SuperFlow® – High-Performance Perl Mill®.

BÜHLER

Powerful true grinding and dispersing for many different applications.

You start your TFT screen or your new laptop, or you use a mobile phone with colour display with brilliant colours and a high resolution. There is a high probability that the colour filter dispersion for the displays was manufactured on a SuperFlow® Perl Mill®. A large number of state-of-the-art automotive paints and brilliant colour coatings also owe their outstanding quality to the unique dispersing characteristics of a SuperFlow®. Further examples of the numerous areas of application: Paints and lacquers, Agrochemical industry, Printing inks, Chemical industry, Paper and Nanotechnology.

Nano- and microdispersions for high-tech products of everyday life – better and more economical by SuperFlow® technology:

- High-quality colour filters of TFT screens and LCD displays
- More gloss for automotive paints: high solids and waterbased products
- More resistance for heavy-duty coatings
- More brilliance by nano-grinding of highly light-fast pigments
- More economic efficiency due to increased colour strength in the manufacture of high-quality tinting pastes
- More gloss and transparency for high-quality packaging and foil inks
- More quality for premium inkjet products
- More quality and economic efficiency in the development and manufacture of a wide range of products with high demands in the area of dispersing and true grinding


BÜHLER
SuperFlow

Unique – Linear scale-up from R&D through pilot to production.

Fig. 4.1: R&D Perl Mill® SuperFlow® 4 with control package PREMIUM and complete setup for recirculation operation

Fig. 4.2: SuperFlow® 12 while lowering of grinding vessel

High power densities in the order of $P_V \geq 2–4$ kW/l (definition see below), as realised in the grinding chamber of SuperFlow® Perl Mills® result in:

- **Higher productivity from smaller grinding chamber**
- **Significantly increased quality level**

Due to the consistency of the main dimensions of the rotor and stator geometry, which are decisive for the grinding process, and due to the effective cooling independent of the mill size, the same high power densities can be realised in all Perl Mills® of the SuperFlow® series without overheating the product.

The comprehensive SuperFlow® range

The complete SuperFlow® range consisting of six mill sizes fulfils all requirements from the development lab up to the large-scale production of high-tech products. The unique high-performance mill concept permits a fully linear scale-up for all models, such as:

- R&D Perl Mill® SuperFlow® 4, development of formulations with minimum product requirement (Fig. 4.1)
- Pilot Perl Mill® SuperFlow® 12, preparation of small batches and samples (Fig. 4.2)
- Production Perl Mill® SuperFlow® 85 with control package COMFORT, speed-variable drive (Fig. 5.2)
- High-performance production Perl Mill® SuperFlow® VCR 200 with rotor cooling (Fig. 3.1)
- High-performance Perl Mill® SuperFlow® VCR 400 with up to 110 kW drive and mill chamber volume of 30 litres (Fig. 5.1)
- Large-volume Perl Mill® SuperFlow® 800 for demanding bulk products (Fig. 5.3)

Definition of power density P_V

$$P_V = \frac{P_{total} - P_{without\ media}}{V_{grinding\ chamber}} \left[\frac{kW}{litre} \right]$$

Fig. 5.1: SuperFlow® VCR 400 with special painting: High-performance recirculation Perl Mill® for the manufacture of concentrates

Fig. 5.2: SuperFlow® 85: Production Perl Mill®
with speed-variable drive, control package COMFORT

Fig. 5.3: SuperFlow® 800 – Large-volume Perl Mill® for the nano-grinding of pigments, 250 kW drive with grinding chamber volume of 79 l

The SuperFlow® principle: Patented technology for better product quality.

Rotor
The rotor is designed as a double-jacketed hollow cylinder closed on top. The outer rotor surface is equipped with a large number of agitator pegs. In the upper centrifuge area, the rotor features largely dimensioned, slotted openings around the periphery allowing the recirculation of the grinding media from inside to outside.

Stator housing
The active surfaces of the stator housing contacting the product consist of an outer stator cylinder, a lower stator bottom as well as an inner stator cylinder. In the area of the active outer grinding chamber, the outer cylinder is equipped with a large number of stator pegs. On the inner stator the agitator pegs are helically arranged. Above the inner stator there is a large-surface cylindrical protective screen, to which the central discharge pipe is connected.

Grinding chambers
The rotor, which rotates centrally in the stator housing, divides the process chamber into an upper eddy current inducing cylindrical gap area and a subsequent set-up in series of an outer and inner grinding chamber.
The grinding chambers can be filled up to the lower edge of the protective screen with grinding media of various materials, preferably of high density, media with diameters ranging from 0.2 mm to 1.5 mm. The protective screen is located above the grinding media filling level during machine standstill.

Operating principle
The product to be ground is fed into the SuperFlow® from the top by a pump and distributed rotation-symmetrically above the outer rotor. In the cylindrical gap between the outer centrifuge area of the rotor and the stator, the product is exposed to an intensive pretreatment. In the subsequent turbulent grinding zone, a high load on the product is generated between the grinding media, which is exposed to continuous impulse changes by the interaction of the rotor and stator pegs. In the area of the stator bottom, the mixture of product and grinding media is deflected into the inner grinding chamber, where it flows upwards from the bottom to the top. Here the grinding media is activated between the stator pegs and the inner surface of the rotor.

The turbulent motion of micro grinding media achieves an effective true grinding and dispersing to the submicron or down to the nanometer range, dependent on the application.

The defined flow through the outer and the following annular inner grinding chamber results in a particularly narrow residence time distribution of the product in the mill and thus in generating a narrow particle size distribution.

Grinding media separation
Above the inner grinding chamber, the grinding media is accelerated to full peripheral speed by means of baffles. Because of the difference in density, the grinding media is separated by centrifugal force and returned through the slotted openings of the rotor to the cylindrical eddy current inducing gap. With new product flowing into the mill, the separated grinding media is again transported to the outer rotor/stator grinding zone. In this way, a closed internal recirculation of the grinding media through the outer and inner grinding chamber is effected.

Product discharge
As a result of the pressure exerted by the feed pump, the product which has been separated from the grinding media by centrifuging flows counter to the centrifugal effect through the centrally arranged cylindrical protective screen and is discharged through the following discharge pipe. The screwed assembly of discharge pipe and protective screen can be removed easily.

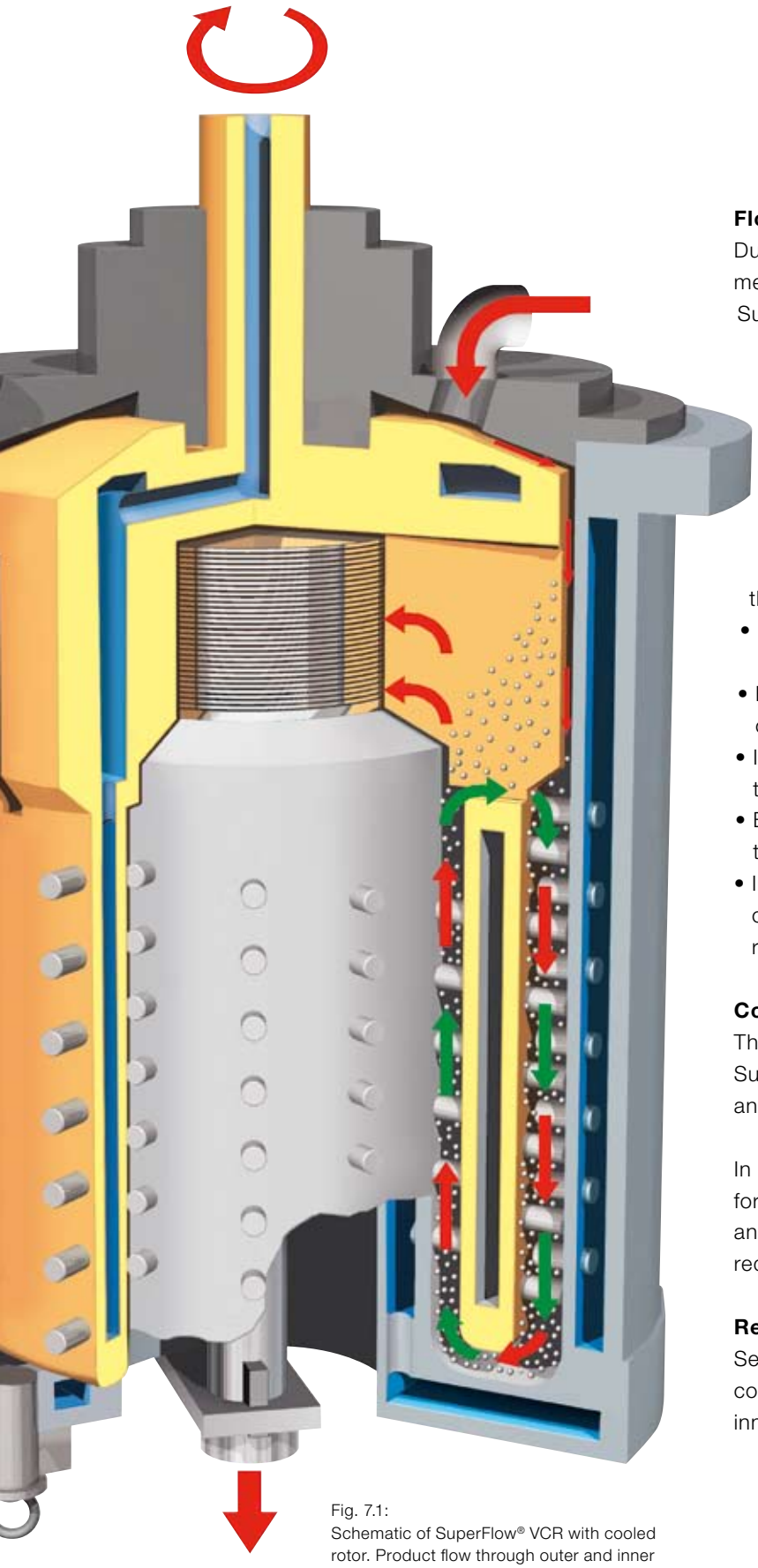

Fig. 7.1:
Schematic of SuperFlow® VCR with cooled rotor. Product flow through outer and inner grinding chamber marked by red arrows, internal grinding media recirculation marked by green arrows

Flow rate capability

Due to the effective centrifugal separation of grinding media and the internal grinding media recirculation, a SuperFlow® can be operated with flow rates which are up to more than 10 times higher compared to a conventional large-volume mill.

Unsurpassed cooling concept

As both the rotor and the outer and inner stator are cooled, all product contact surfaces of the SuperFlow® act as intensive cooling areas. During its defined flow through the mill, the product passes through many cooling zones:

- Precooling of the product in the eddy current inducing gap
- Effective stator and rotor cooling in the outer grinding chamber
- Intermediate cooling in the deflecting area of the stator bottom
- Effective stator cooling when product flows through the inner grinding chamber
- Intensive cooling in the inner grinding chamber by constant turbulent motion of the product at the inner rotor surface

Convincing advantages of high-intensity cooling

Thermosensitive products can be processed safely in a SuperFlow® with quality-increasing high power densities and low grinding temperatures.

In either pass or recirculation operation, there is no need for external cooling. Cleaning-intensive heat exchangers and cost-intensive cooled vessels are generally not required.

Remark:

Selected SuperFlow® mill sizes are available without rotor cooling, while the high-intensity cooling of outer stator, inner stator and deflecting bottom is maintained.

Fig. 8.1: SuperFlow® 12 pilot Perl Mill® with control package PREMIUM and complete setup for recirculation operation

Flexibility for pass and recirculation operation.

Buhler SuperFlow® agitated media mills are ideally suited for:

- **Defined single- or multiple-pass operation (Fig. 8.2 and 8.3)**
- **Economic recirculation operation with extraordinarily high flow rates (Fig. 8.4 to 8.6)**

For an optimum recirculation operation, the content of the mixing vessel should be recirculated at least five times through the process chamber of the mill. For generating a narrow particle size distribution, it is particularly important that the product is thoroughly mixed in the product vessel.

In special cases it may be appropriate to provide for a defined filling pass preceding the recirculation operation (Fig. 8.5). At conclusion of the recirculation operation, the finished product may be taken out of the recirculation vessel directly, or the product may be supplied to a finished product vessel in a defined transfer pass through the mill (Fig. 8.6).

For the optimised solution of your specific application Buhler offers tailor-made system components as well as semi- and fully automatic plant concepts.

Pass operation and recirculation operation

Single-pass operation

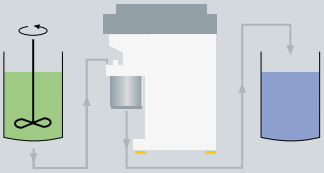

Fig. 8.2

Multi-pass pendular operation

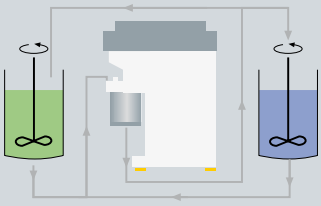

Fig. 8.3

Recirculation operation

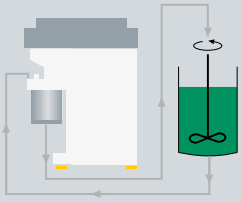

Fig. 8.4

Recirculation operation with filling pass

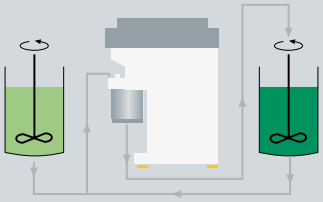

Fig. 8.5

Recirculation operation with filling and transfer passes

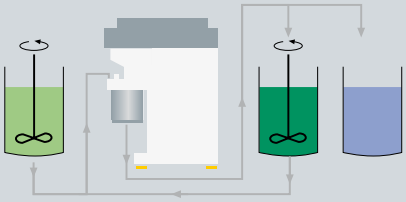

Fig. 8.6

User-friendly down to the smallest detail.

Fig. 9.1: Optimisation of grinding media filling degree of a SuperFlow® VCR 200

Fig. 9.2: SuperFlow® VCR 200 – grinding vessel lowered and pivoted

Fig. 9.3: Removal of protective screen from a SuperFlow® VCR 200 filled with grinding media

Quick and easy handling

The SuperFlow® is designed for ease of operation. All servicing can be done quickly and easily.

- Comfortable filling of grinding media through upper filling aperture (Fig. 9.1)
- Minimum requirement of cleaning liquids in case of product change
- Removal of protective screen from closed mill without draining of product or grinding media (Fig. 9.3)
- Minimum time and cleaning requirement for grinding media change
- Simple lowering of grinding vessel by integral lifting device (Fig. 9.2 and 9.4)
- Grinding vessel can be lowered and pivoted for optimum accessibility (Fig. 9.3)

Fig. 9.4: Foot-operated hydraulics for lifting of grinding vessel of a SuperFlow® VCR 200

Buhler automation: Consistent quality with highest economic efficiency.

The advantages at a glance

For precisely controlling of the required power input, SuperFlow® high-performance Perl Mills® are equipped with speed-variable drive with frequency inverter control as a standard feature.

For user-specific requirements the control and automation packages COMFORT and PREMIUM are alternatively available.

COMFORT package

With the COMFORT control package, the power density in a SuperFlow® is exactly adjustable to the product-specific requirements.

PREMIUM package

The PREMIUM control package fulfils the highest demands with respect to user friendliness, automation and control options as well as indication and storage of operating parameters.

Fig. 10.1: COMFORT operator panel

Fig. 10.2: PREMIUM operator panel

PREMIUM package

- Rotor speed control by frequency inverter
- Pump speed control by frequency inverter
- PLC-based control, software control loops, administration of setpoint data
- Control panel as graphics-capable VGA colour display or multi-line monochrome display, each with sealed touchpad for input or indication of:
  - Rotor speed n_R [min^{-1}]
  - Pump speed n_P [%]
  - Power rotor P_R [kW]
  - Pressure in product supply p_{Pr} [bar]
  - Product discharge temp. t_{Pr} [°C]
  - Mass flow rate (option) M_{Pr} [kg/h]
  - Mass-specific energy input E_m [kWh/t]
  - Product quantity M_{Pr} [kg]
  - Required grinding time t_{Mahl} [hh:mm]
  - Configuration of the integrated software control loops
- Free choice of different control algorithms, resp. different possibilities of combination. Choice of automated optimisation strategies:
  a) Power rotor
  b) Product temperature
  c) Pressure
  d) Optimization according to concept of mass-specific energy input (E_m = const.)
  e) Cleaning cycle
- Choice of different display masks:
  - Input mode
  - Indication mode operating parameters
  - Visualisation Perl Mill® and peripherals
  - Trend diagram (development of process parameters)
  - Administration of setpoint data
- Options:
  - Interface printer
  - Interface superordinate systems
  - Interface remote diagnosis

COMFORT package

- Rotor speed control by frequency inverter
- Relay control
- Control panel with push buttons and separate indications for:
  - Speed adjustment faster/slower +/–
  - Digital indication of rotor speed n_R [min^{-1}]
  - Digital indication of power consumption P_R [kW]
  - Indication of product discharge temperature by pointer instrument t_{Pr} [°C]

The Solution for research and development – Perl Mill® PML 2 with SuperFlow® 4 process unit.

Fig. 11.1: SuperFlow® 4 with removed grinding vessel

Fig. 11.2: SuperFlow® 4 with automation package PREMIUM

Buhler R&D Mill® PML 2 offers unmatched flexibility for lab-scaled process development.

The universal pivoting drive unit is the core part on which established Buhler process units in several executions can be operated. The effective grinding volume of the process unit SuperFlow® 4 is 0.275 litres.

Dependent on the process unit, either a vertical or horizontal operating position is selected. The SuperFlow® 4 process unit is operating generally in a vertical position. A service position allows the cleaning and maintenance of the process unit as well as filling of grinding beads. This ensures easy handling and reduces set-up times. An optional stainless steel machine frame is available for high-tech applications in the clean room. The R&D mill is offered with PLC control and graphic display touch-screen or basic execution with relay control.

The SuperFlow® 4 is perfectly suited for fundamental trials with minimised test material requirement. The large-scale production of the achieved qualities can be transferred safely to all SuperFlow® sizes while the defined limit temperature is kept.

Fig. 11.3: SuperFlow® 4
in recirculation operation

GD 52029 de 0209 1000 DF

Bühler AG
CH-9240 Uzwil, Switzerland
T +41 71 955 11 11
F +41 71 955 31 49
grinding.dispersion@buhlergroup.com
www.buhlergroup.com