

AUTODESK MOLDFLOW 2016

What's new - Solver

이재훈 대리

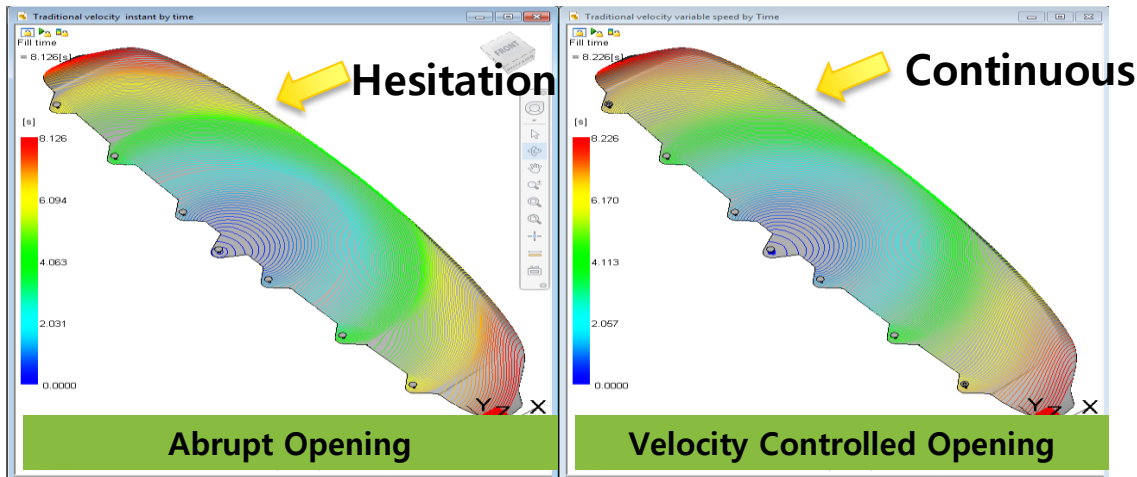
(주)이디앤씨 오토데스크 기술지원팀

The big improvements

New Slowly Opening Valve gate settings

- 점차적으로 Valve gate를 열수 있음
 - 낮은 hesitation (정체) 효과
 - 결함을 방지
 - Valve Gate open 시 속도를 설정할 수 있음

Synventive



Model courtesy of HRS – Inglass S.p.A

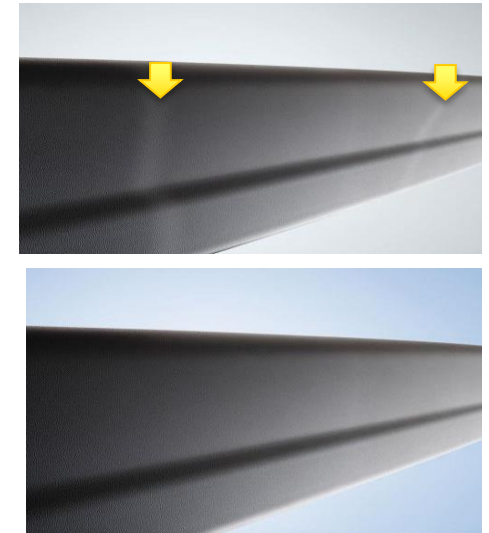
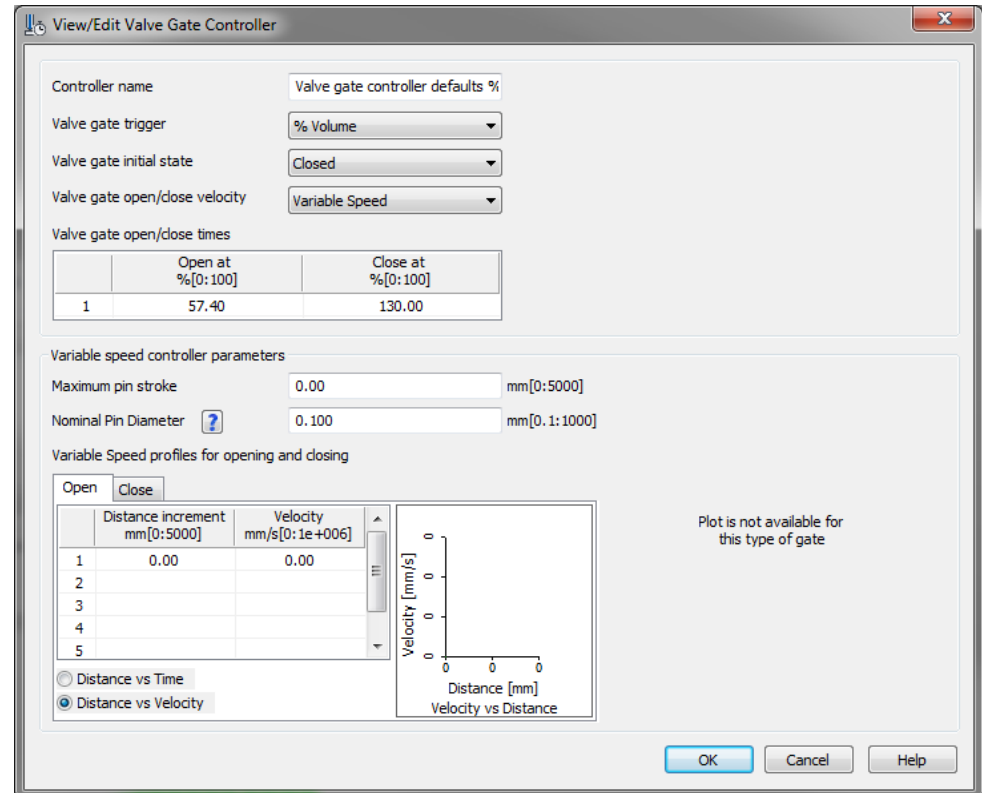


Image from Synventive Molding Systems

Controlled Opening and Closing of Valve Gates

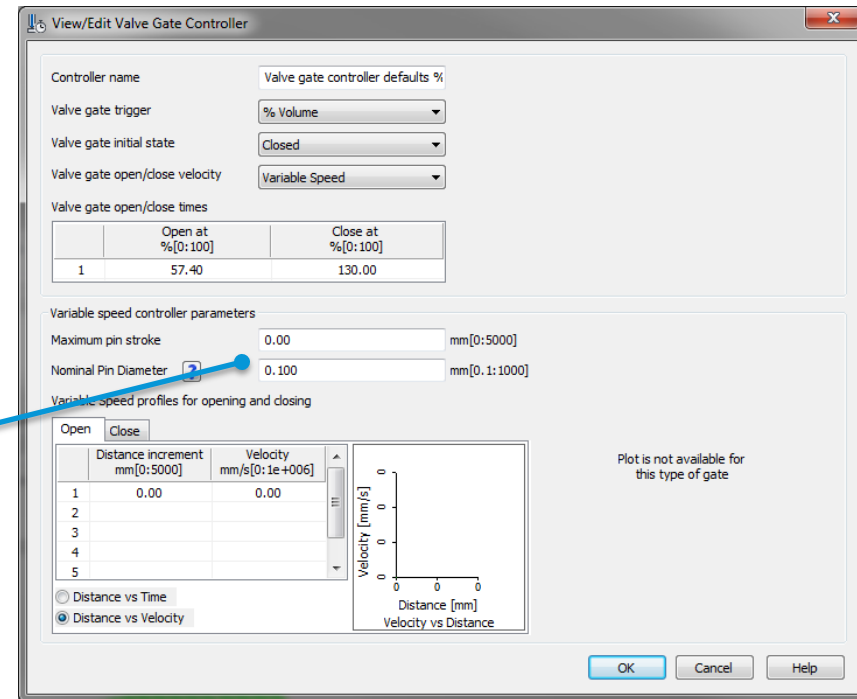
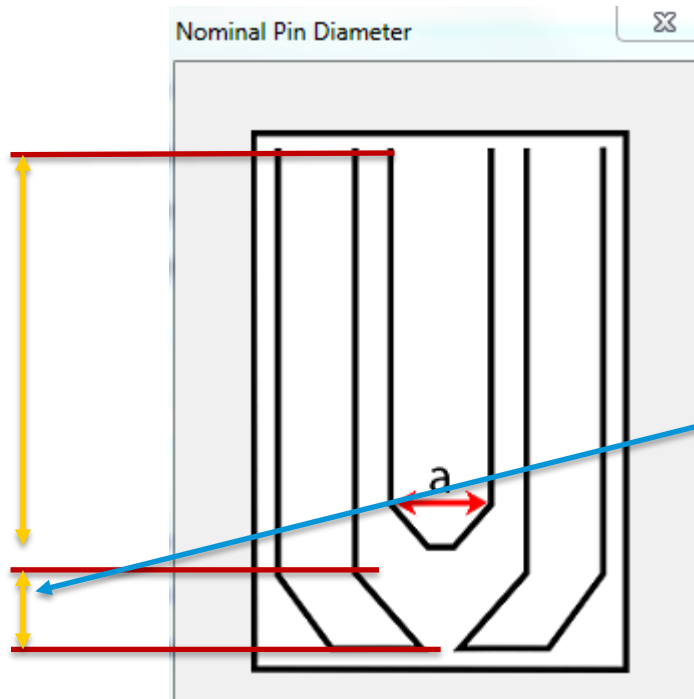
- 속도제어로 Midplane과 Daul-Domain type에서 Valve Gate를 열고 닫을 수 있음
- Valve Gate Initial State :
 - 즉시 개방 (legacy)
 - 속도 변경



Modeling valve gate

Annular
elements

Tapered
non annular



Valve gate setup

Valve gate open/close times

	Open at s[0:1200]	Close at s[0:1200]
1	0.00	2.00

Variable speed controller parameters

Maximum pin stroke mm[0:5000]

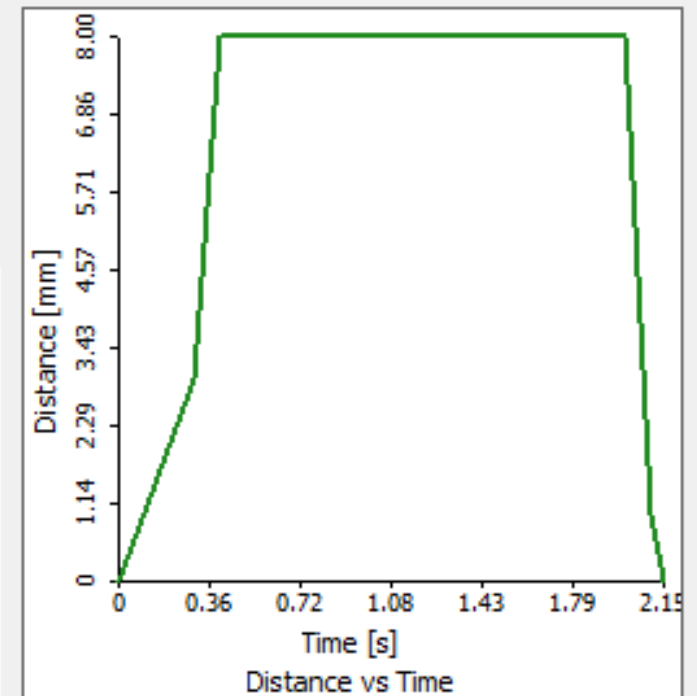
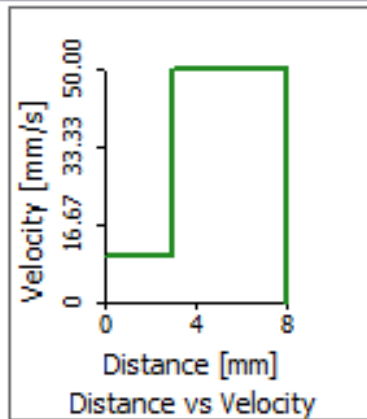
Nominal Pin Diameter mm[0.1:1000]

Variable Speed profiles for opening and closing

☒ Open

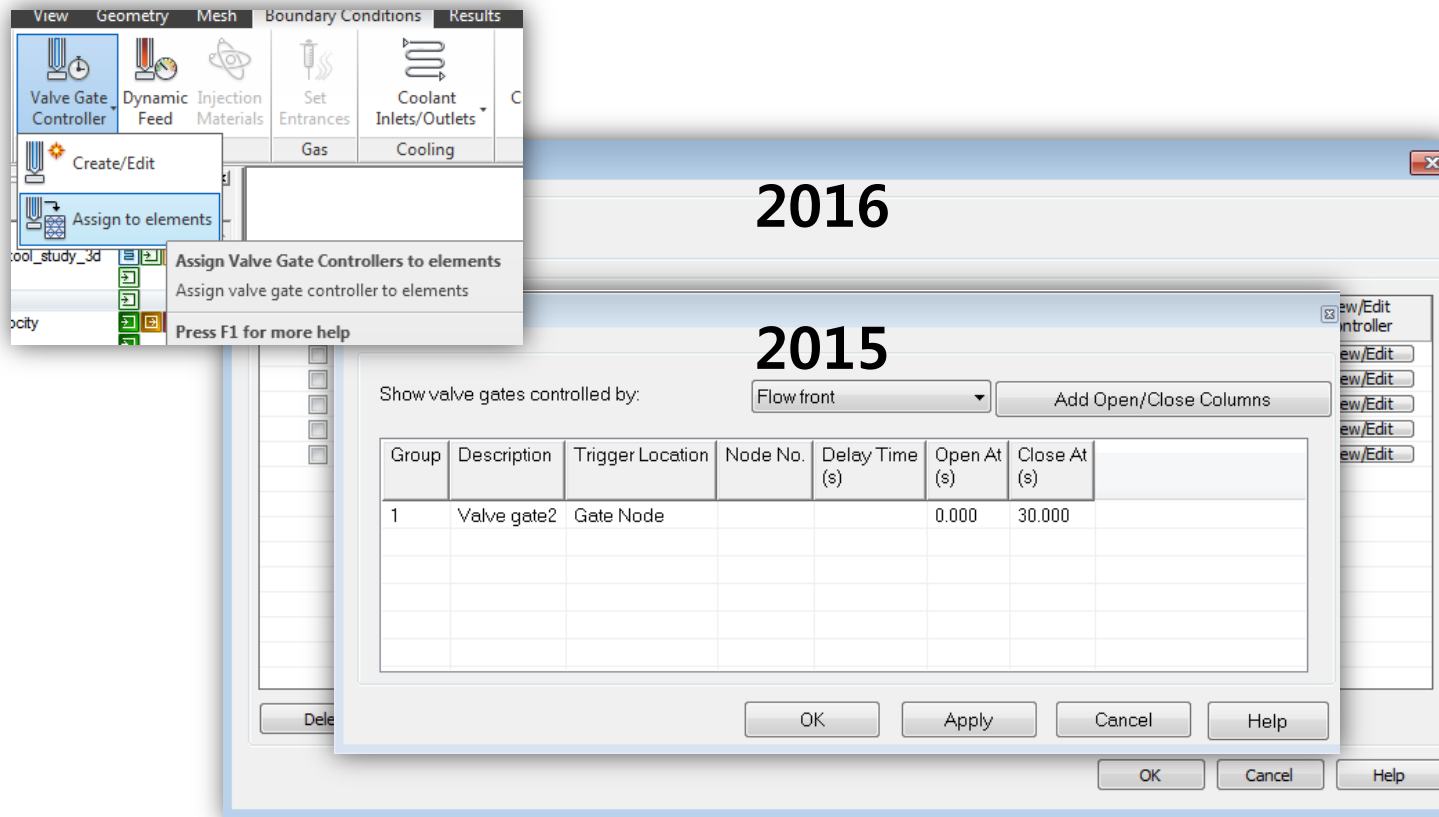
☐ Close

	Distance increment mm[0:5000]	Velocity mm/s[0:1e+006]
1	3.00	10.00
2	5.00	50.00
3		
4		
5		



New valve gate table

- 목록에서 Valve Gate를 할당
- 모든 Valve Gate를 나열, 표시 하고 편집 가능

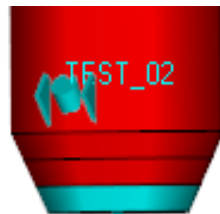


Extra enhancement

- Valve Gate 이름은 Log에 표시 됨

18.435	58.87	60.00	0.13	P	
18.685	58.90	60.00	0.13	P	
18.935	59.74	60.00	0.13	P	
19.185	60.55	"Valve gate by Flow Front #2" # 3 (Elem# 2549) started closing...			
19.185	60.55	"Valve gate by Flow Front #2" # 3 (Elem# 2549) has fully closed.			
19.185	60.57	60.00	0.12	P	
19.685	62.24	60.00	0.12	P	

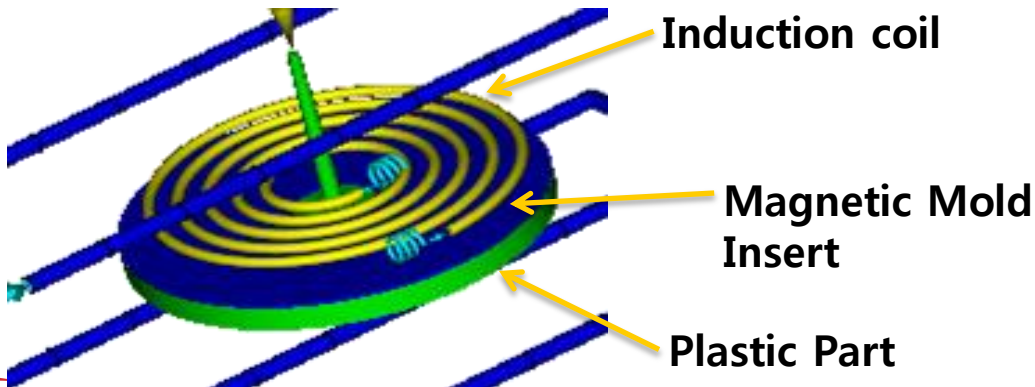
- Valve Gate ID가 화면에 표시 됨



- 새로운 결과가 추가 됨.(기본 아님)
 - Valve pin position vs. Time:XY Plot

Induction Heating for Cool FEM

- Induction Heating for RHCM (rapid heating and cooling)
 - 금형에서 Magnetic components를 가열하는 Electro-magnetic Induction을 사용
 - 고품질의 표면외관이 가능
 - 웰드라인을 해결 할 수 있음

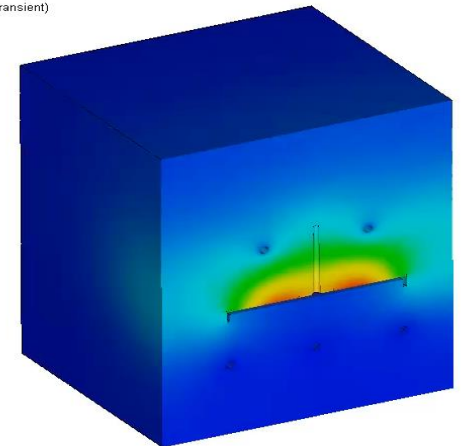
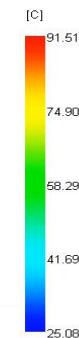


ROCTOOL

INNOVATIVE MOLDING TECHNOLOGIES



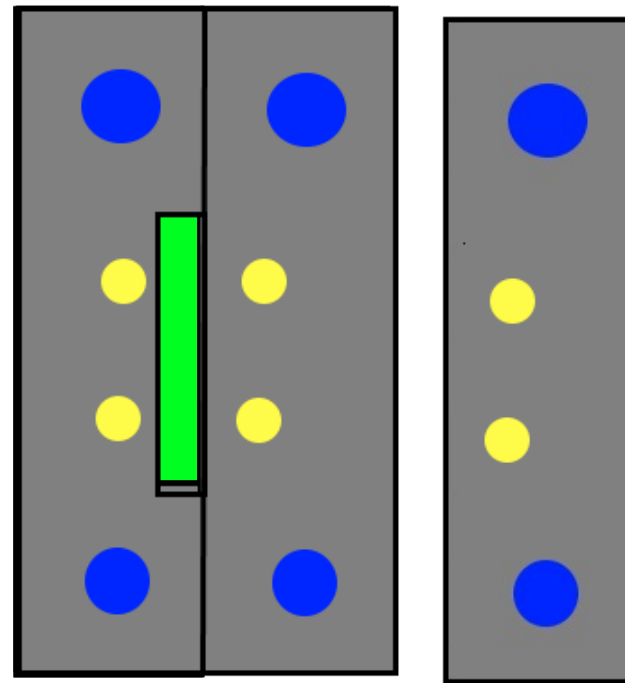
Temperature, mold (transient)
Time = 0.0000[s]



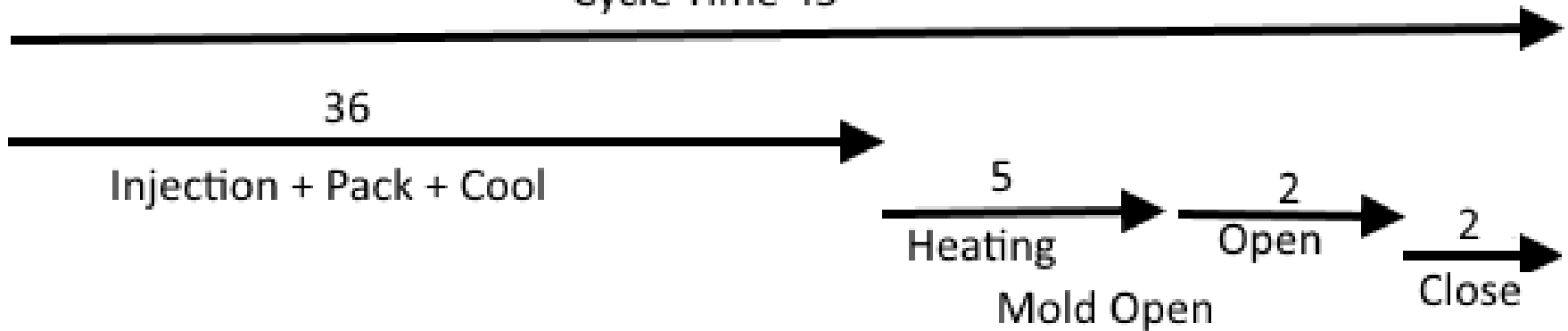
Induction heating for rapid heating and cooling analyses

- Dual Domain & 3D Mesh Type에서 가능
- 새로운 결과:
 - Joule heat
 - Magnetic vector potential
 - Induced current density
 - Source current density
 - Source electric potential
 - Magnetic flux density

Simulation technology-Process Settings

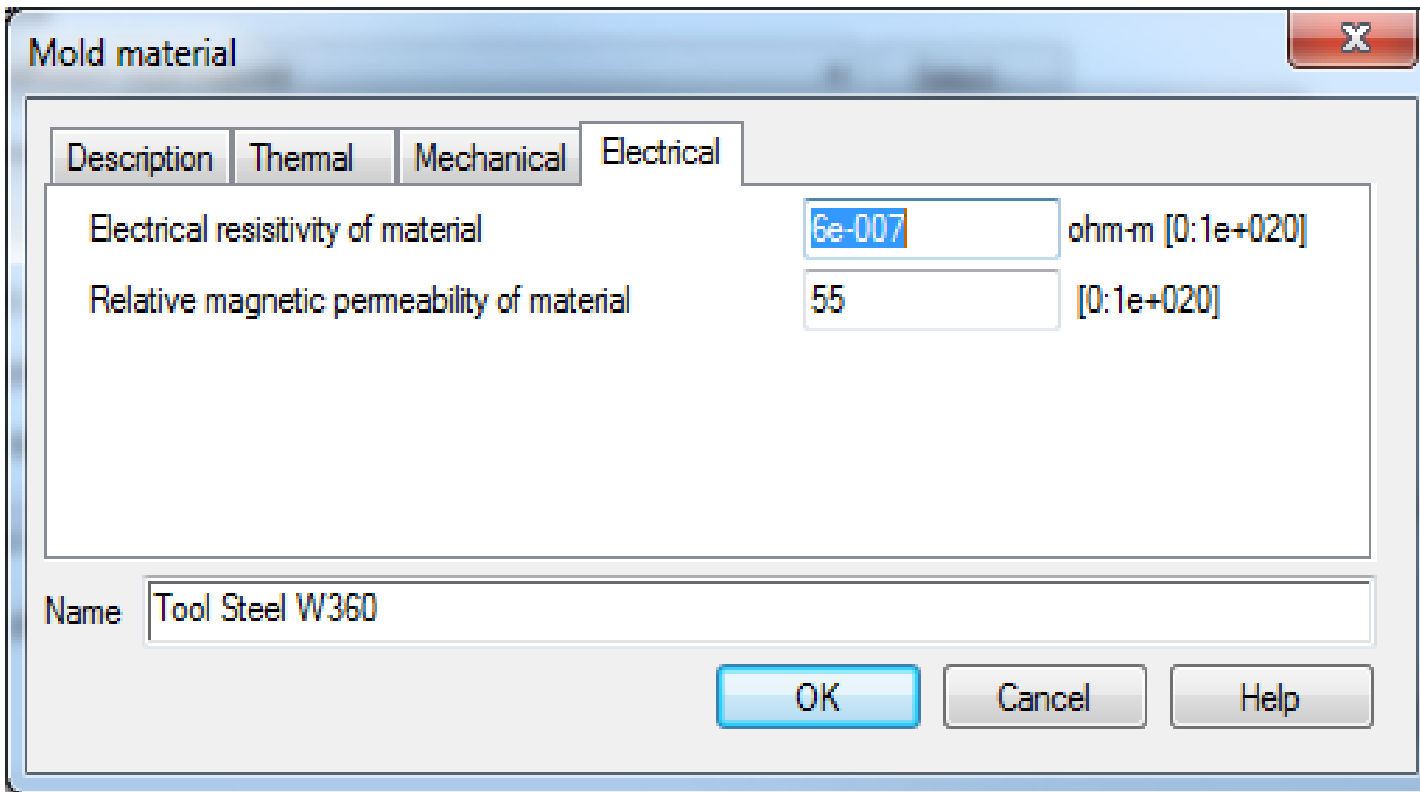


Cycle Time 45



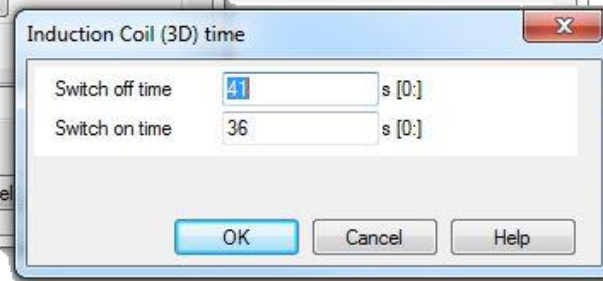
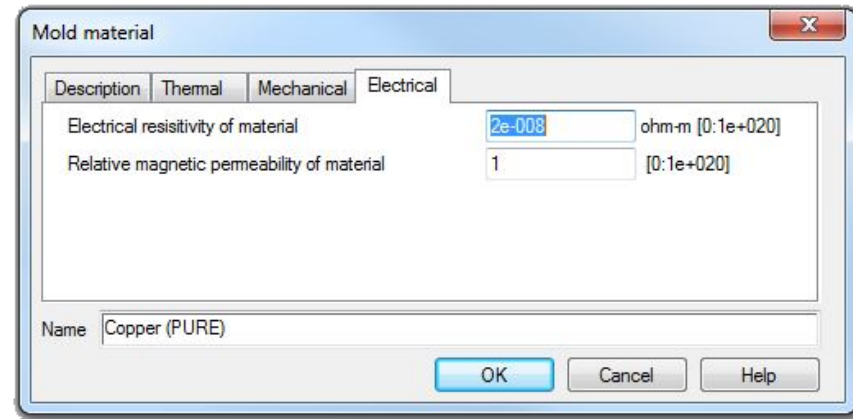
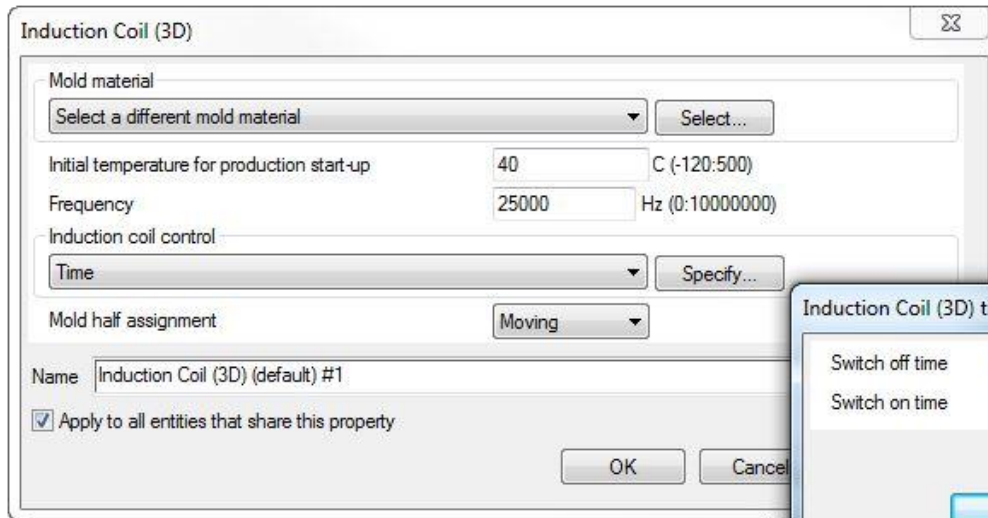
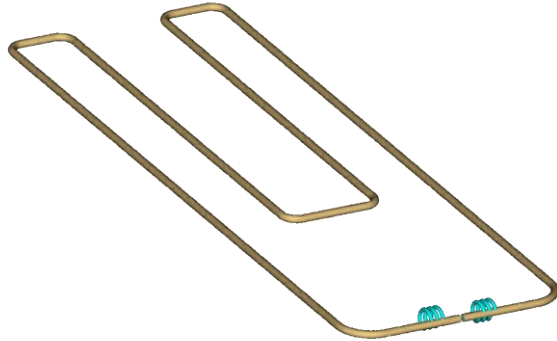
Simulation technology-Materials

- 금형과 금형 Insert에 모두 Electrical properties를 지정해야 함



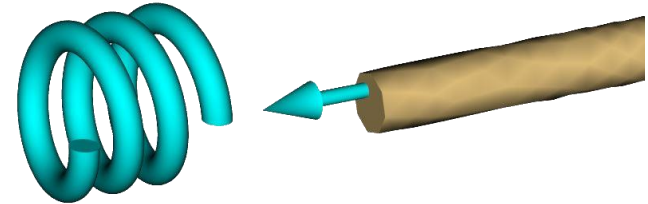
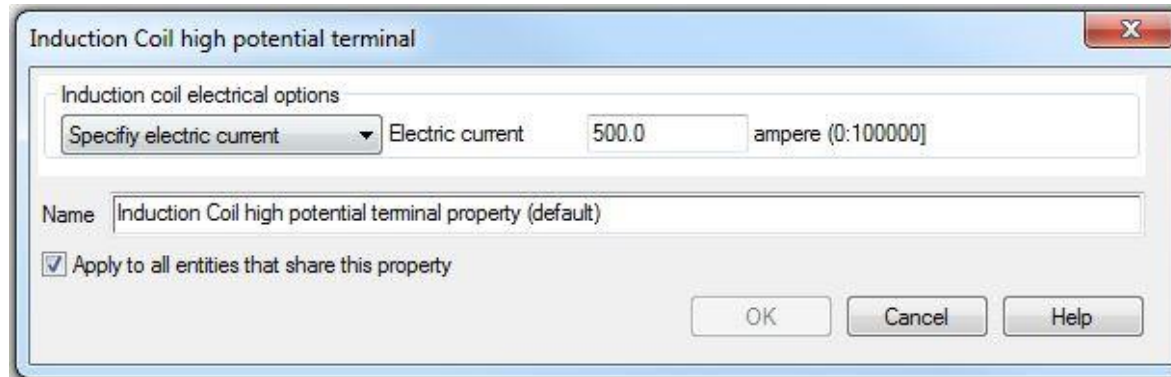
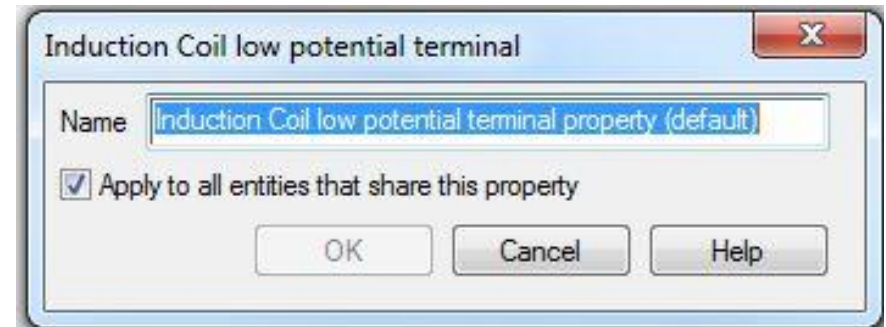
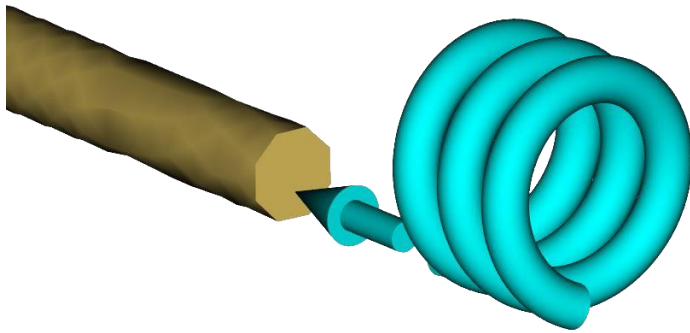
Simulation technology- Induction Heating

- Elemental properties는 Coil로 지정 해야 함



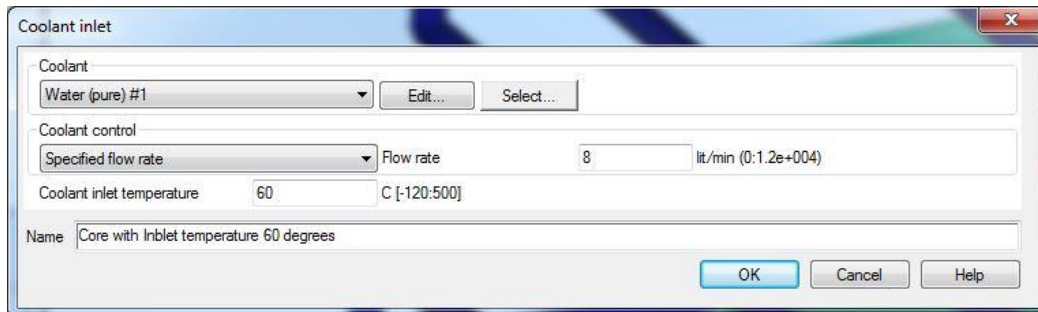
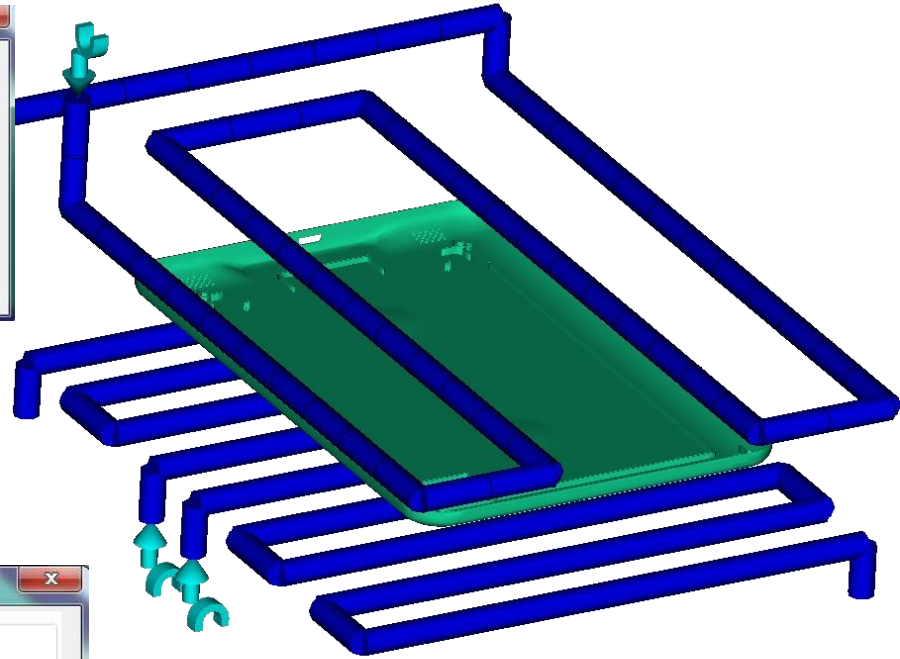
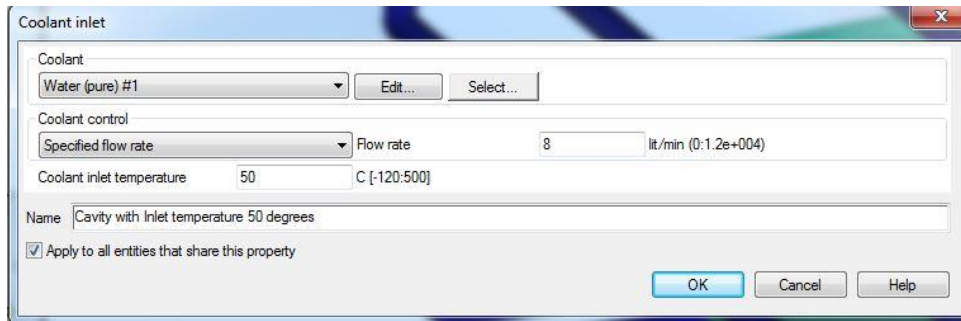
Simulation technology- Boundary conditions

- 전류의 높고 낮음의 전위를 지정하여야 함 (전류의 방향)



Simulation technology- Boundary conditions

- 냉각채널은 달라진 것이 없음



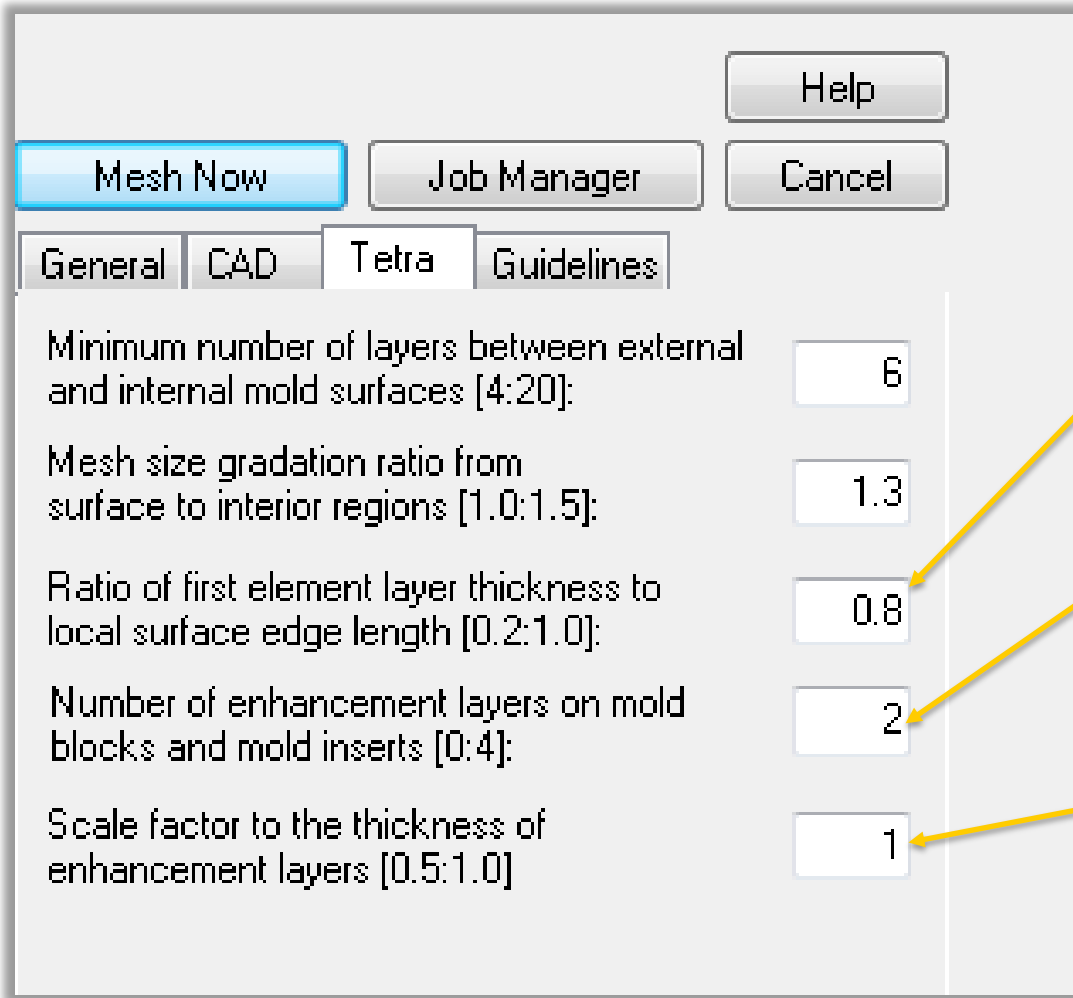
Mesh for induction heating

- 도움말 참고
 - « meshing guidelines for induction heating »
- Induction heating은 전류의 86%가 도체 표면 레이어에 집중되어 있음
- (스킨의 깊이) $\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}$ (스킨 두께 계산)
 - f : 주파수
 - μ : 재료의 자기 투자율
 - σ : 재료의 전류 전도율 (전기 투과율)

Induction - Meshing

- Skin thickness는 모든 Mold의 구성요소를 계산 함
 - (Mold, Insert)
- 중요한 부분은 Coil과 Part사이의 Mold Insert이지만 모든 금속요소는 Skin layer가 고려되어야 함
- Element의 edge length는 스킨 두께 공식을 사용하여 구하고 값을 0.8로 나누어 입력 $mesh\ size = \frac{\delta}{0.8}$
- tetrahedral mesh의 첫 Layer의 두께는 스킨 두께 공식으로 구해 진 δ (델타) 여야 함
- Enhancement layers는 이 Layer에 들어가야 함. (4 추천)

Induction - Meshing



The screenshot shows a 'Meshing' dialog box with the following components:

- Buttons at the top: 'Mesh Now' (highlighted in blue), 'Job Manager', 'Help', and 'Cancel'.
- Tabbed interface with 'General', 'CAD', 'Tetra' (selected), and 'Guidelines' tabs.
- Five input fields with corresponding labels and ranges:
 - 'Minimum number of layers between external and internal mold surfaces [4:20]': value 6
 - 'Mesh size gradation ratio from surface to interior regions [1.0:1.5]': value 1.3
 - 'Ratio of first element layer thickness to local surface edge length [0.2:1.0]': value 0.8
 - 'Number of enhancement layers on mold blocks and mold inserts [0:4]': value 2
 - 'Scale factor to the thickness of enhancement layers [0.5:1.0]': value 1

Yellow arrows point from Korean text annotations to the input fields for 0.8, 2, and 1.

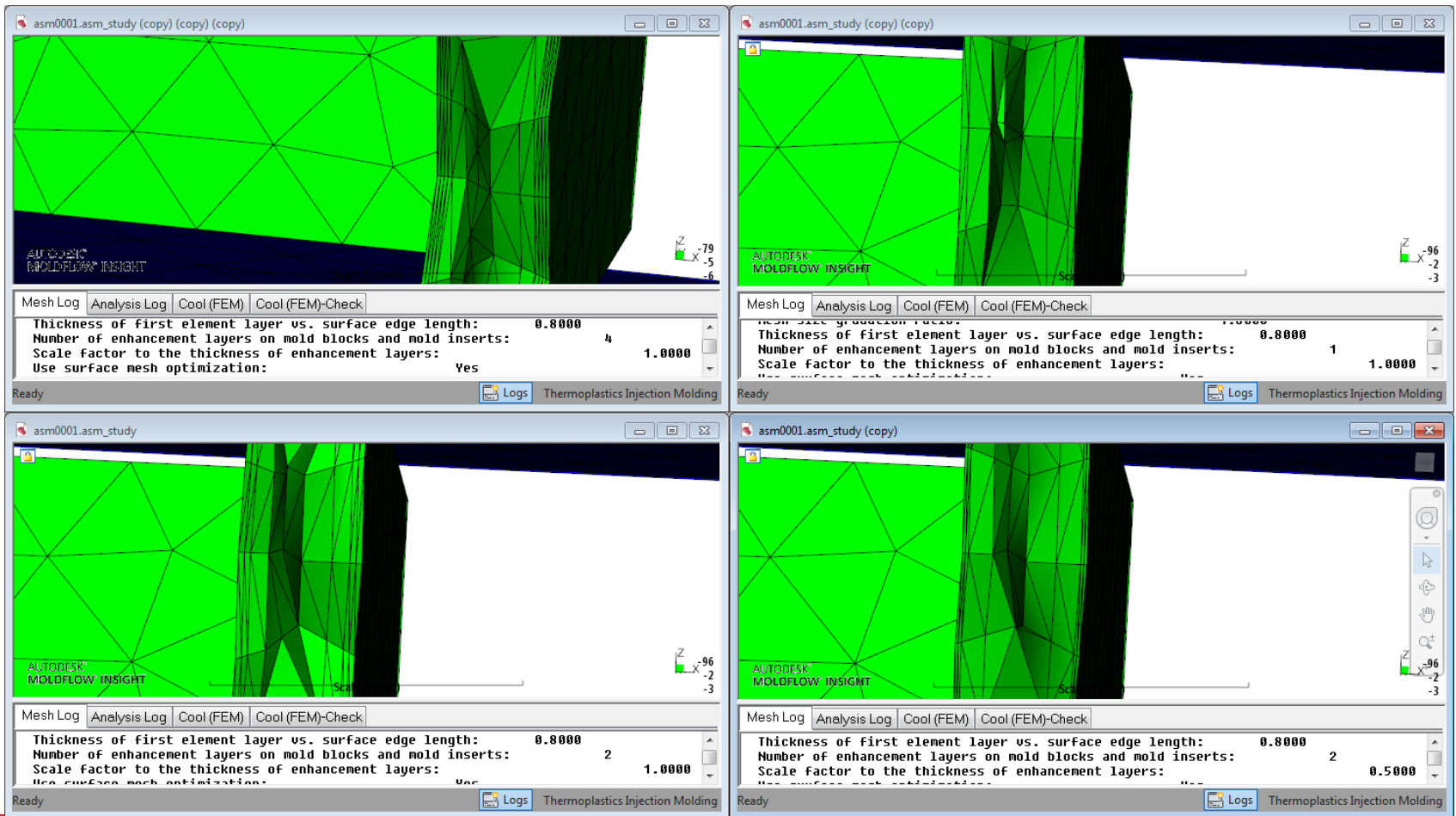
첫번째 Layer 두께 사이즈 결정

첫번째 Layer를 추가로 나누기

추가 Layer의 얇은 정도 설정

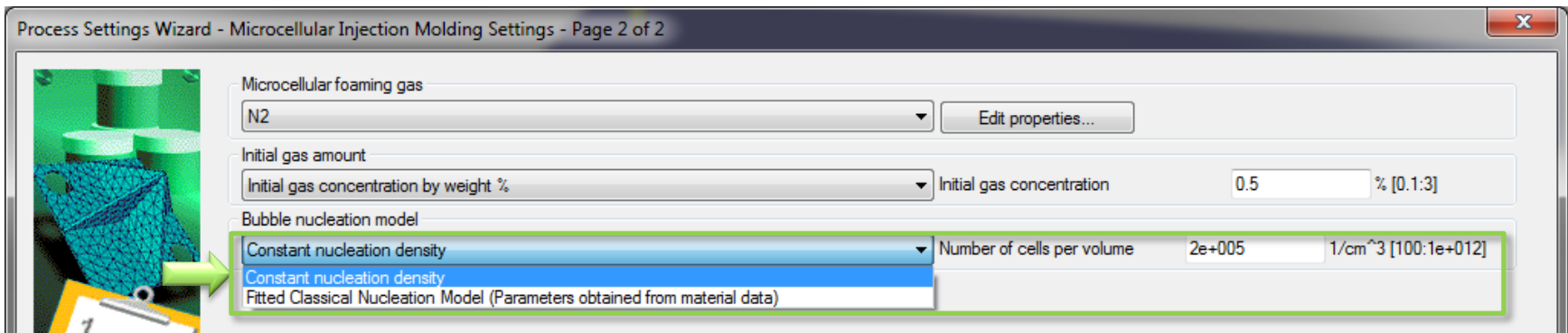
Induction - Meshing

- 목표 : Skin의 두께를 여러 Layer로 나누는 것



Microcellular injection molding

- Mucell이 (trexel technology의 상품명) Microcellular로 변경 됨
- 3D mesh도 가능
- mid/DD/3D에서 2종의 Bubble 결정핵 생성 모델이 가능
 - Constant nucleation density model
 - New Fitted Classical Nucleation model



Microcellular process settings

- Process settings 이 바뀜
 - 3D 와 DD이 동일해 짐
 - 불필요한 옵션 제거
 - ✓ 초기 Bubble의 반지름
 - ✓ 처음 채워진 부피
 - Packing profile에 기본값이 없어짐
 - ✓ Microcellular process에 맞춤

Microcellular Process Settings Page 2

Volume filled at start of foaming ✗	90	% [0:100]
Initial bubble radius ✗	0.001	mm [0:1]
Number of cells per volume	2e+005	1/cm ³ [0:1e+014]
Initial gas concentration	0.5	% [0:10]

2015

Slightly different!

2016

1

2

3

Initial gas amount

Initial gas concentration by weight % Initial gas concentration 0.5 % [0.1:3]

Bubble nucleation model

Constant nucleation density Number of cells per volume 2e+005 1/cm³ [100:1e+012]

Microcellular foaming gas

N2 Edit properties...

- 초기 가스의 량

1

Initial gas amount

Initial gas concentration by weight %

Initial gas concentration by weight %

Initial gas saturation pressure

NEW

- 기포의 결정핵 생성모델



NEW

(see next slide)

2

Bubble nucleation model

Constant nucleation density

Constant nucleation density

Fitted Classical Nucleation Model (Parameters obtained from material data)

- 발포 가스

3

Microcellular foaming gas

N2

N2

CO2

Custom

Edit properties

Surface tension (Guggenheim model) parameters (N2)

SIGM0 0.04716 N/m

1/TC 0.0010941 1/K

Viscosity coefficients for gas (N2)

v1 1

v2 -58.381

v3 3520

Solubility coefficients for gas (N2)

k1 1.45e-009 kg/(kg·Pa)

k2 0 K²

Diffusion coefficients for gas (N2)

d1 6e-009 m²/sec

d2 0 K

Fitted Classical Nucleation Model parameters (N2)

F1 1.75e-023

F2 0.0008

OK Hide

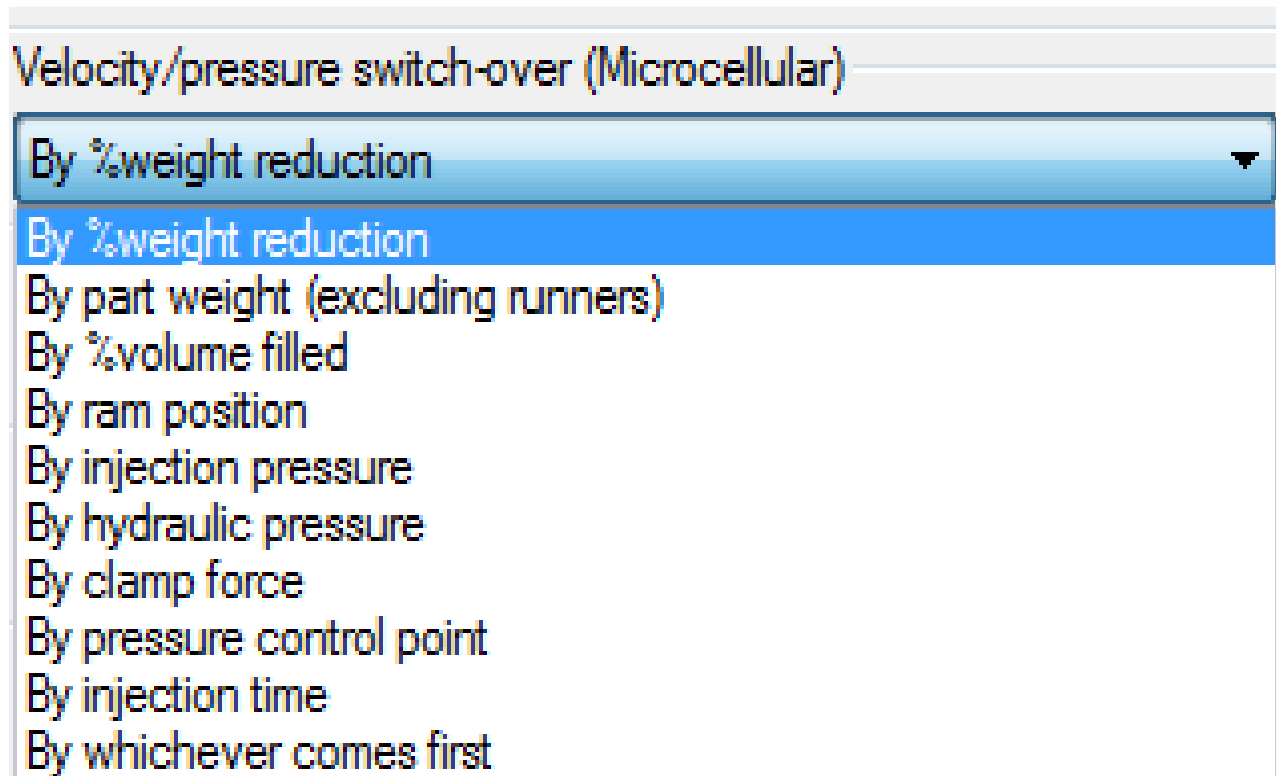
Properties needed

Microcellular Process Settings new options

- **중량감소 %에 따른 V/P전환**
 - 기존의 사출 성형 부품에 비해 Microcellular process 에 의해 제조된 부품의 무게가 감소 됨
 - 기존의 사출성형의 Part 무게는 Part의 부피와 Material data(PVT, transition temperature)에서 예상 되었음 → 일부 오류가 있을 수 있음
 - 새로 들어온 기본 V/P전환 옵션인 %무게감소. 이전의 Sdy는 모두 빈칸으로 바뀜
 - 그대로 해석을 시작하면 경고 30824가 나옴

Microcellular Process Settings new options

- V/P By part weight (Runner 제외)
 - 속도제어에서 압력제어로 전환하기 전에 사출 할 수지의 무게를 입력



Microcellular Process Settings

■ Bubble number density

Bubble nucleation model

Constant nucleation density Number of cells per volume 2e+005 1/cm³ [100:1e+012]

- Default option
- 제품에 일정한 핵 밀도를 가정
- 부피당 핵의 수를 입력
- 기본값은 Polystyrene으로 플라크 모델로 테스트 됨

Bubble nucleation model

Fitted Classical Nucleation Model (Parameters obtained from material data)

- 기포의 수를 예측 함
- 기포수의 밀도가 계산됨
- 이 계산에 사용된 값은 Microcellular material data로 부터 얻어짐
- 이 단계에서는 재료의 데이터를 얻기 힘들

Microcellular Process Settings

■ Bubble number density

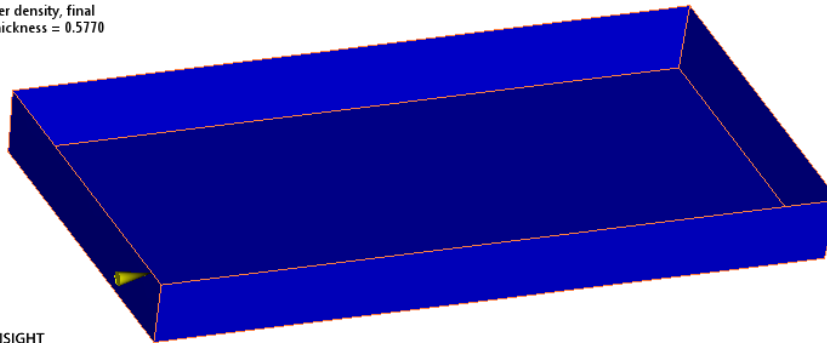
Bubble nucleation model

Constant nucleation density ▼ Number of cells per volume 1/cm³ [100:1e+012]

Bubble number density, final
Normalized thickness = 0.5770

[1/cm³]
2.000E+05
2.000E+05
2.000E+05
2.000E+05
2.000E+05

AUTODESK
MOLDFLOW INSIGHT



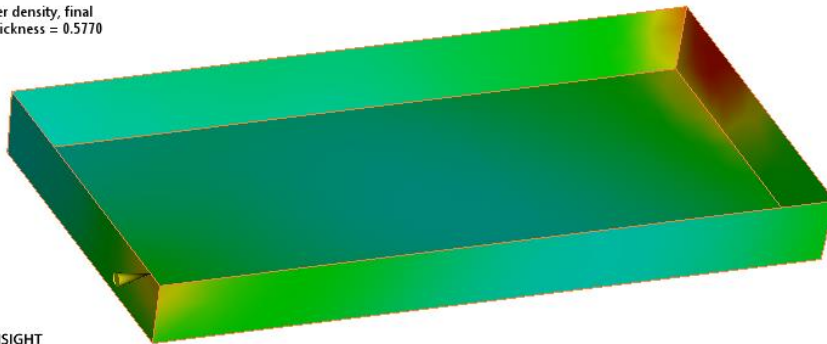
Bubble nucleation model

Fitted Classical Nucleation Model (Parameters obtained from material data) ▼

Bubble number density, final
Normalized thickness = 0.5770

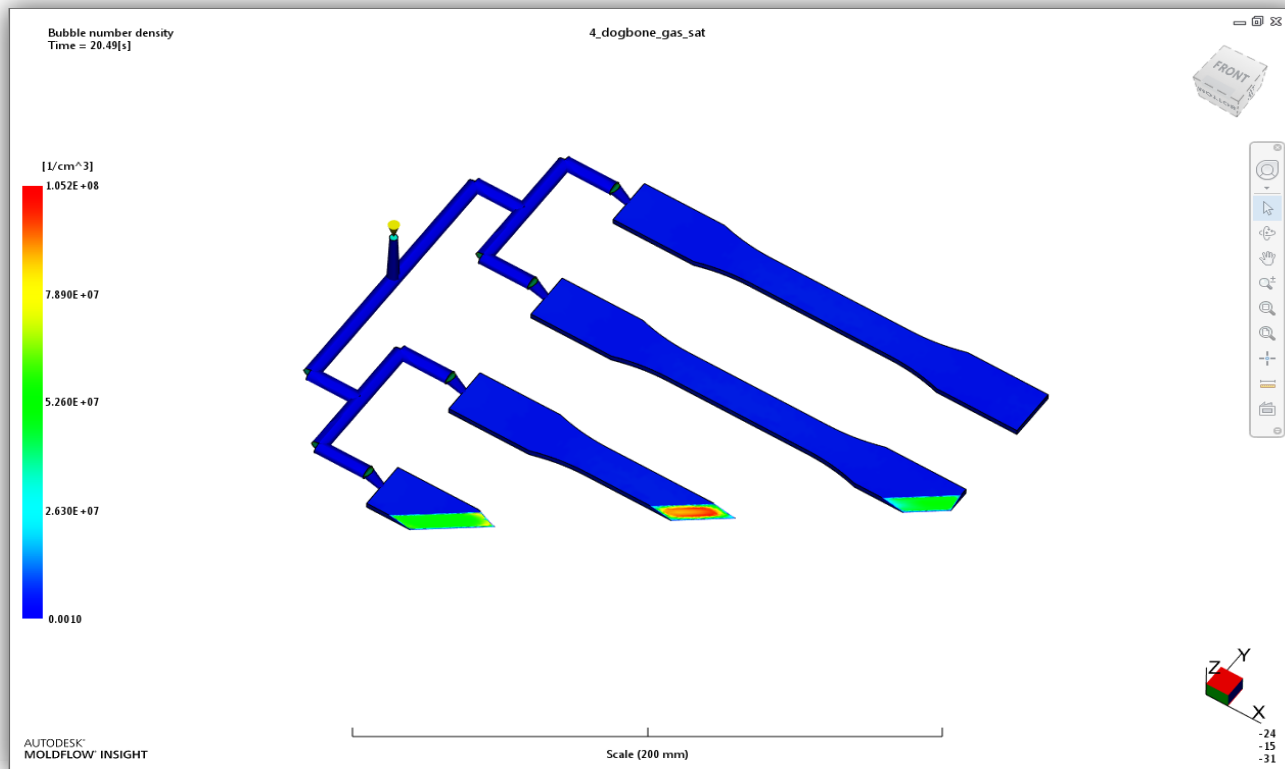
[1/cm³]
2.206E+07
1.655E+07
1.103E+07
5.516E+06
0.0010

AUTODESK
MOLDFLOW INSIGHT



Microcellular new results

- Bubble number density
- Bubble number density, final
(Midplane과 Dual-Domain만 나옴)



Microcellular foaming Gas properties

2015

MuCell © Material Properties

Optical Properties Environmental

MuCell material data

	Description
1	N2

Molecular weight of the gas: 28 [0:1e+010]

Surface tension: 5e-005 N/mm [0:1]

Viscosity coefficients for gas

v1: 1 [0:10]

v2: -58.381

v3: 3520

Solubility coefficients for gas

k1: 1.3489e-009

k2: -1.7089e+005

Diffusion coefficient for gas

d1: 3.819e-007

d2: -2830.5

Same settings

2016

Microcellular Properties

Optical Properties Environmental Impact Quality

Microcellular foaming gas

N2 View properties...

Edit properties

Surface tension (Guggenheim model) parameters (N2)

SIGM0: 0.04716 N/m

1/TC: 0.0010941 1/K

Viscosity coefficients for gas (N2)

v1: 1

v2: -58.381

v3: 3520

Solubility coefficients for gas (N2)

k1: 1.45e-009 kg/(kg-Pa)

k2: 0 K^2

Diffusion coefficients for gas (N2)

d1: 6e-009 m^2/sec

d2: 0 K

Fitted Classical Nucleation Model parameters (N2)

F1: 1.75e-023

F2: 0.0008

OK Hilfe

새로운 온도
의존적 모델에
대한 Data

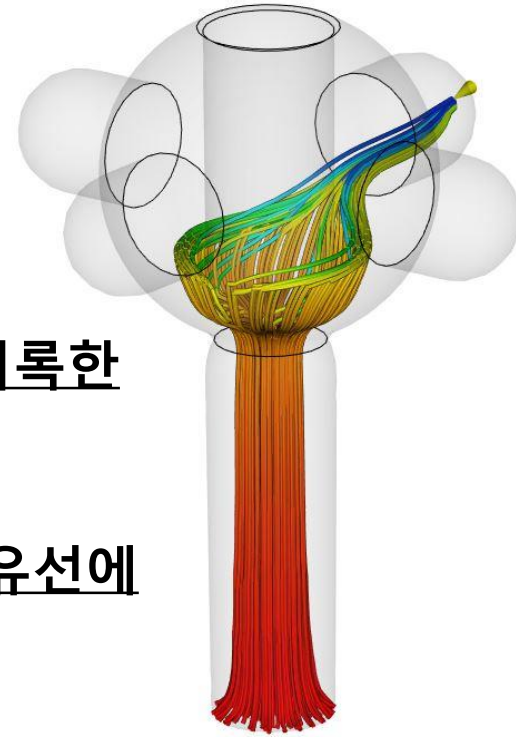
$$\sigma = \sigma_0 \left(1 - \frac{T}{T_c}\right)^{11/9}$$

σ 표면 장력
 σ_0 각각의 재료 상수
 T 온도
 T_c 임계온도

새로운 핵 분열
모델에 대한
데이터

Pathlines: Description

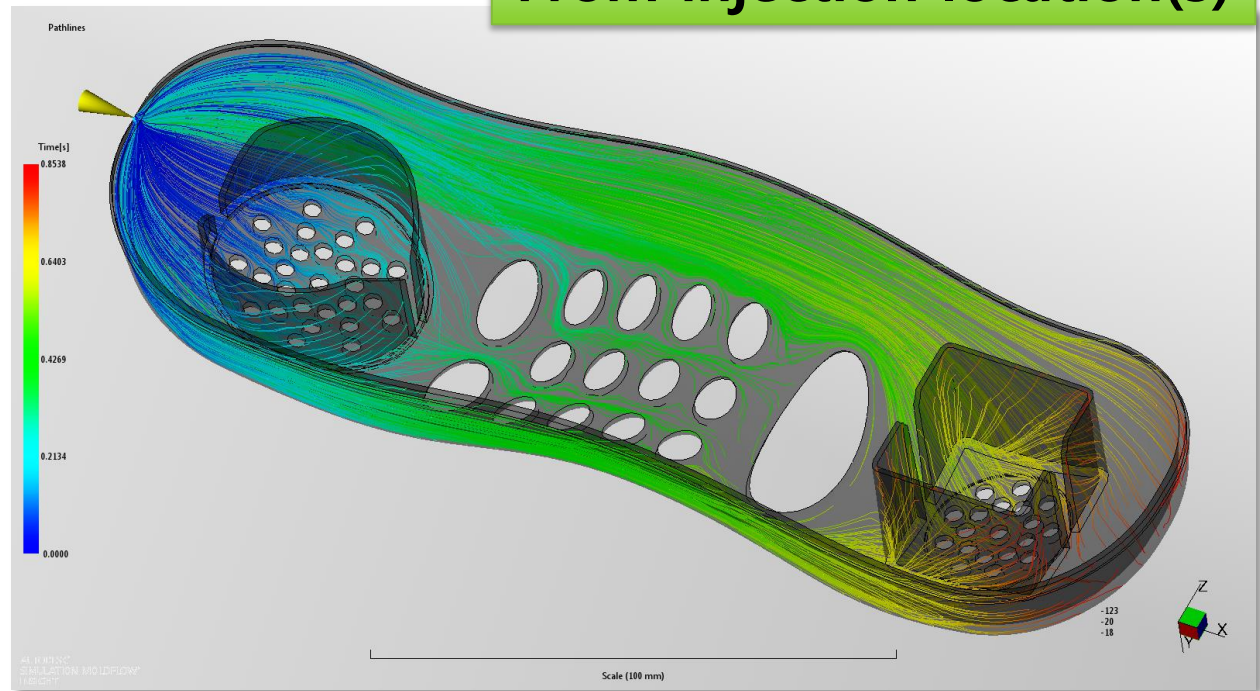
- Pathlines는 각각의 유동입자들의 궤도
 - 일정기간 동안의 흐름에서 유동입자의 통로를 기록한 것이라고 생각 하면 됨
 - 통로가 갈리는 방향은 각각의 시간에서 유동의 유선에 의해 결정
- Note: Pathlines은 Flow lines/Streamline과 다름
(Good definition on Wikipedia)
- 가끔 표면결함의 원인이 결함 위치로부터 멀리 떨어져 있을 수 있음



Pathlines plot

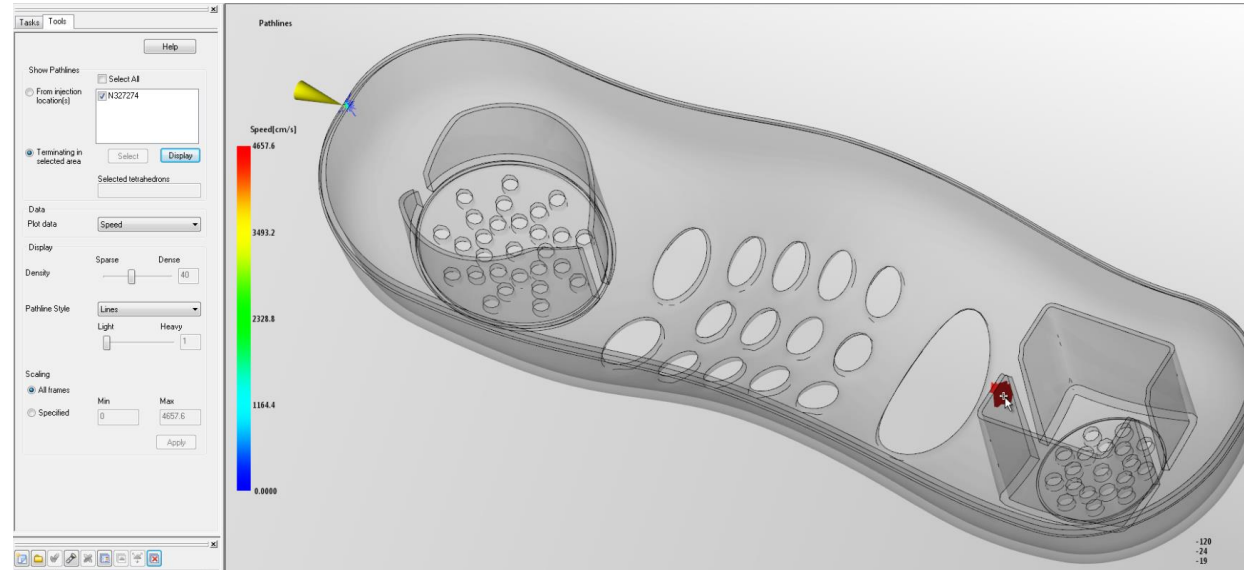
- 두가지 옵션:
 - Injection 위치에서 시작(s)
 - 선택한 영역까지
- 결과
 - Pressure
 - Temperature
 - Shear rate
 - Time
 - Speed

From injection location(s)

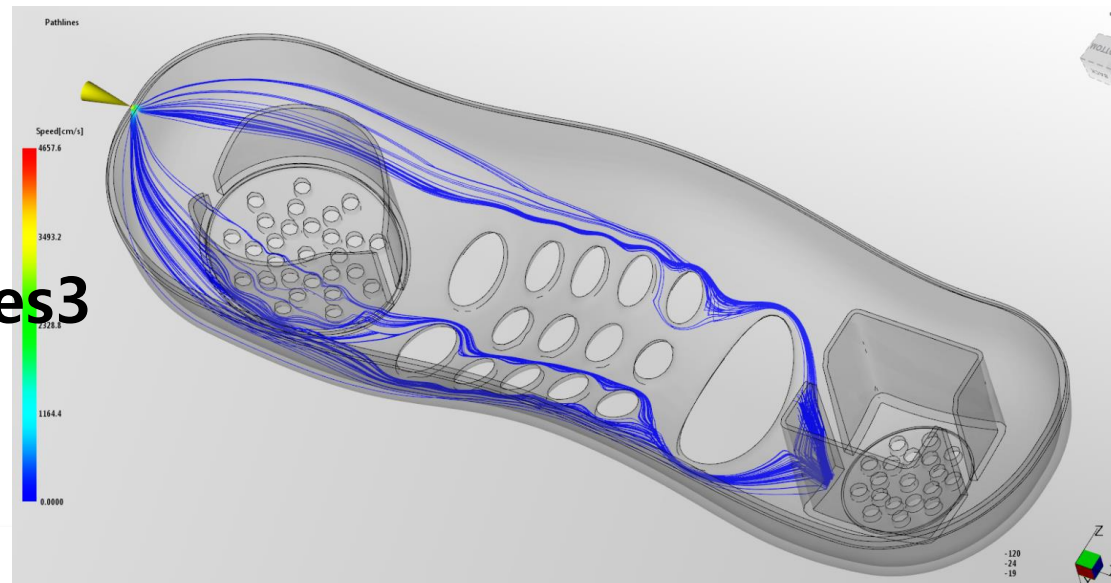


Pathlines plot

- 선택한 영역 까지

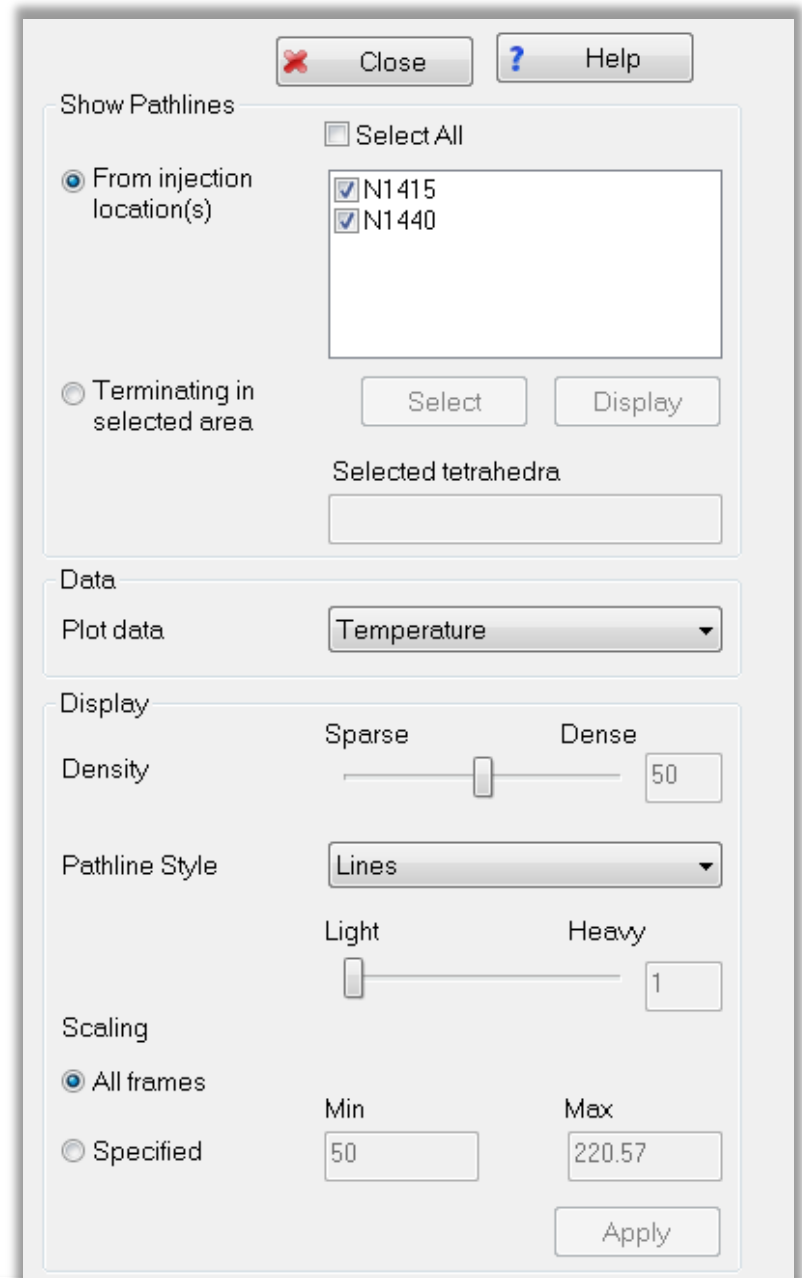


- 특정 위치에 도달한 유동입자들의 Pathlines3



Pathlines UI

- 밀도의 증가는 계산시간이 증가함
- Pathline style :
 - 표시에 문제가 있을 수 있음
- Scaling :
 - 이상 할 수 있음



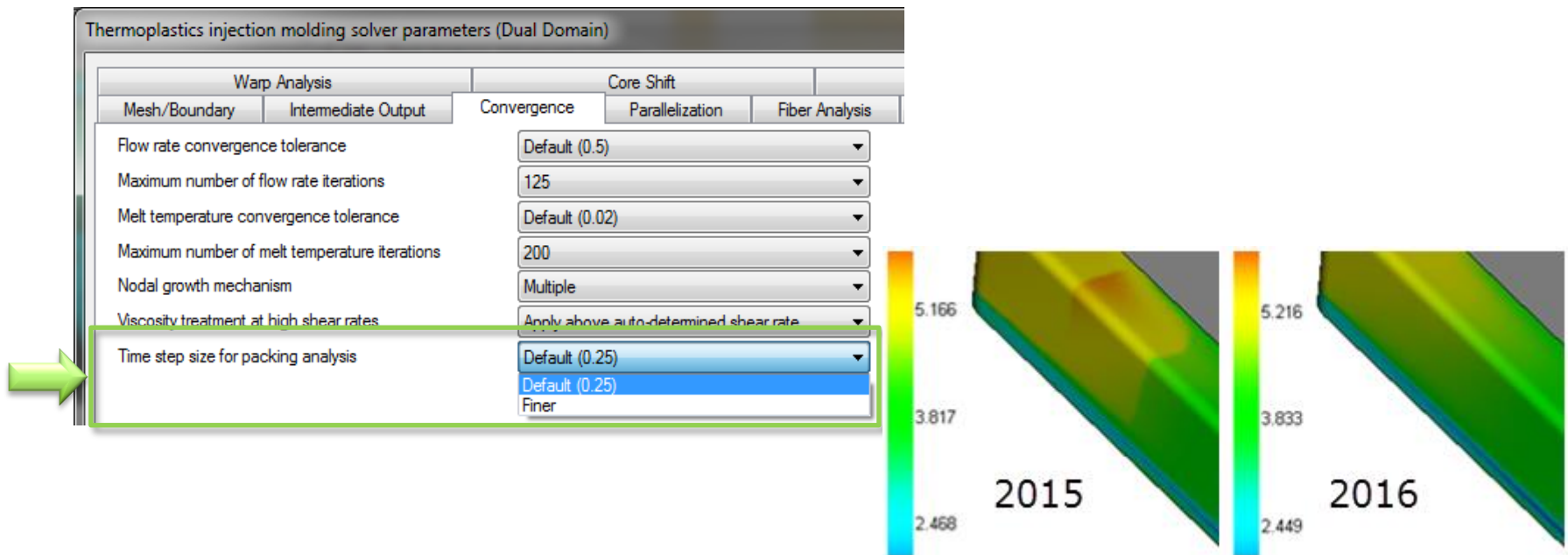
The smaller improvements

3D Automatic injection time

- 3D 해석을 위한 Automatic injection time의 계산이 개선됨
- 다음과 같이 3D 해석에서 Automatic injection time의 성능이 개선
 - 계산 속도의 증가
 - 계산 정밀도의 향상

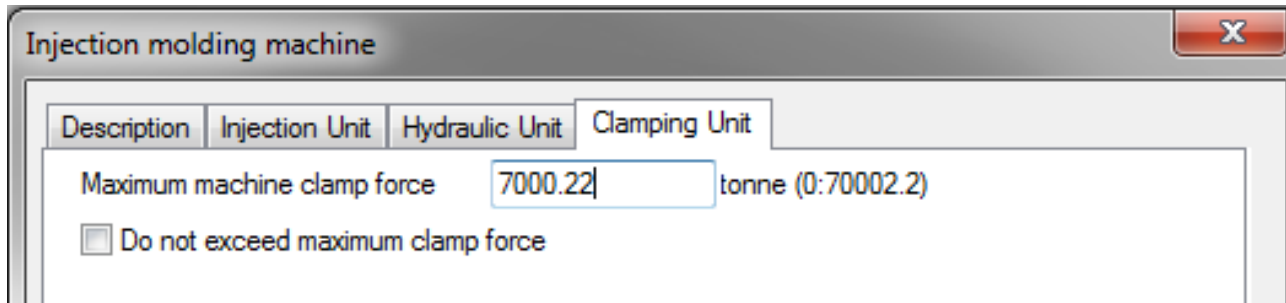
Packing Time Step Control

- Midplane 과 DD 에서 Packing timestep size을 사용할 수 있음
 - Banded 결과로 나타남



Do not exceed maximum clamp force implemented for 3D solver

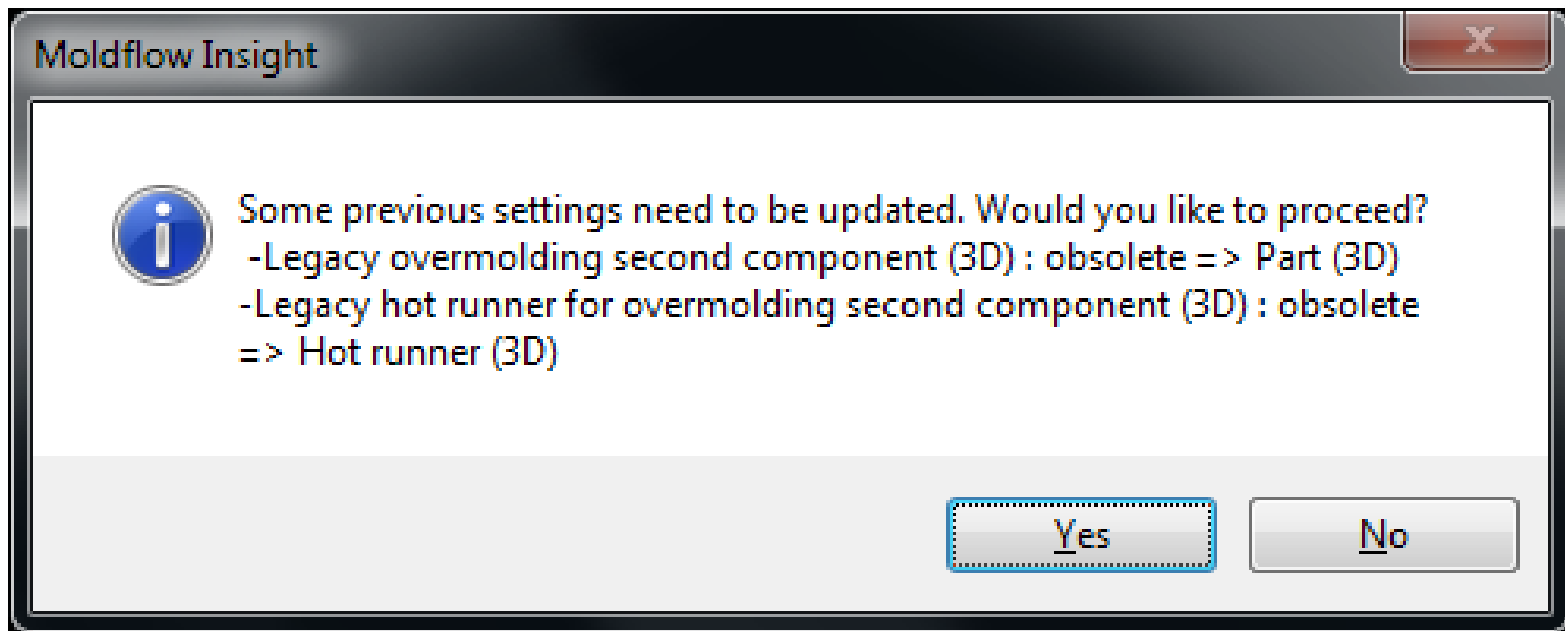
- “Do not exceed maximum clamp force” 기능을 3D에서도 사용 가능함
 - Midplane과 DD에서는 이미 존재 했음



Mesh Log	Analysis Log	Fill	Machine Setup	Fill-Check
1.112	22.113	3.070e+00	8.88e-03	1.995
** WARNING 98932 ** The clamp force required to fill/pack the part is greater than the maximum machine clamp force value in the clamping unit properties of the currently selected injection molding machine. The maximum machine clamp force will be maintained in the analysis.				
1.295	25.771	3.156e+00	1.00e-02	1.929

3D overmolding

- legacy overmolding elements 지원 안함
 - 사용자는 2015버전에서 경고를 확인 했을 것
 - 2016 에서는 Legacy elements를 지원하지 않음



Fiber breakage results for reactive molding

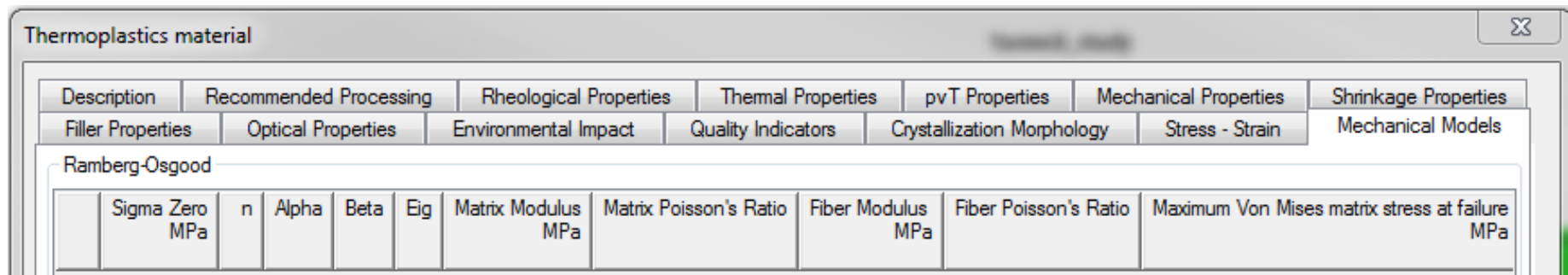
- 프로세스 범위, Mesh의 기술 그리고 해석 Sequence에서 열경화성 수지에 대한 Fiber Breakage 결과를 제공함
- Fiber가 함유된 수지는 Fiber breakage 계산이 가능하도록 기계적 성질이 입력되어 있어야 함

Reactive molding		
Analysis sequence	MidplaneDual Domain3D	
Fill + Pack		
Fill + Pack + Warp		
Cool (FEM) + Fill +Pack		
Cool (FEM) + Fill +Pack + Warp		
Fill (Compressible)		
Fill + Pack (Compressible)		
Fill + Pack + Warp (Compressible)		
Runner Balance (Compressible)		

...more tables are available, see what's new Synergy help

Ramberg-Osgood coefficient calculations

- Ramberg-Osgood 방정식은 Stress-strain 탭의 Stress-strain data를 통해 계산 됨



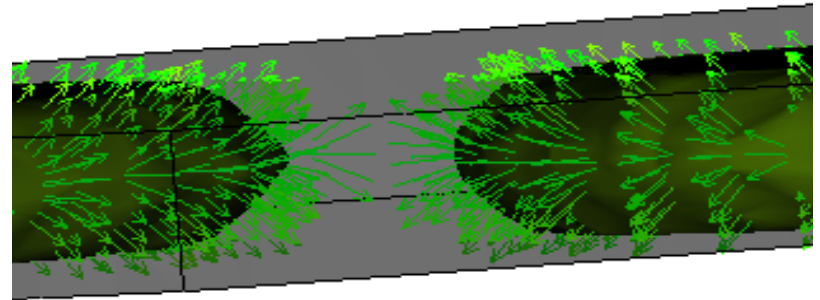
- Autodesk Material Exchange가 사용됨

Results

3D Weld Surfaces: Definition

- 다음 식으로 정의 됨

$$\frac{dS}{dt} + \vec{U} \cdot \nabla S = 0$$



- Where

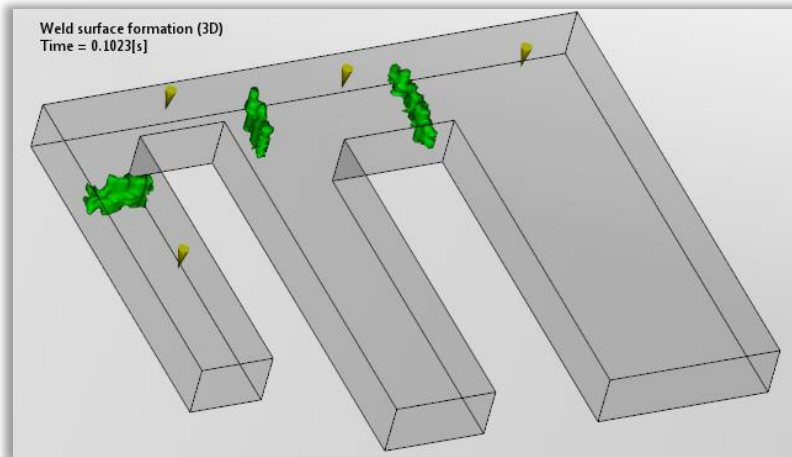
- ✓ S = distance to the flow front
- ✓ T = time
- ✓ $\vec{U}$ = Velocity Vector

- 이 결과는 유동선단의 결과를 바탕으로 함 (not fill time)

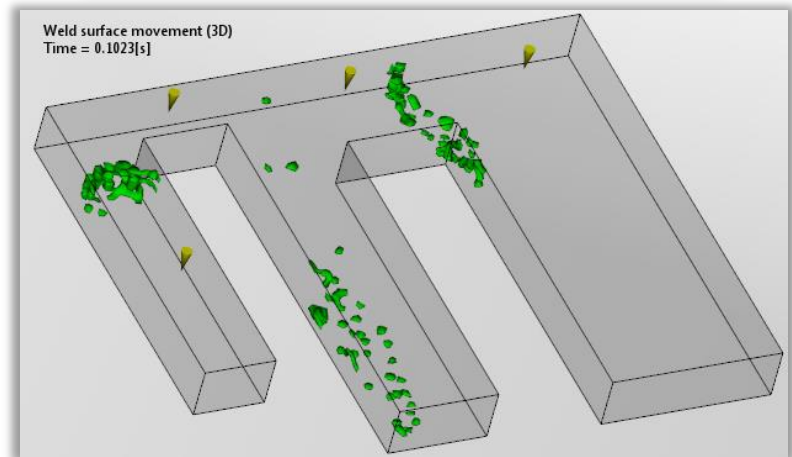
Weld surface 3D results

- Part의 두께 방향으로 Weld Line형상을 확인가능
 - 두개의 새로운 결과를 확인 가능
 - 2개의 결과가 겹치는 경우 Weld부분이 취약
 - 정확한 결과를 위해 intermediate results를 증가하는 것이 좋음

Weld surface formation (3D)

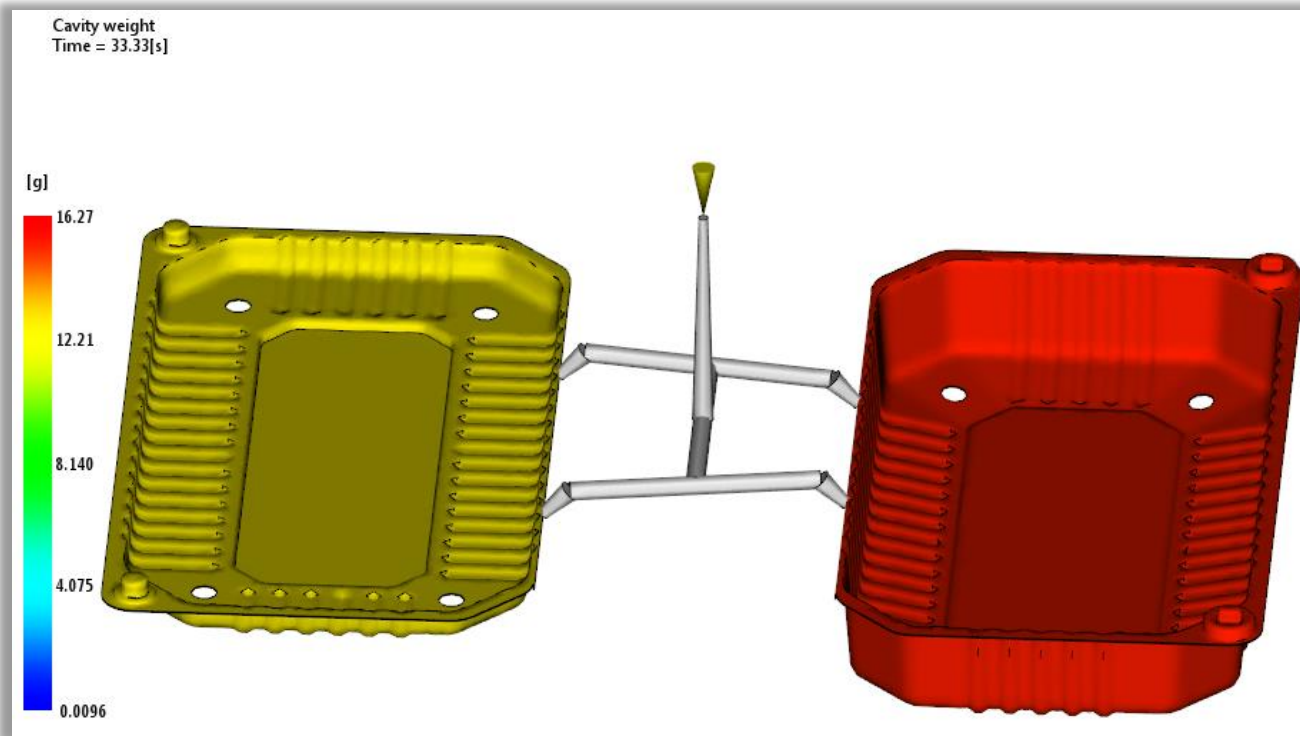


Weld surface movement (3D)



New cavity weight result

- Midplane, DD, 3D의 Cavity무게 확인 가능
- 시간에 따른 Animation 결과

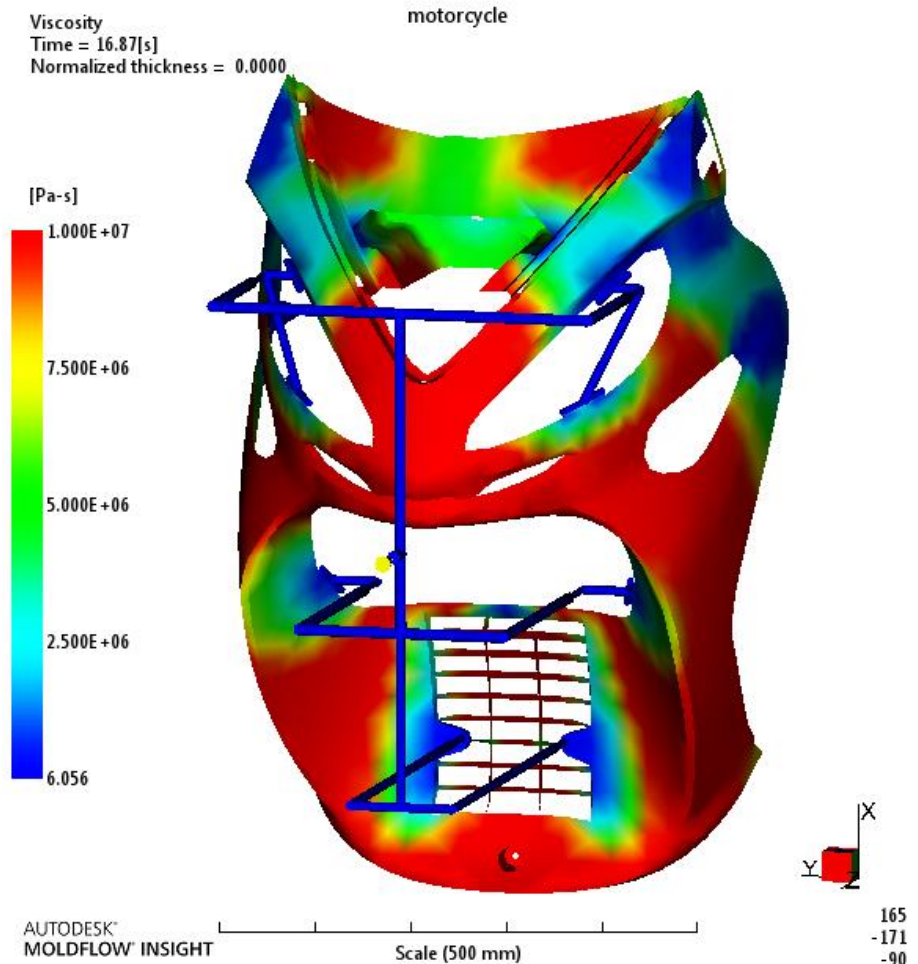


Example: 각 개별 캐비티의 무게

Viscosity result for all mesh types

- 점도결과 추가 (Midplane and DD)

- 3D는 이미 적용
- 시간에 따른 Animation 결과
- Layer 별 결과 확인

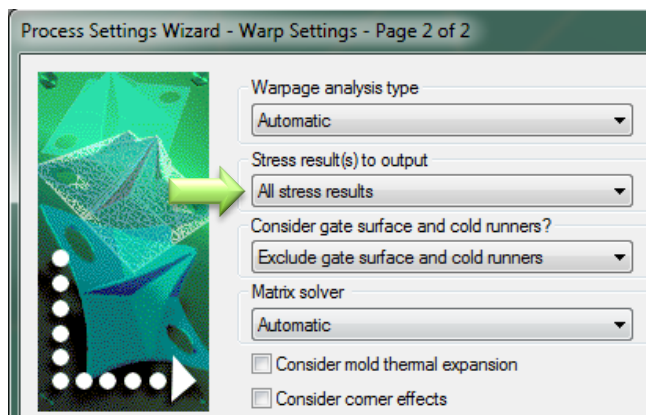
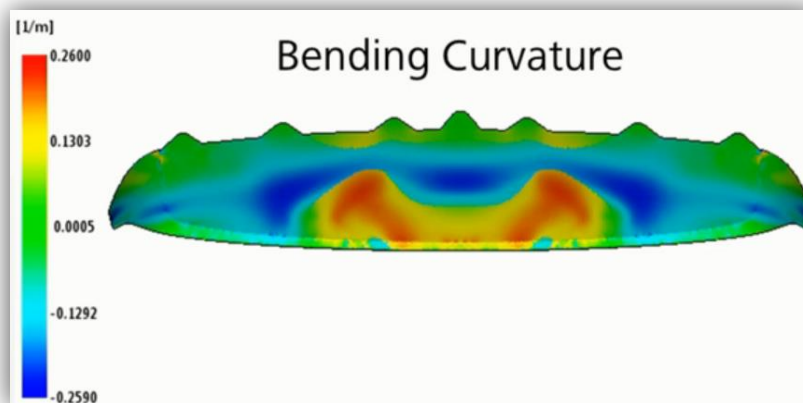
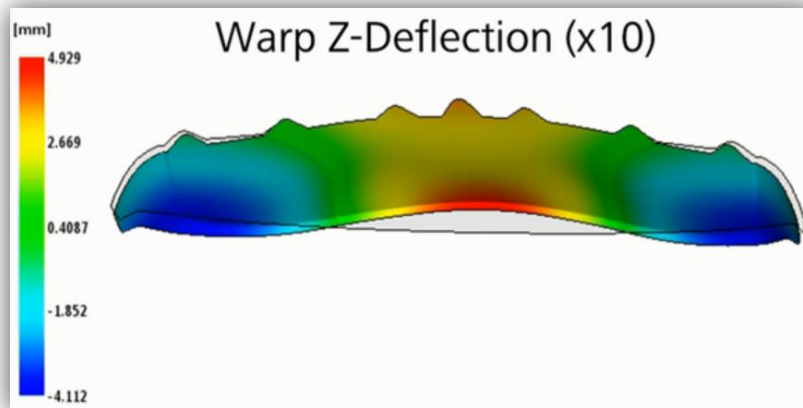


Initial bending moment

■ 신규 결과: Initial bending moment (midplane; warp)

Warp

- ☐ Deflection, all effects:Deflection
- ☐ Deflection, all effects:X Component
- ☐ Deflection, all effects:Y Component
- ☐ Deflection, all effects:Z Component
- ☐ Maximum shear stress (warp)
- ☐ Stress, Mises-Hencky (warp)
- ☐ Stress tensor (warp)
- ☒ **Initial bending curvature**
- ☐ Bending curvature(warp)

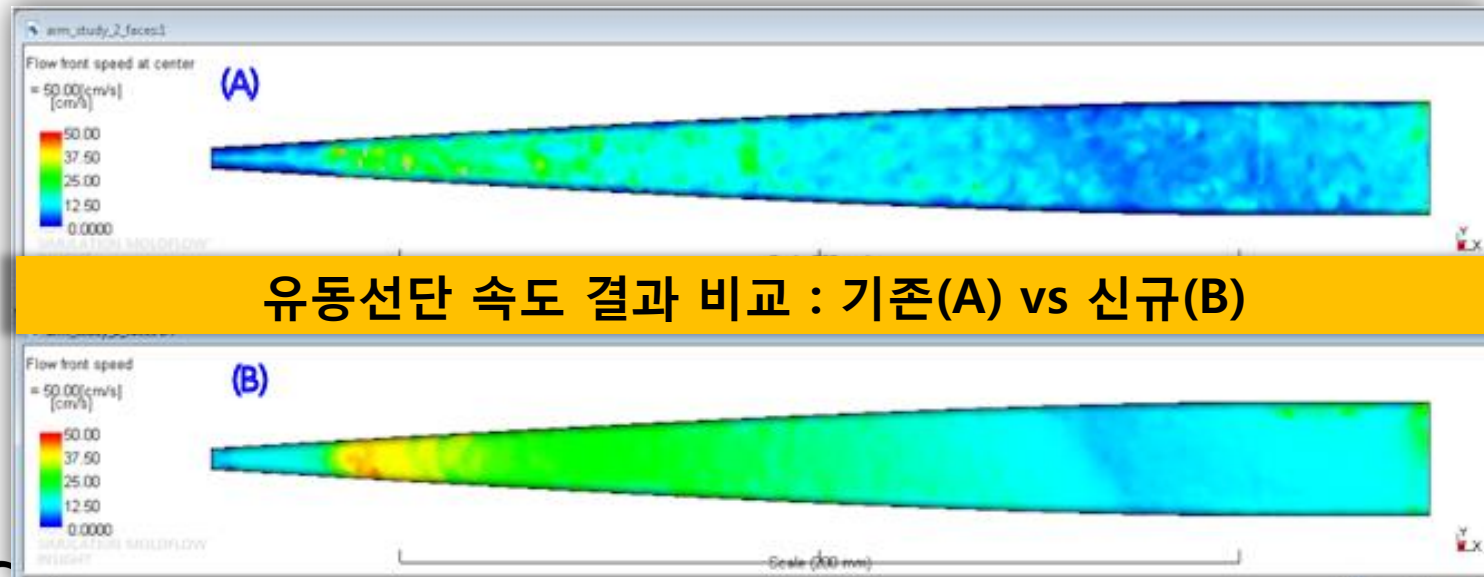


Model courtesy of HRS – Inglass S.p.A

응력결과 선택 필요

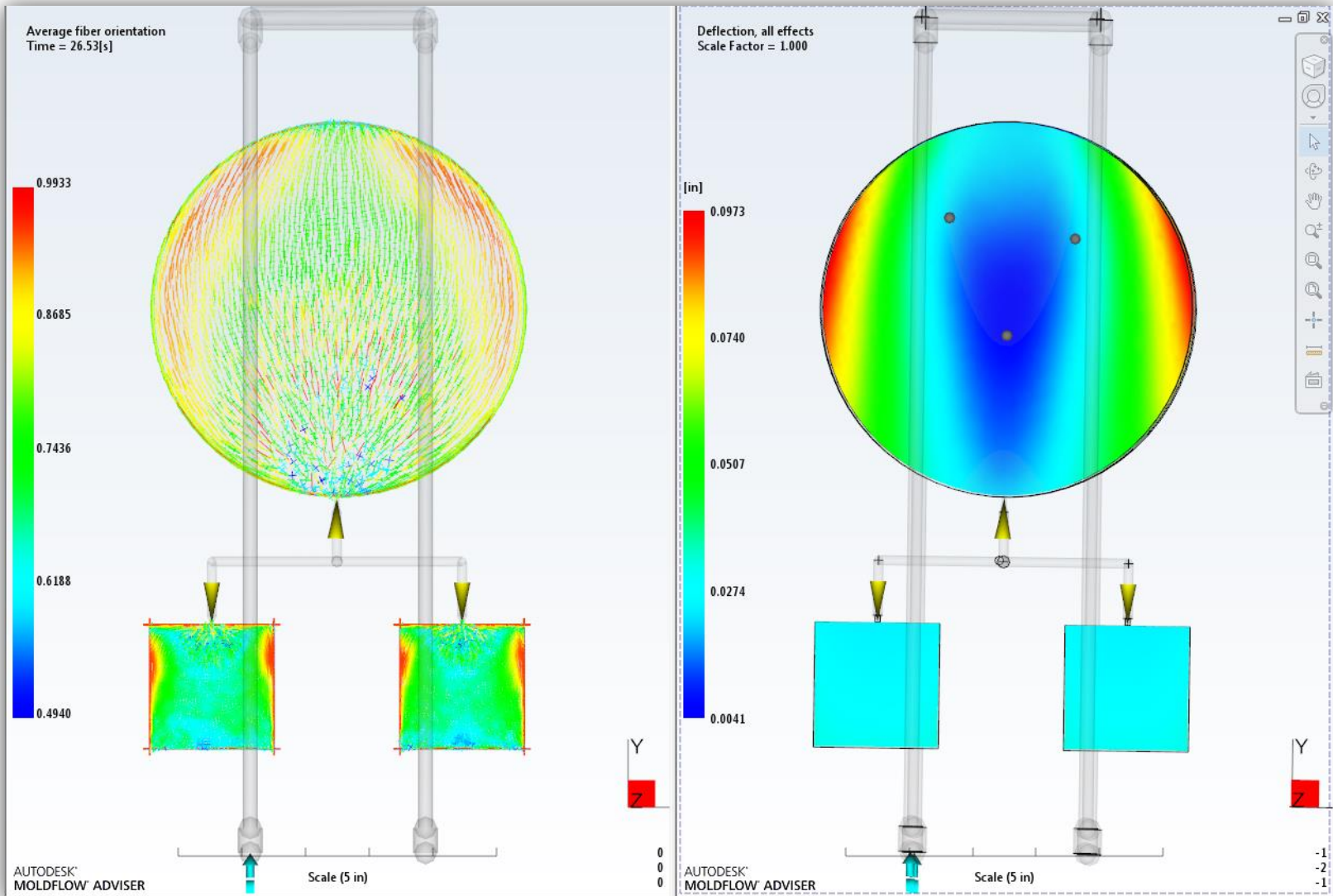
Flow front speed result

- 새로운 유동선단 속도 결과는 기존 중심에서의 유동선단 속도결과를 대체함
- 새로운 유동선단 속도 결과는 평균값을 나타내는 결과임
 - (A) : 기존 중심에서의 유동선단 속도 결과
 - (B) : 새로운 유동선단 속도 결과



Adviser

Fiber and warp results



Fiber and warp in AMA

- Fiber : AMI와 동일한 기본값 적용(수정불가)
- Warp :
 - 변형모델은 AMI(DD)과 다르게 CRIMS 사용 안함
 - Mesh aggregation 옵션(3D)



Material database

Material database

■ 주요 변경사항

Changes to the Thermoplastics material database

- Total number of suppliers: 482

Since the 2015 release

- New suppliers added: 16
- Suppliers deleted: 11

- Total number of grades: 9610

Since the 2015 release

- Grades added: 500
- Grades amended: 675
- Grades deleted: 147

Supplier added to the database

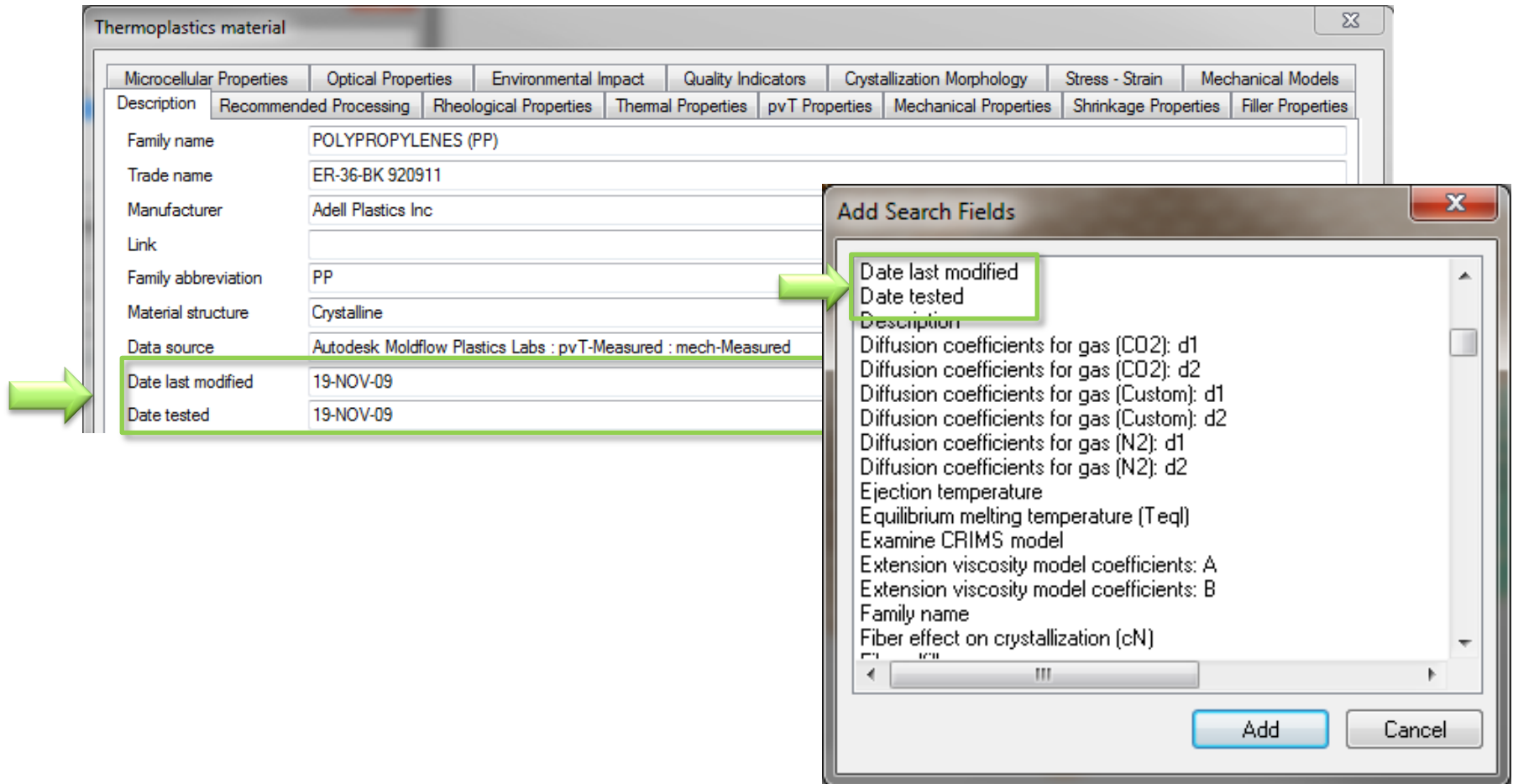
A Schulman Thermoplastic Compounds Sdn Bhd
Autotech Polymers India Pvt Ltd
Citadel Plastics
Cool Polymers
Initz
Lotte Chemical
Nanjing Julong Science & Technology Co Ltd
Nilit Plastics Europe GmbH
Samsung SDI Co Ltd
Teijin Chemicals
Tosaf Compounds Ltd
VI Compounding
BASF Engineering Plastics
Trinseo APAC
Trinseo EUR
Trinseo NA-LA

Supplier deleted from the database

The Matrixx Group
Styron APAC
Styron EUR
Styron NA-LA
BASF
BASF Customer Specific Grades
Celanese (Europe Revised)
Celanese (Europe)
DuPont Fluoropolymers
DuPont Kabushiki Kaisha
Solvay Engineering Plastics

Search fields

- 수정 또는 테스트 진행 날짜 기준 검색 가능



Expiry date for Material quality indicator

- 품질 인디케이터가 만료되는 시점

Packing Data Quality Details

pvT data details

- ☒ Recently modified
- ☒ Measured data
- ☐ Tested by indirect dilatometry
- ☐ Data tested in cooling

Packing quality indicator Expiry Date 01-Nov-24

OK Aide



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