

#### **PU Chemical Foaming**

EMEA Alex Lu

# Moldex3D

MID Molding Innovation Day 2018, Italy 14 June, 2018 Hotel dei Parchi del Garda, Lazise, Italy . . . . . . . . .

#### **PU Foaming**



## **Challenges in the Foaming Process**

- Difficulty of processing control (control of state of thermodynamic instability)
- > Unknown status in a foaming process (temperature and pressure variation)
- > Part defects
  - Lack of material
  - Bubbles
  - Aspect defects
  - Dimensional defects
- > Development of reliable CAE technology



#### **Category of Polymeric Foams**



# What Moldex3D PU Chemical Foaming can Do

- > Support Polyurethane(PU) foaming process simulation
- > Assumptions
  - Curing Kinetics
  - Foaming Kinetics
- > Results
  - Curing conversion rate / Foaming conversion rate
  - Cell size / Cell Density (New in R16)
- > Special Process
  - Support oscillating rotation (New in R16)
- > Only support Solid mesh file

#### **Computation Parameters**

- > Calculate cell size and density
  - Build-in gas type

N2

- Others
  - Further information needed

Accuracy/Performance Vent	ing Foamir	ng Wall Slip BC
Calculate Cell Size and Ce	ll Density	
Gas type : C	02	•
Material Properties		
Gas solubility parameter :	1.15e-010	mol/(cm^3Pa)
Surface tension :	0.000123	N/cm
Nucleation Parameters		
Correction factor f0 :	3.5e-022	
Correction factor F :	0.0014085	
Threshold of bubble(Jt) :	1	1/cm^3s
		Default
		Donadit

#### **Process setting**

- > Rotating setting
  - Rotation origin and rotation axis
  - Angular speed profile

	Rotation origin   X: 0 cm Y: 0 cm Z: 0 cm	
A.	Rotation axis   X: 0 Y: 0 Z: 1	
	Rotational velocity Maximum angular speed : 10 rad/sec	
	Angular speed profile	



#### **PU Kinetics Measurements**

- > Records the parameters of the foam's creation process with use of proper measurement tools
  - Measurement of reaction temperature
  - Measurement of pressure
  - Measurement of profile of foam growth (foaming kinetics)
  - Determination of viscosity level (foaming viscosity)
  - Measurement of dielectric polarization (curing kinetics)



## Moldex3D Chemical Foaming Example: PU Foaming

#### 2 venting into overflow





analysis on the part, runner and overflow

Simulated flow

pattern matches

in performing a

weight reduction

reality, further used



#### **Analysis Output**

#### > Melt front time



#### **Analysis Output**

- > Conversion
  - Degree of curing/crosslinking
- > Foaming Conversion
  - Degree of foaming reaction
- > Density
  - Density distribution considering the foaming cells







## Analysis Output (New in R16)

- > Cell Size
  - Foaming cell size distribution
- > Cell Density
  - Foaming cell density distribution





12

Moldex3D

#### **Gravity Force Effect**

without gravity force

> Under the gravity force, low viscosity PU foam flows along the bottom of the cavity









#### **Rotating mold (New in R16)**

#### > Supporting rotating mold

• Available to simulate the polymer behavior in the rotating mold





Ran 14:10x10x10\_0dot25\_PIO.mtfe/PU\_PU-2\_A2-e12\_1.mtx/MoldRotation\_Gravity\_90.pro At 100% (0.493 sec) (Enhanced Solve),Ep=64.640 Epi=640 Ec=0 Err=0 <Hexa> Copy of Run 27 slow rotGrav in -thetaS4=1(Copy of Run 1)A=26-12 75sec(Copy of Run 9)(Copy of Run 10)

R16(160.0) 18:30:29-12-28-2017

#### Moldex3D

#### **Venting Gap Effect**

No vent gap region provides a high resistance force to compressed air





without venting effect



with venting effect





# Water (Blowing Agent) Concentration Effect

Filling - Gas Volume Fraction 62,60 Gas Volume Fraction = 62.5% Higher water concentration > 52.17 Gas Volume Fraction = 53.7% causes faster foaming, so 41.73 shorter filling time 31.30 20.87 10.43 Conc.(water) = 780 mol/m<sup>3</sup> Conc.(water) = 260 mol/m<sup>3</sup> 0.00 ..... 37.56 43.82 6 26 1252 18 78 25.04 31.30 50.08 56 34 polyol = 3045 mol/m\*3/socyanate = 4604 mol/m\*3water = 780 mol/m\*3 Conc.(water)= 260 mol/m<sup>3</sup> Conc.(water)= 780 mol/m<sup>3</sup> Filling\_Melt Front Time Mell Front at 27.658 sec Filling\_Melt Front Time Melt Front at 13.515 sec [sec] [sec] 27.658 13.515 25.815 12.614 23.971 11.713 22.127 10.812 20.283 9.911 18,439 9.010 16.595 8.109 14.751 7.208 12,907 6.307 11.063 5.406 9,219 4.505 7.376 3.604 5.532 2,703 3.688 1.802 1.844 0.901 0.000 0.000 Moldex 3D 55 0 45 1.60 K×× 55 copyright © 2016 Moldex3D. All right reserved. 1.0 50.0 mm

#### **Moldex3D PU Foaming**

> Filling Pattern with foaming behavior

> Foaming conversion rate and density of the part

> Gravity and venting effect

> Warpage prediction



#### **Thank You**

#### Moldex3D

www.moldex3d.com Copyright © 2018 Moldex3D. All rights reserved.