HKP in the Simoloyer®

## Heating vs. Cooling at Scale-up, overcapacity

Simoloyer® is equipped with separated cooling/heating circuits in order to operate at elevated/deviated processing temperature while equipment-relevant units such as bearings, seals and pre-seals are kept under appropriate conditions. The processing temperature is effected by double-jacket cooling units following the chamber geometry and at larger units CM400 and CM900 optionally by an inner rotor-blades cooling circuit. For calculation, the "Heat-exchange-Surface" of the Chamber (HS_C) is simplified to full cylindrical shape, the rotor-blades are described by both shield-faces for the corresponding blade-number (HS_B).

Benz in 2003 set up the dependency of GM-surface vs. Chamber Heat-exchange-Surface media-cooling ratio coefficient, inner rotor-blades cooling circuit came later in 2022.

A_C effective cooling surface $A_C \approx A_M$ $r_s = A_K / A_M$ r_s **media-cooling ratio**	**I**nner **v**essel A_M I_v surface D_M I_v diameter L_M I_v length

$$r_s = \frac{A_K}{A_M} = \frac{n_K \pi D_K^2}{2\left(\dfrac{\pi}{4} D_M^2\right) + \pi D_M L_M} = \frac{n_K D_K^2}{\dfrac{1}{2} D_M^2 + D_M L_M} = \frac{n_K D_K^2}{\dfrac{D_M}{2}(D_M + L_M)}$$

[5] H. U. Benz, "Überlegungen zu Oberflächenverhältnissen verschiedener Simoloyer", internal report Zoz GmbH 13.11.2003, unpublished (2003)

[6] inner rotor-blades cooling circuit, single blade, Zoz GmbH (2022)

inner vessel surface, shield surface rotor blades, media-cooling ratio

Simoloyer®	CM01b		CM08a		CM20b		CM100b	CM400b	CM900
Mahleinheit [l]	01	02	05	08	10	20	100	400	900
WM-Innenfläche [m²]	**0.078**	**0.096**	**0.173**	**0.225**	**0.342**	**0.467**	**1.335**	**3.266**	**5.338**
Kühlfläche Rotor [m²]	--		--		--		-0.505-	1.262	1.927
Kühlfläche Rot. [%] v.(1)	--		--		--		-37.8-	38.6	36.1
Kühlung 2bar [l/min] max	5		15		30		50	75	100
Kugelkühlverhältnis r_s	**6.538**	**7.396**	**9.538**	**11.422**	**11.082**	**13.769**	**24.097**	**39.372**	**54.200**

Results of [5] are given right above at the line „Kugelkühlverhältnis". Interesting is the severe impact of the optional rotor-cooling at close to 40% (37.8/38.6/36.1%) of the simplified cooling-surface provided by 9 blades (CM100/400) and 11 blades (CM900) providing additional heat-exchange surface of approx. 0.5, 1.3 and 1.9m² respectively. When calculating, the efficiency for technical realization must be reduced to about 1/4, still the additional cooling effect is estimated at 10-20%. However, graph [7] suggests that for set common parameters, rotor-cooling is not required.

[7] heat exchange deviation and additional rotor-cooling
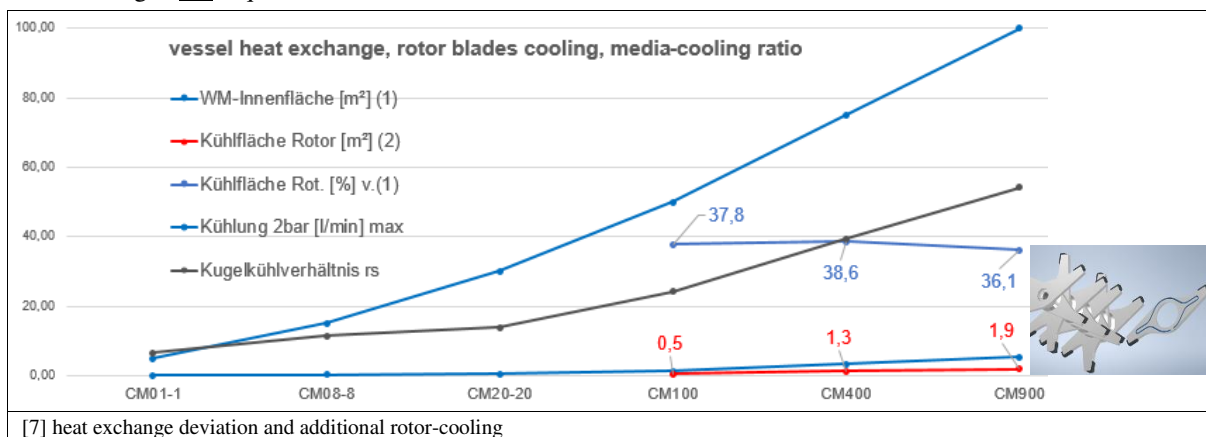
Most significant in graph [7] is the not-given change of slope as of CM20 through CM900 slightly overcompensated by the cooling-flow deviation at 2 bar. This suggests linear cooling impact at least.