HKP in the Simoloyer®

Media Reload Processing (MRP) for SMART PM2020

DispersoidChargingUnit (DCU)

High Kinetic Processing (HKP) in the Simoloyer® represents the most advanced technique for Mechanical Alloying (MA), High Energy (HEM) and Reactive Milling (RM) for making Nanostructures. General processing modes are the common batch-process (01), auto-batch (02) with automatic loading and unloading as well as the semi-continuous processing route (03) for insitu separation/classification by the adapted carrier-gas/multiphase flow circuit.

Media Reload Processing (MRP)

On route to automatic processing at industrial importance at best economic condition, Media Reload Processing (MRP) was developed in 2023 as a variant to batch- and/or auto-batch mode.
MPR allows entirely discharging of processed material (PM) including grinding media (GM) utilizing MediaProductSeparator (MPS) for PM/GM-separation outside Simoloyer® under continued atmosphere control. Different RotaryVaneFeeder (RVF) allow reloading GM (RVF ZS-GM) and charging starting powder material (RVF ZS-ZP).
MPR can substantially improve cooling efficiency (heat-storage GM), significantly reduce total processing time (discharging time towards zero) and by the latter may improve product quality due to constant PM/GM wt-ratio at all time. The former process-bottleneck, namely the draingrating for discharging under controlled atmosphere at the absence of dead-zones as well as discharging itself under severe alteration of PM/GM wt-ratio, can be eliminated [1].

Simoloyer® automatic loading/charging

At auto-batch and so at MRP, Simoloyer® is automatically loaded from one or more ChargingContainer CFB. Portioning is provided by RVF ZS-ZP at appropriate precision over its rotation number. To some extent, portioning precision can be increased by decreasing mass-transportation per rotation at the rotary vane feeder.

SMART material for NuclearFusionReactor 1st wall

SMART describes a safety-issue material W-Cr-Yttrium for the 1st wall plasma facing side at the Fusion Power Plant. In NuclearFusion (NF) operation, SMART behaves like Tungsten. In case of severe accident e.g. at a loss of coolant at first wall temperatures >1000°C, SMART forms a self-propagating protective surface layer [2]. In early stage, utilizing Simoloyer® CM20, processing times were reduced from 60h (lab, g-scale) to 20h (kg-scale). The composition at present is W-11.4Cr-0.6Y (wt%), once commercialized, SMART shall become PM2020 [3].

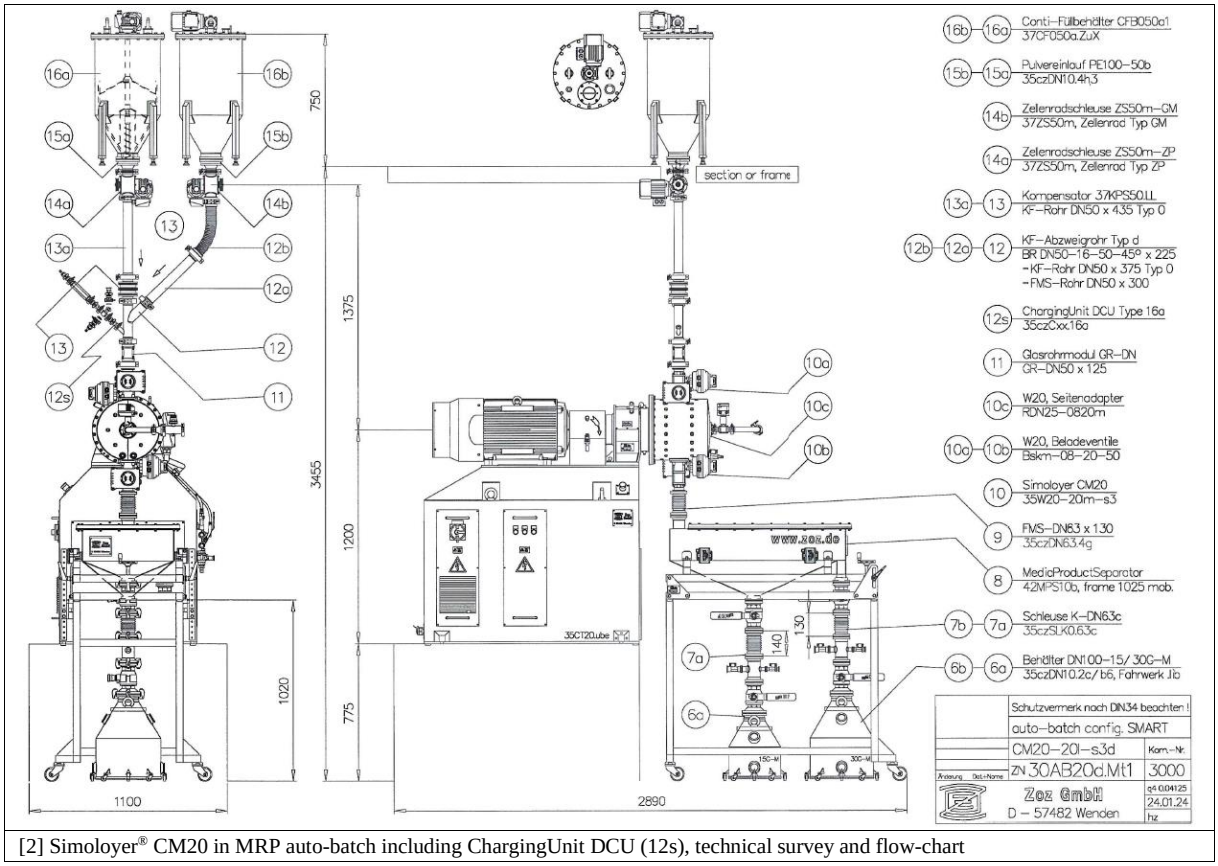
Charging small component fraction, insitu portioning

Due to its small dispersoid-fraction (Yttrium), SMART describes another challenge towards HKP at industrial manufacturing. Precise portioning/vessel-loading now becomes a strict requirement that in auto-batch processing could not have been provided under the technical state of the art. In NF, ODS/NFA structural materials for the plasma face-away side at 1st wall, undergo identical relevance.
In batch processing, any component fraction by weight can be loaded one by one using given airlocks, if necessary then premixed and then processed. To achieve a precise composition in auto-batch, pre-mixing of final composite is not acceptable due to the potential of subsequent de-mixing in the ChargingContainer CFB and/or piping and interconnections enroute to the processing chamber.

DispersoidChargingUnit (DCU)

A new device shall allow charging small but precise amounts of powder material into the processing vessel. General requirements are low cost and maintenance, no moving parts and no wear. Charging port shall be located utmost close to processing chamber, given support such as gravity shall be utilized.

The DispersoidChargingUnit (12s) is adapted at CalmingPipe (12) as a part of the airlock for charging right at the vessel. DCU is assembled in 45° angel, thus gravity supports in transfer direction. Entry-port is right where starting powder and GM from ChargingContainer (16b) and (16a) res. come straight down inside (12). Uptake of small fraction by two large fractions is suggested.



[2] Simoloyer® CM20 in MRP auto-batch including ChargingUnit DCU (12s), technical survey and flow-chart

DCU is equipped with its independent airlock (21) with vacuum- and inert-ports assembled under 70° thus here gravity supports solids-flow in desired direction hindering the opposite/exhaust. The Dispersoid (here Yttrium) comes as the precise portion in the sealed glass-tube (22) to be connected at airlock (21).

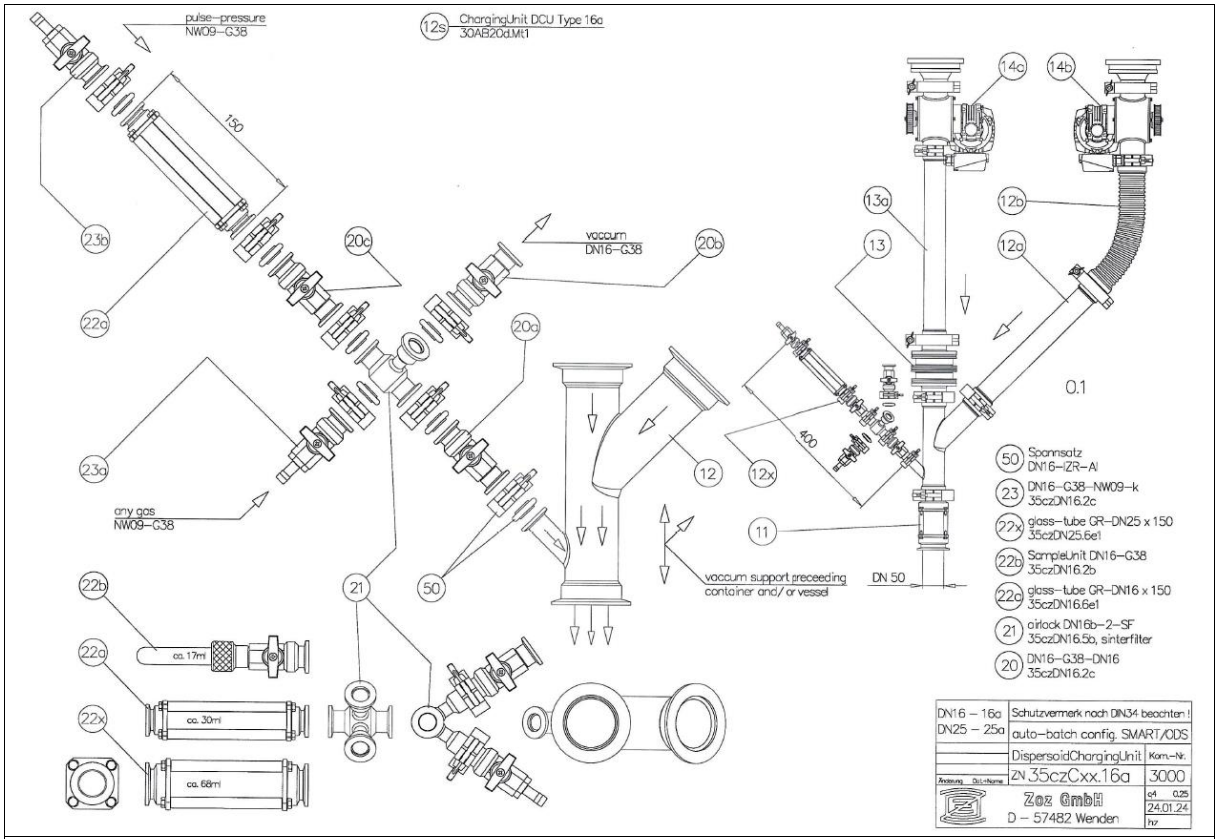
(a) after clearing atmosphere and opening transfer valves (20a+c), Dispersoid flows into the vessel supported by gravity;

(b) simultaneously to (a), GM and starting powder from ChargingContainer (16b+16a) may flow in supporting (a);

(c) optionally, vessel and pipe-system can be set under preceding vacuum, supporting Dispersoid-flow by depression mode. Evacuation may be pulled via CFB (16b+16a), side adapter (10c), MPR-unit (8) or via airlocks (7a+b) whatever evacuable volume is required for depression;

(d) once (a-c) would not provide appropriate result, which may be visually controlled at glass-tube (22a) and glass-tube module (11), ventilation valve (23a) may be connected to an inert gas source and subsequently opened for expansion and/or used for pulsed pressure into the comparably multiple times larger vessel/pipe-volume.

The Dispersoid, here Yttrium, is precisely loaded into the vessel after an estimated handling time below 3min at discontinuous operation during auto-batch processing.



[2] DCU ChargingUnit for SMART auto-batch configuration, technical survey and flow-chart

pos.	unit-definition	what for ?
12x	DispersoidChargingUnit	loading small fraction, e.g. dispersoid ODS/NFA/SMART
20a	KF-Adapter DN16-G38-DN16	airlock transfer-valve intra locking CalmingPipe (12)
20b	dito	airlock evacuation valve extra locking
20c	dito	closing (22a)
21	DN16a-2-SF airlock	transfer small fraction under controlled atmosphere
22a	Glass-tube GR-DN16 x 150, 30 ml approx.	carry precise small powder fraction
22b	DN16 SampleUnit, 17 ml approx.	alternative for smaller small fraction to be loaded
22x	Glass-tube GR-DN25 x 150, 68 ml approx.	alternative for larger small fraction to be loaded
23a	DN16-G38-NW09	airlock gas flow-in valve
23b	dito	closing (22a), depr. gas supply and/or pulse pressure valve
50	clamp set DN16-IZR-Al (ISO)	seals all components

[T1] DCU16a at Simoloyer® CM20 in MRP auto-batch, main component list

Glass-tubes (22a) or (22x) are utilized as Dispersoid charging container. During further realization, the closing valves 23b + 23c may be directly connected via inner-thread in order to saving 2x clamping (50) and total DCU-lengths at now 400mm.

Such connector design is realized at the SampleUnit (22b) for smaller Dispersoid volume up to 17ml. For larger volume up to 68 ml, DCU-scale can be altered from DN16 to DN20 (ISO). Optionally, Glass-tube (22a) can be extended in length from now 150mm up to 200mm resulting in about 40ml Dispersoid-capacity.

[1] HKP in the Simoloyer - Media Reload Processing (MRP) eds. 2023-08-31, www.zoz.de

[2] A. Litnovsky, J. Chen, M. Bram, J. Gonzalez, H. Zoz, H.U. Benz, J. Huber, G. Pintsuk, J.W. Coenen, C. Linsmeier, Forschungszentrum Jülich, RWTH Aachen University, Zoz Group, Dr. Fritsch GmbH, University of Wisconsin Madison, SMART materials for DEMO: towards industrial production, Oral P3C5@ISFNT15, International Symposium on Fusion Nuclear Technology, 12.09.2023, Las Palmas, Spain, , proceedings/book of abstracts

[3] H. Zoz etal, nanostructures beyond ODS/NFA + SMART, hydrogen solid state D/T traps and UHPC for nuclear shielding@ Institute of Plasma Physics, Hefei, China, 14.11.2023, www.zoz.de