

IMPACT OF CHOPPER SPEED ON PARTICLE SIZE AND SHAPE FOR LABORATORY HIGH-SHEAR GRANULATION PROCESSES

TIMOTHY J. SMITH¹, BRIAN JENSEN¹
¹FREUND-VECTOR CORPORATION: MARION, IA UNITED STATES

PURPOSE

To study the effects on particle size and shape for high-shear granulations using different chopper speeds in laboratory size mixers.

METHODS

Immediate release (IR) formulations were granulated in a 25 liter high-shear bottom drive mixer (GMXB-Pilot, Freund-Vector Corporation). Formulation batch size was 6.25 Kg and consisted of 55% lactose (312, Foremost); 30% microcrystalline cellulose (EMCOCEL® 50M, JRS Pharma); and 15% pre-gelatinized starch (Spres® B820, GPC) for a dry binder. Activation of the binder was initiated by applying atomized water (22% by weight). Processing parameters are shown in Table 1. Impeller speeds used were default manufacturer settings. Chopper was operated at low speed during infusion and high speed during wet mass. A comparison of chopper speeds was conducted by utilizing the typical low (1500 rpm) and high (3000 rpm) speeds supplied by the equipment manufacturer and a reduced set of speeds (low = 535 rpm; high = 1070 rpm) that would turn the chopper at approximately the same linear velocity as the impeller at the tips of the chopper blade. Description of how the velocities were determined is given in Figure 1. Granulations were split for further processing. One portion was wet-milled in a conical mill (COMIL U5, Quadro) at 900 rpm with square impeller and 0.5 inch square hole screen; and dried in a fluid bed (VFC-15M, Freund-Vector Corporation). The remaining portion was only fluid bed dried. Resulting granulations were analyzed via sieve analysis and particle size imaging (QICPIC, Sympatec).

Process Stage	Time (mins)	Impeller Speed RPM (MPS)	Factory Set Chopper Speed RPM (MPS)	Reduced Chopper Speed RPM (MPS)
Pre-Mix	2.5	180 (3.7)	Off	Off
Infusion				
Phase 1	3.0	180 (3.7)	Off	Off
Phase 2	4.5	180 (3.7)	1500 (7.0)	535 (2.5)
Wet Mass	1.2	360 (7.4)	3000 (14.0)	1070 (5.0)

Process Equipment



Figure 1 – Chopper Velocity/Speed Determination

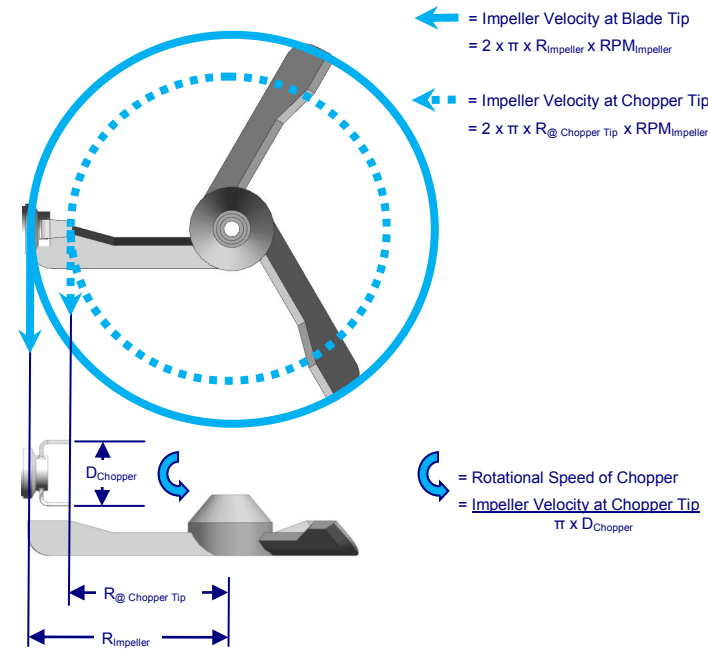


Figure 2 – Chopper/Mixer Working Volume Ratio

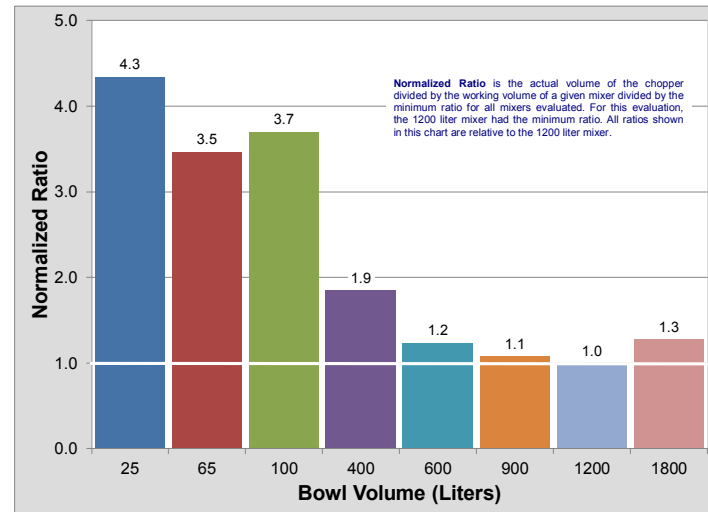
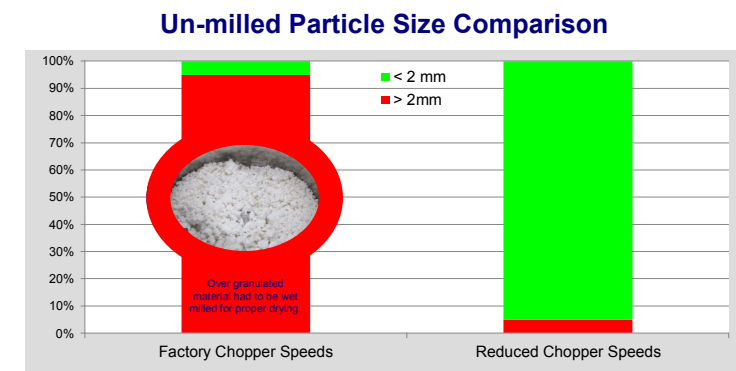


Image Processing

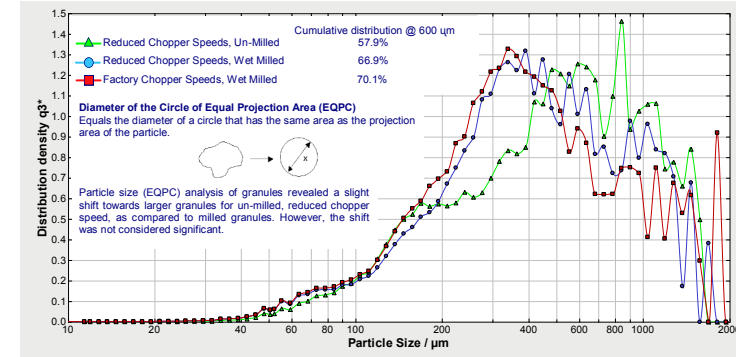


RESULTS

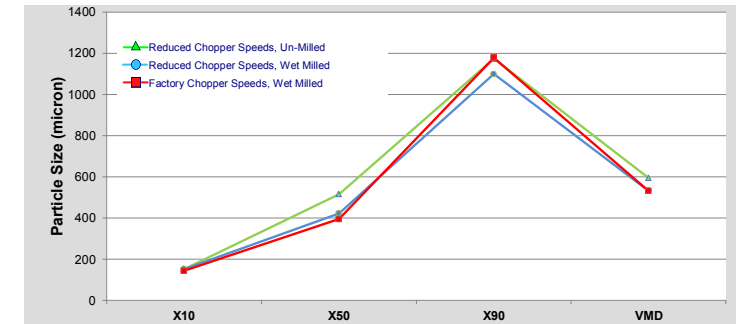
Particle Size Distribution



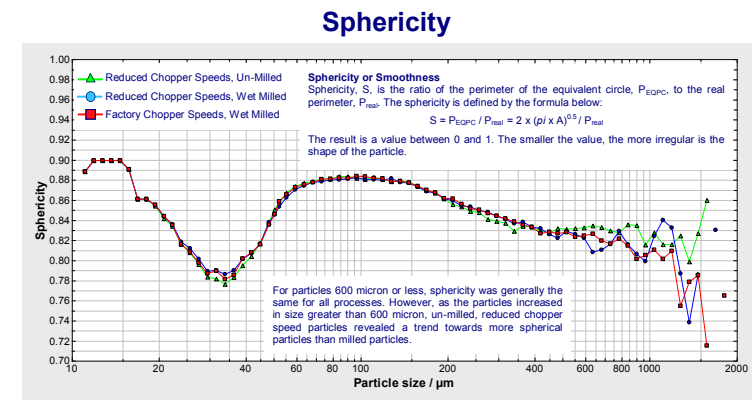
Particle Size Comparison ≤ 2 mm



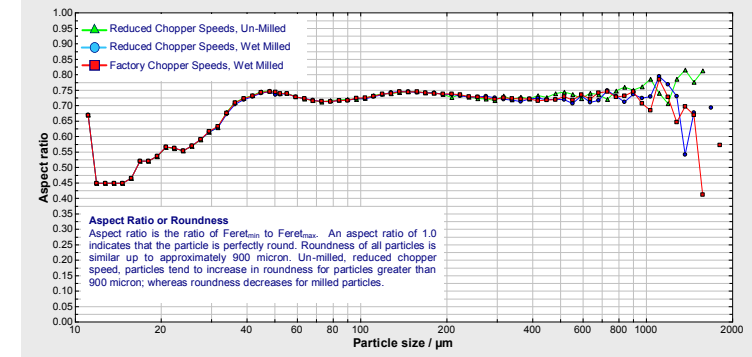
X10, X50, X90, and VMD Comparison ≤ 2 mm



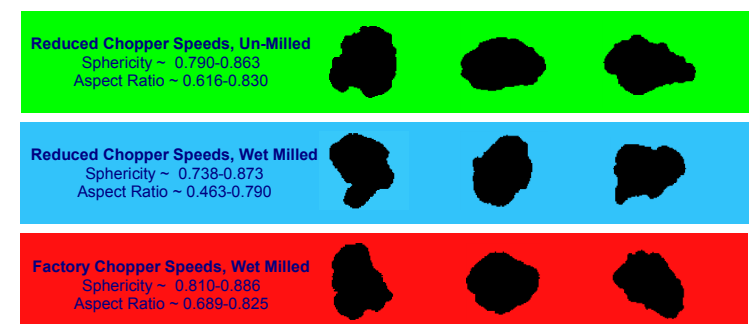
Particle Image Analysis



Aspect Ratio



Particle Images at VMD (Volumetric Mean Diameter)



CONCLUSIONS

Chopper speed was shown to have a significant impact on the particle size of the resulting granulation produced with a bottom drive laboratory sized mixer. The speed impact must be considered when scaling up or down in equipment sizes since the ratio of chopper work zone volume to product volume is significantly greater in laboratory sized equipment than in production models. Reducing chopper speeds to more closely match the impeller velocity will minimize the potential to over granulate a product and may eliminate the need for wet milling.

