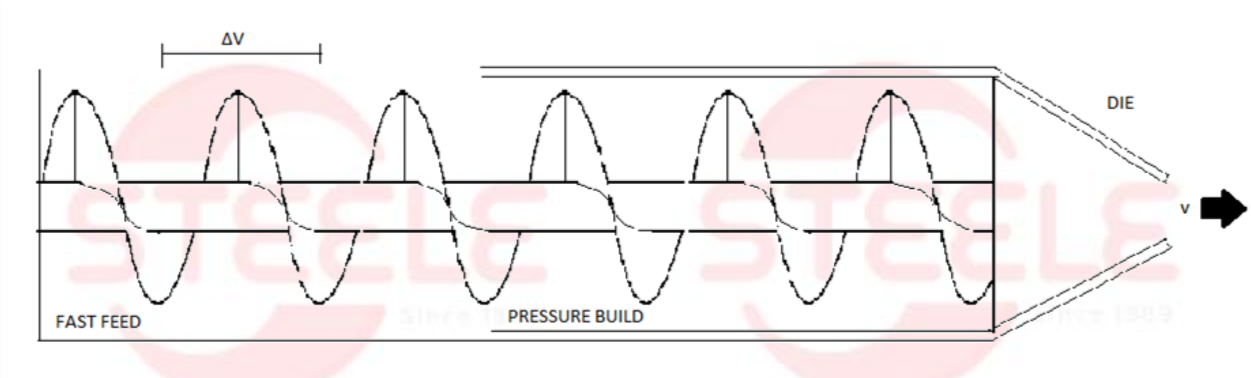
TSB GEN 0002

TECHNICAL SERVICE BULLETIN

EXTRUSION EFFICIENCY WITH NO SLUG CUTTER

THEORY

Extrusion efficiency, η_{eff}, is a ratio of the actual volume displaced by 1 auger revolution, ΔV_{actual}, to the theoretical volume displaced by one auger revolution, ΔV_{theo}. ΔV_{theo} represents a no-slip condition, where the distance a particle is displaced with 1 auger revolution is equal to the length of 1 auger. In reality, multiple types of slip can occur, causing the actual volume displaced to be less than the theoretical value. The theoretical volume can be calculated by multiplying the pitch by the cross-sectional area, then subtracting the area of the auger wings. The limitations of this measurement include that the model ignores power consumption and assumes a uniform drag coefficient. The standard practice is to define ΔV_{theo} at the entry into the point auger.



CALCULATION

The extrusion efficiency, η_{eff}, as mentioned previously, is the ratio of actual volume displaced to theoretical volume displaced: $\frac{\Delta V_{actual}}{\Delta V_{theo}}$. ΔV_{actual} is difficult to directly measure, but can be calculated using the mass rate measured by a belt scale, the density of the material, and the rotational speed of the augers.

The density of the material needs to be measured. One way this can be accomplished is by using a densitometer. Otherwise, the density can be found using the mass and the volume ($\rho = \frac{m}{V}$). The volume can be found using the water displacement method, and the mass with a simple scale.

Once the mass rate, density, and RPM are known, the following equation can be used to calculate ΔV_{actual}:

$$\Delta V_{actual} = \frac{\dot{m}}{\omega \cdot \rho}$$

where $\dot{m}$ is the mass rate and ω is is the RPM of the augers.

$\dot{m}$ is typically found using a weigh scale placed shortly after the exit of the pellets from the die. If the only weigh scale is prior to the pug sealer, the results won't be as accurate over a short time scale.

Now that both ΔV_{actual} and ΔV_{theo} are known, η_{eff} can be calculated using $\frac{\Delta V_{actual}}{\Delta V_{theo}}$.

Care should be taken in ensuring all units cancel each other in the final extrusion efficiency calculation.

MACHINE	**THEORETICAL VOLUME DISPLACEMENT (IN^3)**	**THEORETICAL VOLUME DISPLACEMENT (M^3)**
HD10 HCV	229	0.00375
HD10 HTR	229	0.00375
25BEX SCV	560	0.00918
25BEX CAR	560	0.00918
45ATX, "C" SET	1790	0.02933
45ATX, PR-16 SET	1050	0.01721
75ADEX CV	1622	0.02658

75ADEX BR-16	1390	0.02278
90ADEX, HCV	2060	0.03376
90ADEX, HTR	1750	0.02868
120ADEX HCV	2990	0.04900
120ADEX HTR	2990	0.04900

CONVERSIONS

STANDARD	METRIC
1 inch	2.54 cm
1 foot	30.48 cm
1 lb	0.4536 kg
1 in/min	0.000423 m/s
ρ_{H2O} = 62.43 lb/ft^3	ρ_{H2O} = 1000 kg/m^3

USE

The extrusion efficiency calculation was developed as a means to compare machines against each other. It can also be used to compare the efficiency of different processes using the same machine (i.e. different materials) or compare machines of different sizes. Comparing measured efficiency to an expected value can help determine when wear parts need to be replaced.

FACTORS

Here are some factors that may affect extrusion efficiency:

- Moisture content of material
- Backflow due to gap between augers and liner
- Slickness of augers
- The capacity at which the augers are run
- Wear state of the auger and liner (affecting distance between auger and liner)
- Material Characteristics (i.e. coefficient of friction, temperature, plasticity)