# Optimized for the use of micro beads.
# Convincing up to the smallest detail.

Fig. 11.1: Double-sealed plug for closing of filling and discharge opening for micro beads.


Fig. 11.2: Firmly attachable, sealed special device for filling of micro beads.

Fig. 11.3: User-friendly removal of the double-sealed MicroScreen.

The handling of micro beads in the size range smaller than 0.3 mm down to 0.02 mm (= 20 µm!) presents a challenge increasing with the bead fineness. Thanks to many specifically developed and optimized functional elements, the MicroMedia™ mill series provides ideal conditions for a user-friendly handling of micro beads – from the filling of beads via their removal to the execution of service works:

- Conical, double-sealed plugs for closing filling and discharge openings for micro beads (Fig. 11.1). Thus a jamming of the micro beads is excluded.
- Firmly attachable and sealed specific device for filling of micro beads (Fig. 11.2) securely prevents leakage of beads during filling.
- Hydraulic lowering of stator housing (Fig. 11.4) along a high-precision guiding device prevents damaging of rotor tools which are optimized for the eddying of micro beads.
- User-friendly removal of double-sealed MicroScreen to the top (Fig. 11.3).
- The place of installation of the MicroScreen on top of the inner stator allows for the use of a particularly large-dimensioned screen body. The resulting extremely large free surface area enables highest flow rates even in combination with the smallest slot widths of the MicroScreen.


Fig. 11.4: Lowering and swivelling of stator housing along high-precision lifting device.

GD 52032 en 1010 2000 df

Bühler AG
CH-9240 Uzwil, Switzerland
T +41 71 955 34 91
F +41 71 955 31 49
grinding.dispersion@buhlergroup.com
www.buhlergroup.com

BÜHLER