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Blown Film Calculations

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Agenda

Area of the die, bubble

Flow rate at die, frost line

Line speed, strain rate

Changing the strain rate

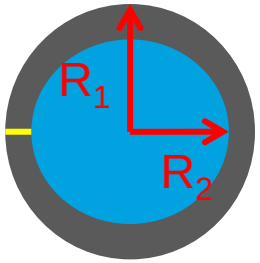
Draw down ratio

Questions?

Area of die, bubble

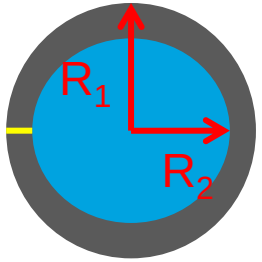
- Calculate the area of the die:
  - $A_d = \pi (R_1^2 - R_2^2) = \pi (R_1^2 - (R_1 - \text{Die Gap})^2) =$ **11.90 cm²**
  - Die Diameter = 250 mm = 25 cm
  - Die Gap = 60 mil = 0.152 cm

Die Gap



- Calculate the area of the bubble at the FLH:
  - $A_b = \pi (R_1^2 - R_2^2) = \pi (R_1^2 - (R_1 - \text{Film thickness})^2) =$ **0.79 cm²**
  - Film thickness = 40 microns = 0.004 cm
  - Blow-Up Ratio = $D_{bubble}/D_{die} = 2.5$
  - Bubble diameter = BUR * $D_{die} = 62.5$ cm
  - Bubble radius = 31.25 cm

t_{film}



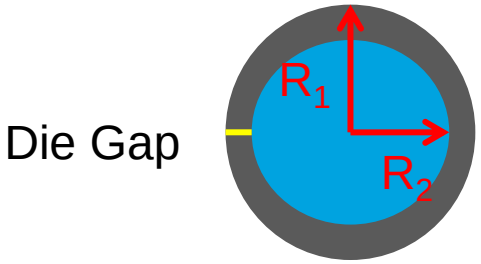
- **KEY: Keeping up with the units!**

Flow rate at die, frost line

- From your film formulation, determine the density of the film
  - Then estimate the density of the melt : $\rho_m \sim 0.8\ \rho_s$
  - For this example:
    - ρ_s = 0.919 g/mL
    - ρ_m = 0.740 g/mL
- We are starting at ~ 500 lbs/hr extruder rate
  - Output Flow = extruder rate / melt density = **85.7 mL/s**
  - FLH Flow = extruder rate / solid density = **68.6 mL/s**

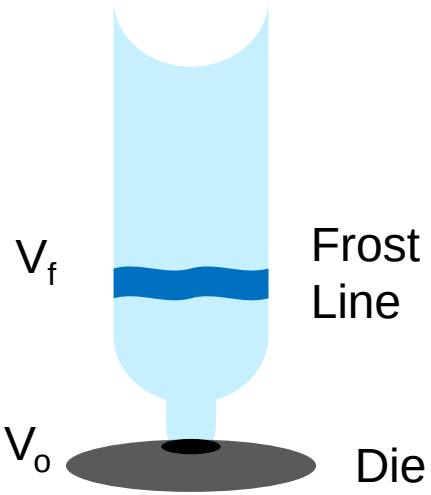
Line speed, strain rate

- From previous:
  - A_d = **11.90 cm²**
  - A_b = **0.79 cm²**
  - Output flow= **85.7 mL/s**
  - FLH Flow = **68.6 mL/s**



- Average Strain Rate = $(V_f - V_o) / FLH$

- Line speed at the die exit:
  - V_o = Output flow / Die area
  - V_o = **7.20 cm/s**
- Line speed at FLH:
  - V_f = FLH flow / Bubble Area
  - V_f = **87.3 cm/s**
- FLH = 36 in. = 91.4 cm
- **Average Strain Rate = 0.88 s^{-1}**



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Changing the average strain rate

- Changing one parameter at a time:
  - Die Diameter = 250 mm = 25 cm
  - Die Gap = 60 mil = 0.152 cm
  - Film thickness = 40 microns = 0.004 cm
  - BUR = 2.5

Film thickness (um)	Avg Strain Rate (s-1)
40	0.88
30	1.19
20	1.83

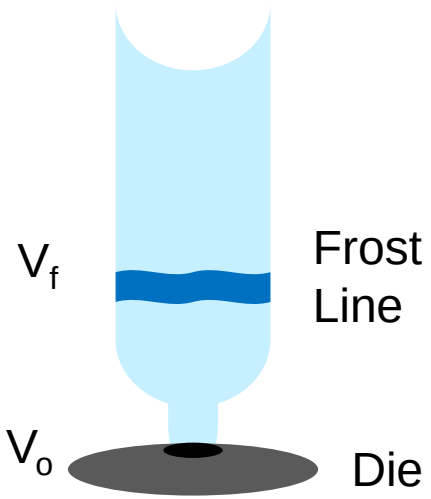
BUR	Avg Strain Rate (s-1)	Layflat (cm)
2.8	0.77	110.0
2.5	0.88	98.2
2.2	1.01	86.4

Calculate DDR

- Drawn Down Ratio – Two ways to calculate

- DDR = Vf / Vo
  - V_f = 80.5 cm/s
  - V_o = 6.64 cm/s
  - **DDR = 12.1 (European style)**

- DDR = die gap / (film thickness * BUR)
  - Die Diameter = 250 mm => 25 cm
  - Die Gap = 60 mil => 0.152 cm
  - BUR = 2.5
  - **DDR = 15.2 (NA style)**



Questions?