How to start a scale up from lab to production batch size

Industry: All industries

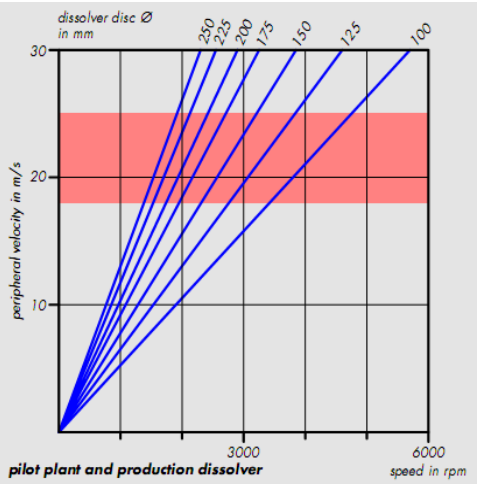
Product: Liquid and flowable products

Challenge: The challenge here was to scale up the results from lab to production size without allowing any variance. Furthermore an easy scale up was requested as well as one system for pre- and fine dispersion plus a flexibility in batch size.

Our Solution:

1. Dispersing at lab scale
2. Calculate scale up from lab to production
3. Dispersing at production scale

	Parameters in laboratory	**Calculation:**	**Parameters for production:**
Instrument	AE02 with a TORUSMILL TML1		TM 100
Container size	3 litres (140 mm inner dia)	Container size/millbase volume ⇒ 3 l / 1.5 l = 2 (scale-up factor) ⇒ 100 l / 2 =50 l	100 litres (490mm inner dia)
Millbase volume	1.5 litres		50 litres
Millbase viscosity	low	same formulation	low
Bead size & material	1.0 mm, ZrO2 , Yttrium-stabilized	constant	1.0 mm, ZrO2, Yttrium-stabilized
Filling ratio of beads	37.8 ml = 60.00%	constant	2.56 l = 60.00%
Dia of dissolver disc	40 mm heavy duty	In lab: Inside dia of container/dia of dissolver disc ⇒ 140 mm / 40mm = 3.5 ⇒ Scale up factor equals 3.5 ⇒ 490 mm / 3.5 = 140 mm	140 mm heavy duty
Shaft speed when predispersing	9000 rpm ⇒ 18.83 m/s (General speed range: 18-25 m/s)	v=π*D*n=(π*0.04 m*9000 rpm)/60 ⇒ v = 18.83 m/s n = v / (π*D)=[18.83 m/s / (π*0.14 m)]*60) ⇒ n = 2570 rpm	2570 rpm ⇒ 18.83 m/s (General speed range: 18-25 m/s)
Predispersion time	Generally 15-30min		Generally 15-30 min
Dia of milling impeller	54 mm		270 mm
Shaft speed when fine grinding	5000 rpm ⇒ 14.13 m/s (General speed range: 10-16 m/s)	v=π*D*n=(π*0.054 m*5000 rpm)/60 ⇒ v = 14.13 m/s n = v / (π*D)=[14.13m/s / (π*0.27m)]*60) ⇒ n = 1000rpm	1000 rpm ⇒ 14.13 m/s (General speed range: 10-16 m/s)
Volume-to-volume ratio	63 ml milling basket volume 1500 ml millbase volume	i = (63ml / 1500 ml) * 100 ⇒ i = 4.2 i = (4.27l / 50l) * 100 ⇒ i = 8.54 The proportion of the volume-to-volume ratio shows that in theory the dispersion of the production batch should take half the time of dispersing at lab scale.	4.27 l milling basket volume 50 l millbase volume



$v = \pi * d * n$

v = peripheral velocity (tip speed)
π = 3.141……
d = dissolver disc diameter
n = revolutions of shaft

This method of scaling up can only be applied if the same type of dispersing system is used in lab as well as in production. The respective parameters indicate a first approach of how to start scaling up to production batch size. Yet in practice to get best possible results varying parameters may be necessary. A scale up from lab to production is nearly one-on-one possible.