AUTODESK MOLDFLOW 2016
What's new - Solver

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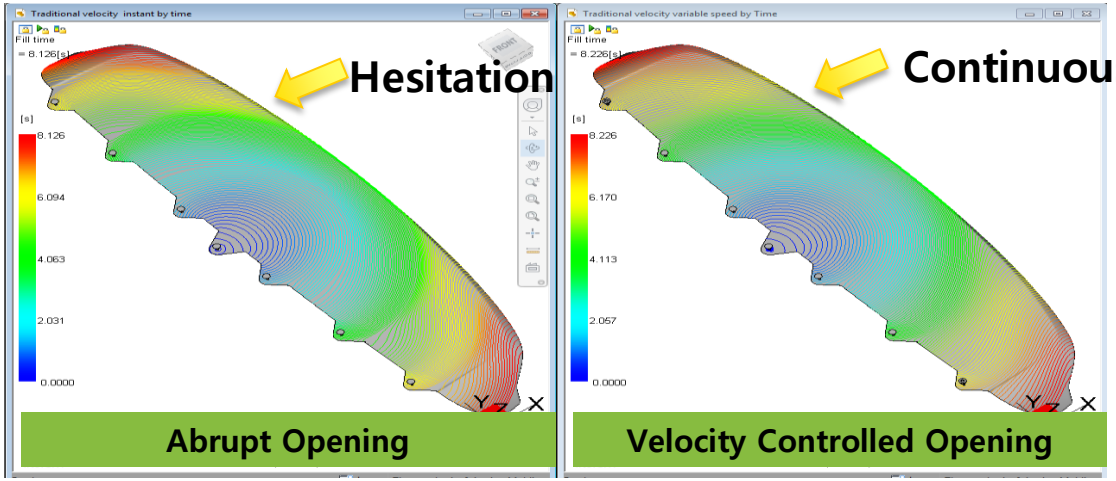
AUTODESK

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



Model courtesy of HRS – Inglass S.p.A

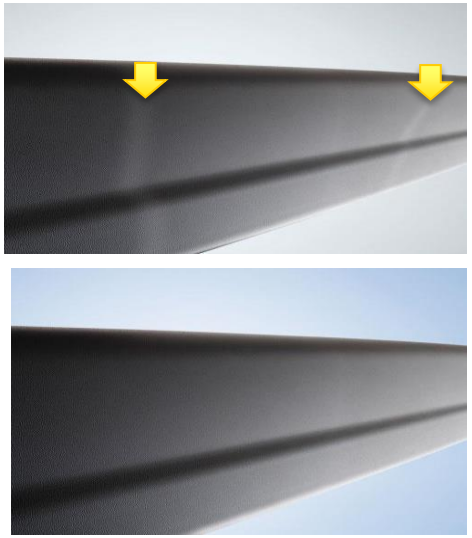
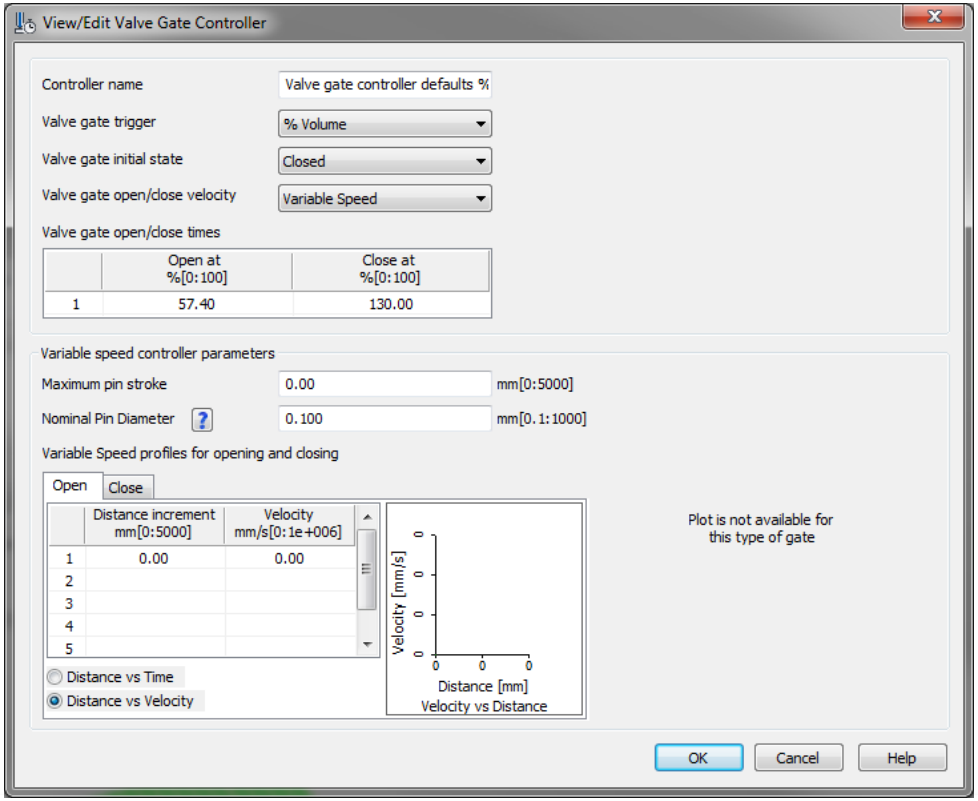


Image from Synventive Molding Systems

Controlled Opening and Closing of Valve Gates

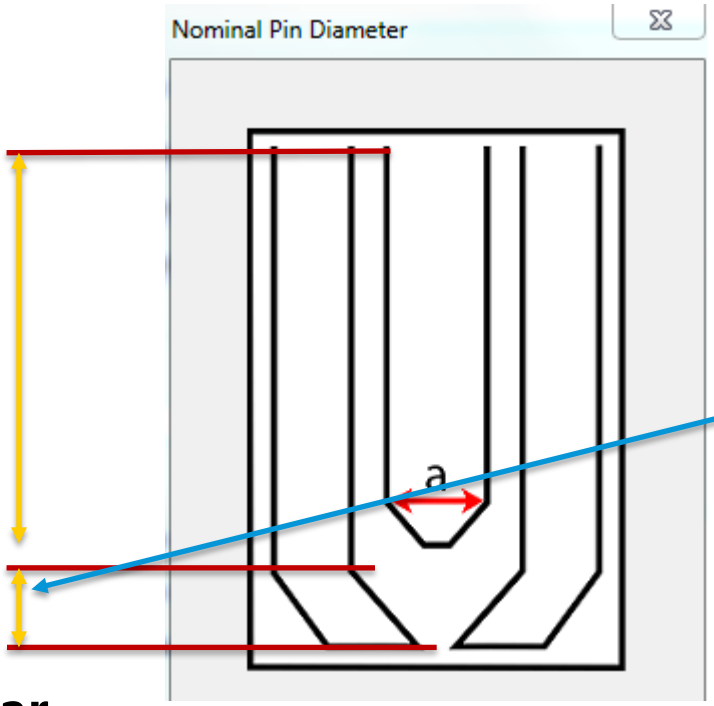
- 속도제어로 Midplane과 Daul-Domain type에서 Valve Gate를 열고 닫을 수 있음
- Valve Gate Initial State :
  - 즉시 개방 (legacy)
  - 속도 변경

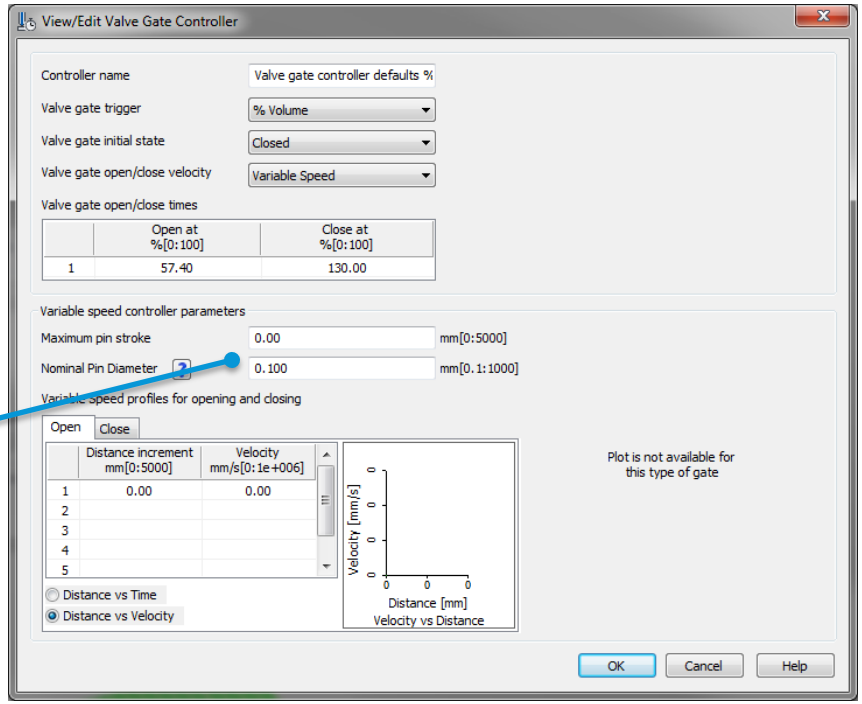


Modeling valve gate

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 8.00 mm[0:5000]

Nominal Pin Diameter 4.000 mm[0.1:1000]

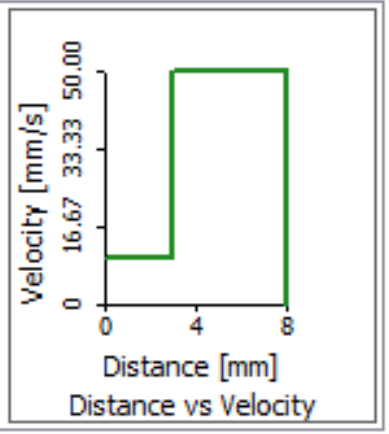
Variable Speed profiles for opening and closing

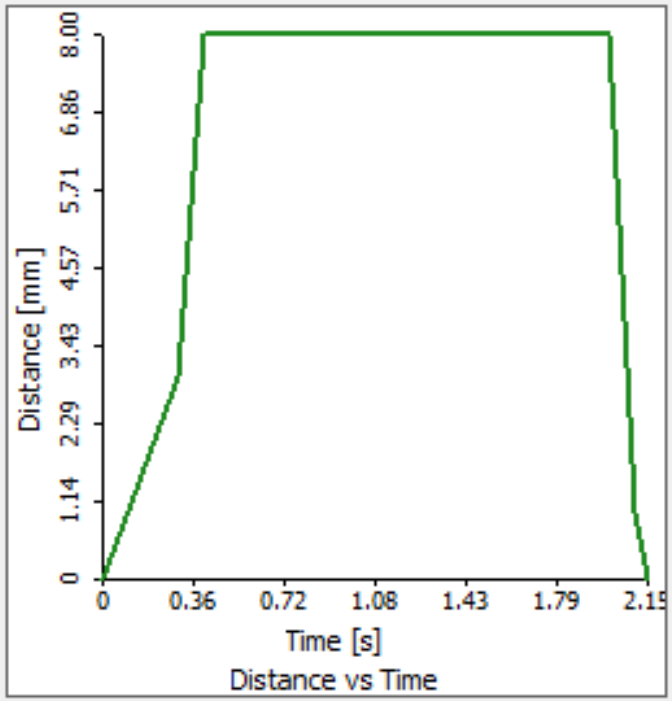
Open | Close

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

Distance vs Time

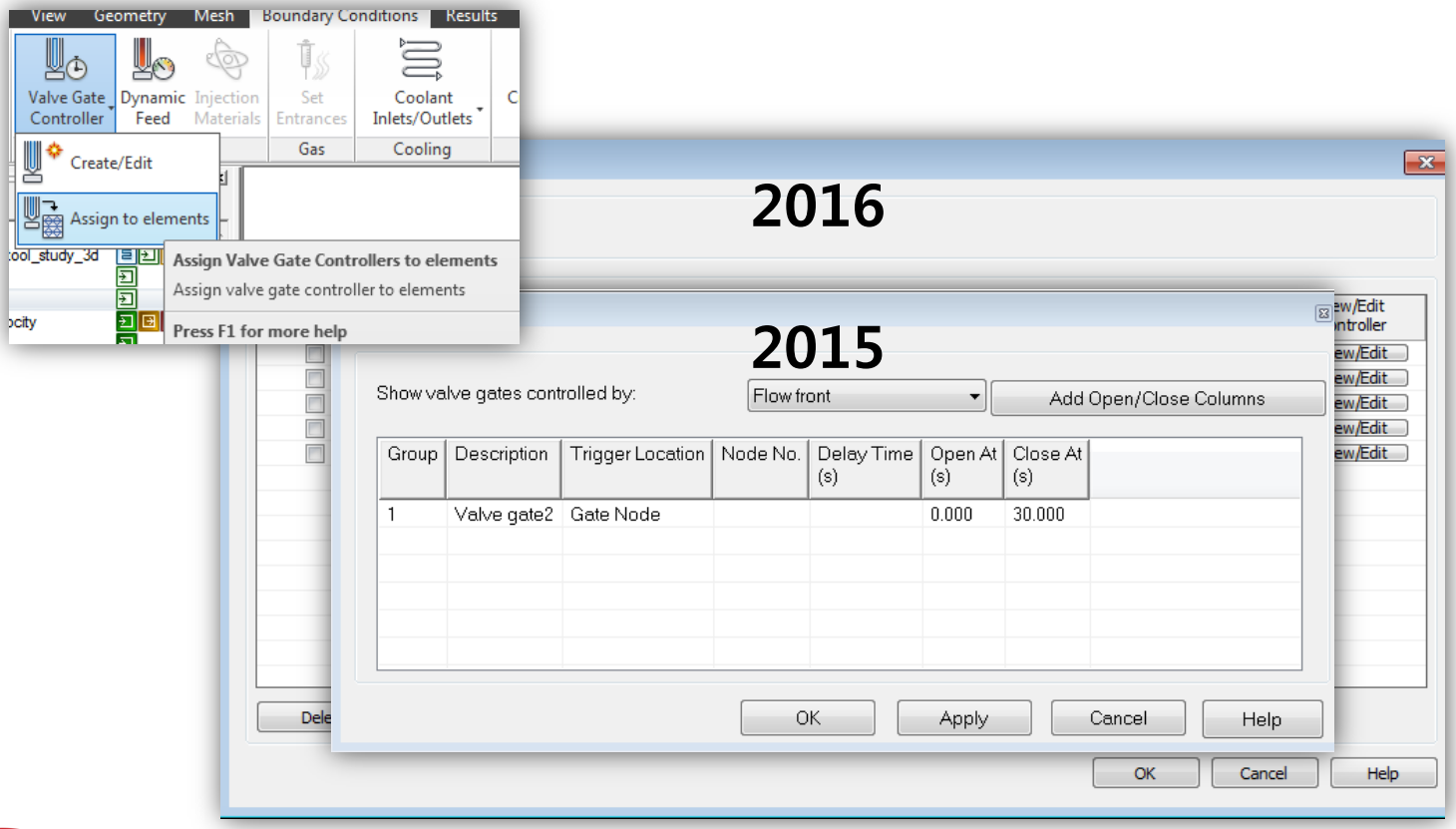
Distance vs Velocity





New valve gate table

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



Extra enhancement

- Valve Gate 이름은Log에 표시 됨

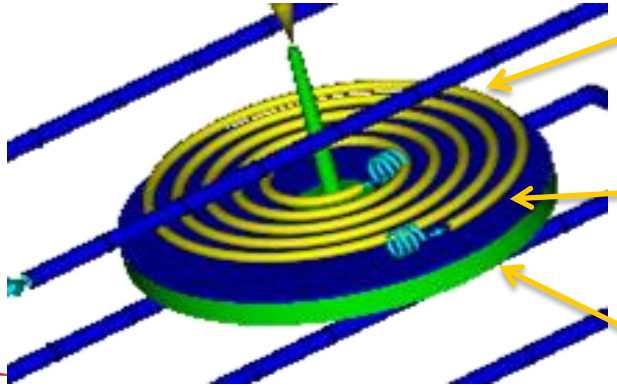
```
| 18.685 | 58.90 |        60.00 |        0.13 |         P          |
| 18.935 | 59.74 |        60.00 |        0.13 |         P          |
| 19.185 | 60.55 |"Valve gate by Flow Front #2" #  3 (Elem#   2549) started closing...|
| 19.185 | 60.55 |"Valve gate by Flow Front #2" #  3 (Elem#   2549) has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

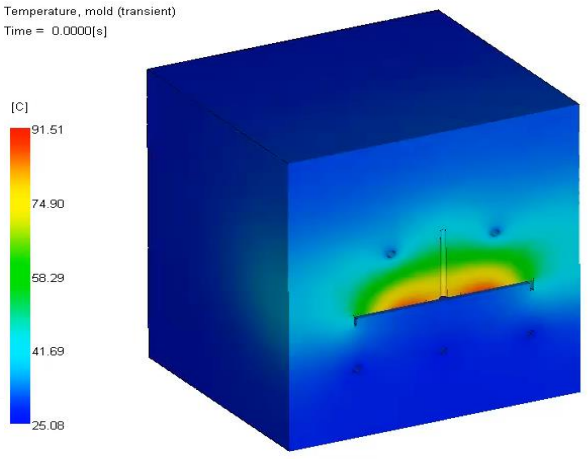
- Valve Gate ID가 화면에 표시 됨

- 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**

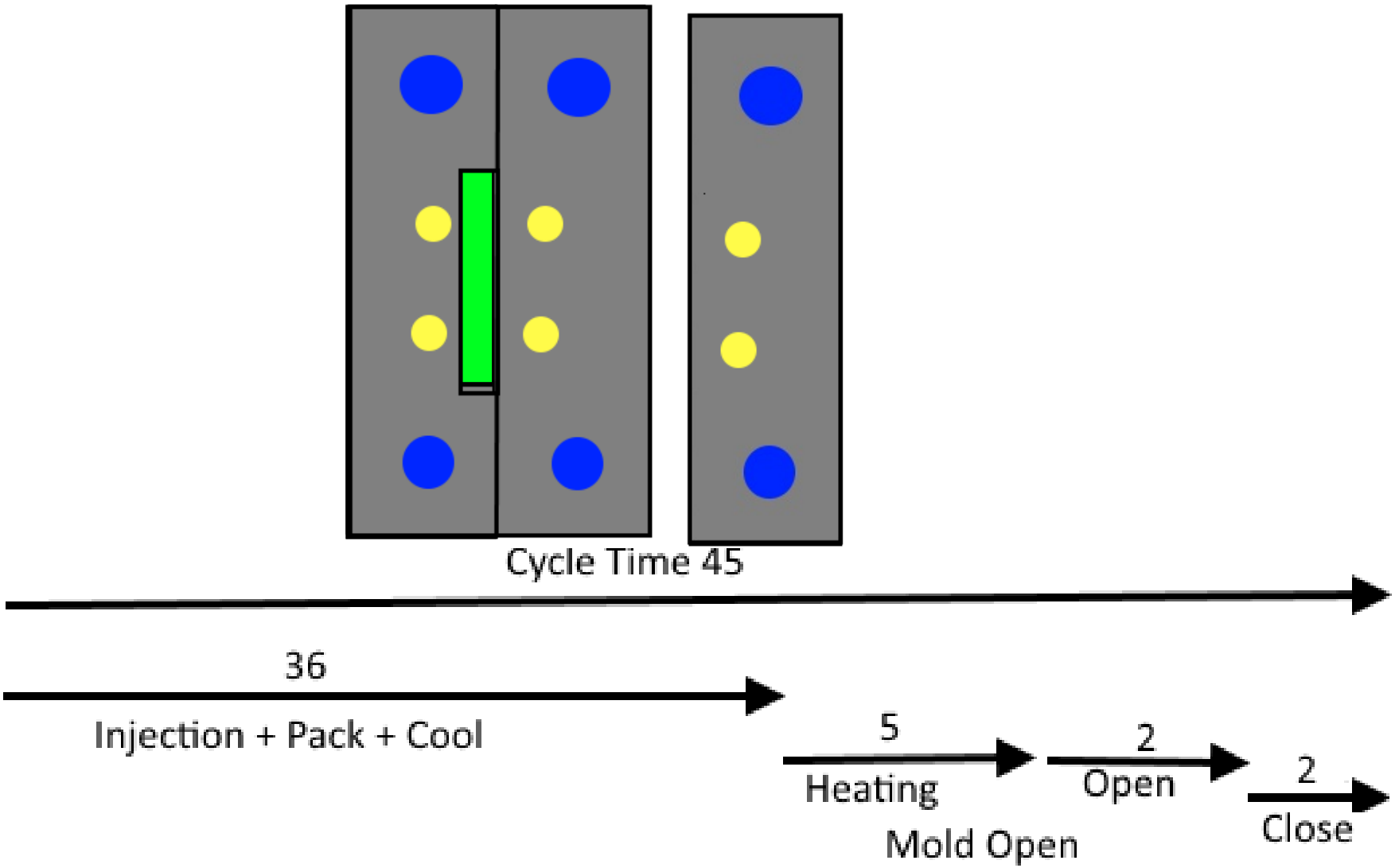




Induction heating for rapid heating and cooling analyses

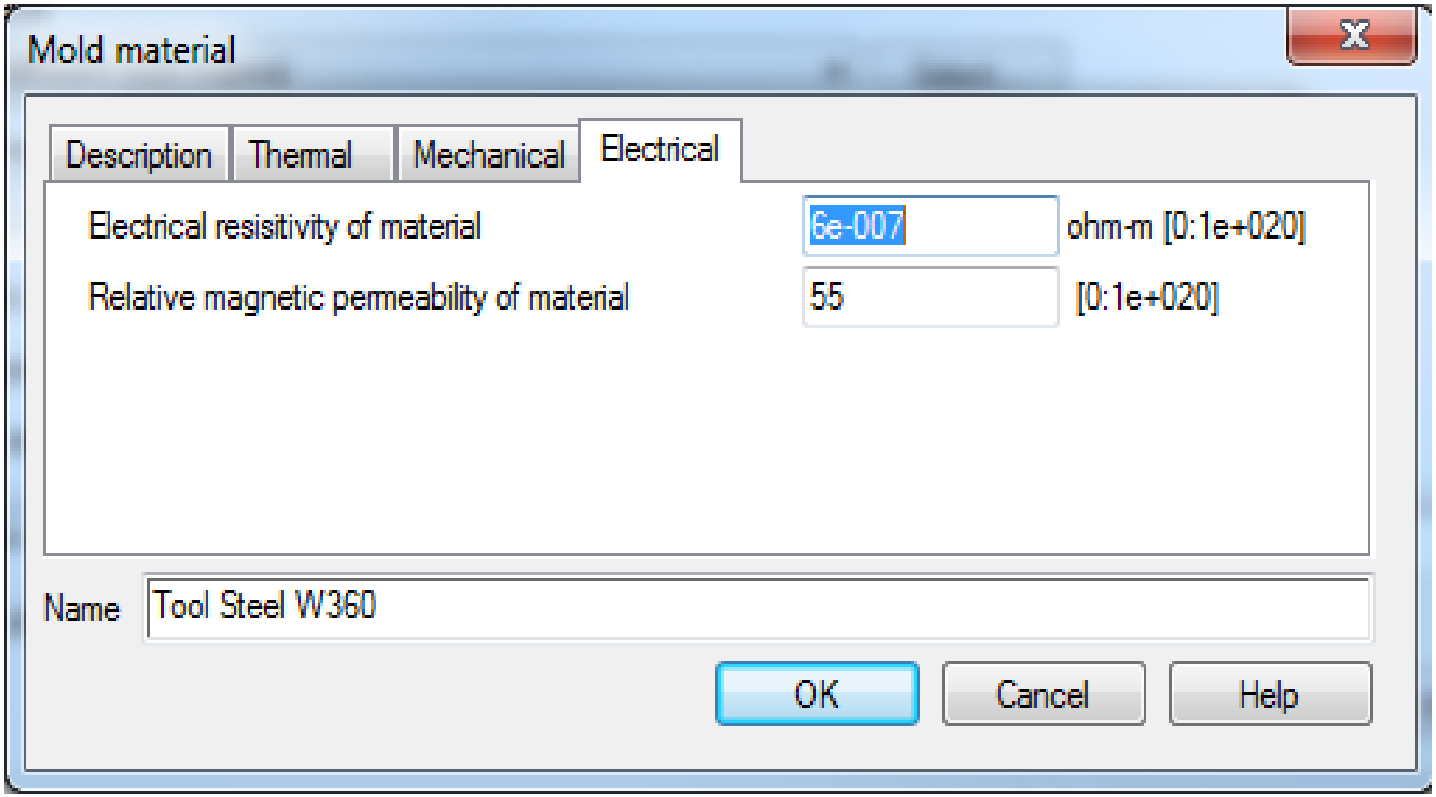
- Dual Domain & 3D Mesh Type에서 가능
- 새로운 결과:
  - Joule heat
  - Magnetic vector potential
  - Induced current density
  - Source current density
  - Source electric potential
  - Magnetic flux density

Simulation technology-Process Settings



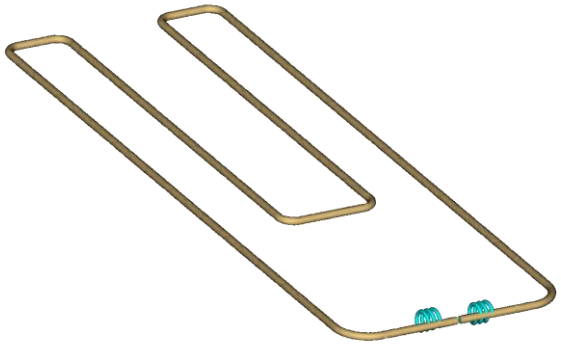
Simulation technology-Materials

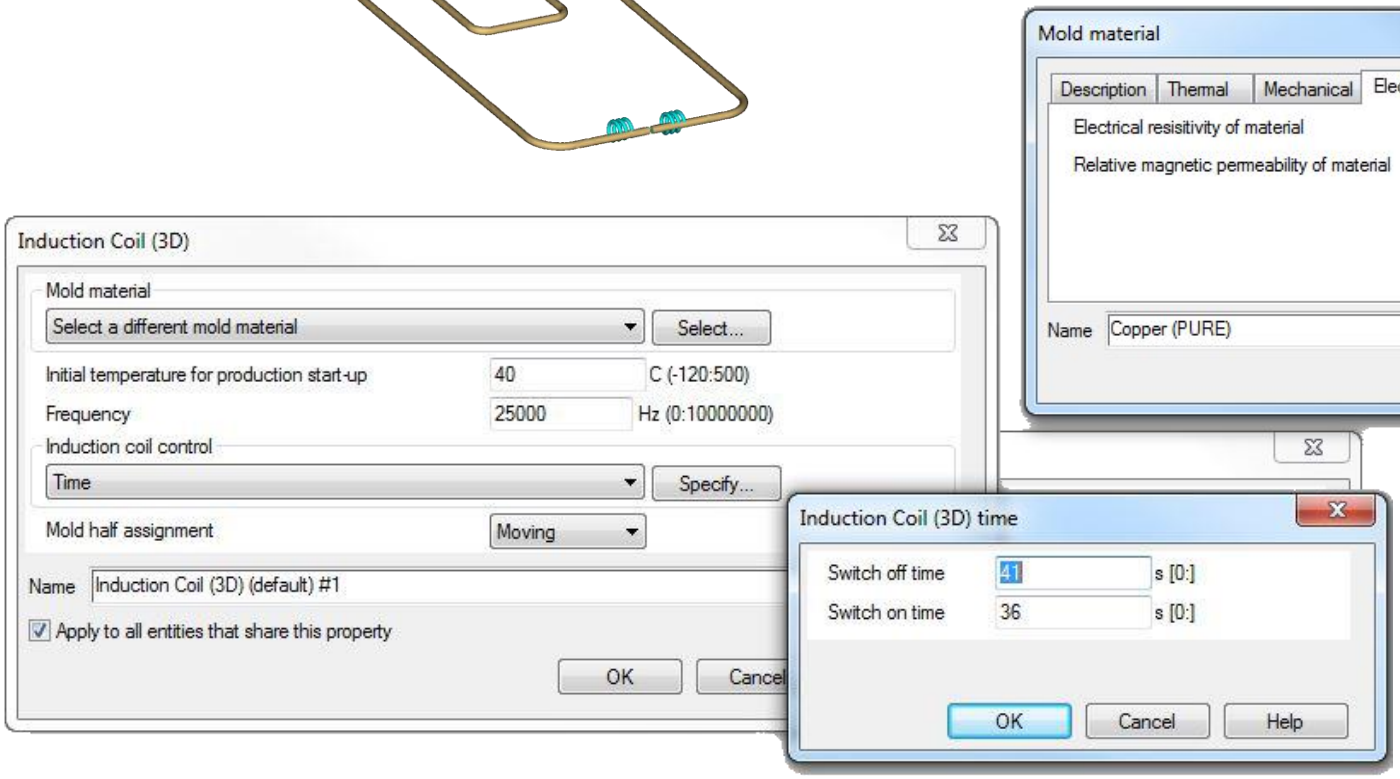
- 금형과 금형 Insert에 모두 Electrical properties를 지정해야 함



Simulation technology- Induction Heating

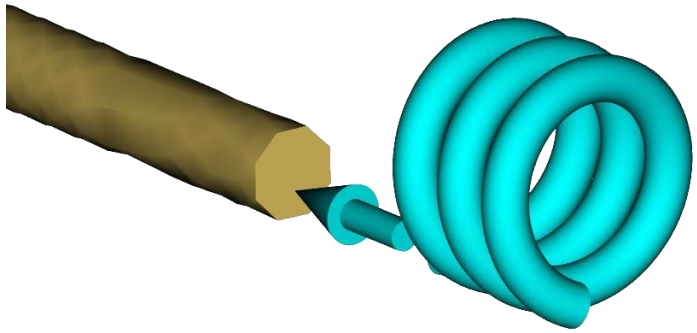
- **Elemental properties는 Coil로 지정 해야 함**

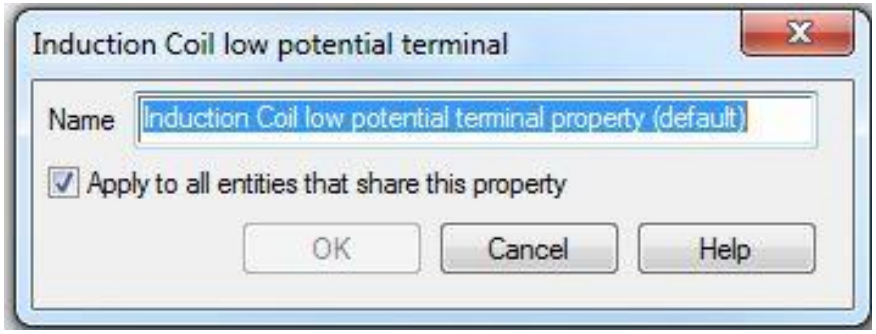


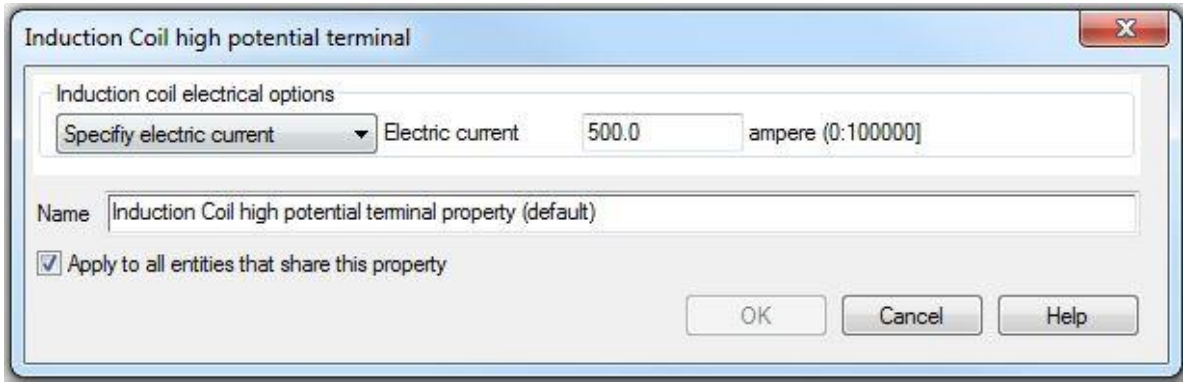


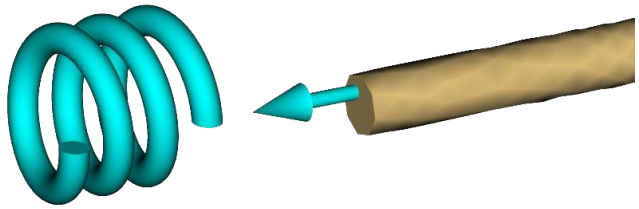
Simulation technology- Boundary conditions

- 전류의 높고 낮음의 전위를 지정하여야 함 (전류의 방향)



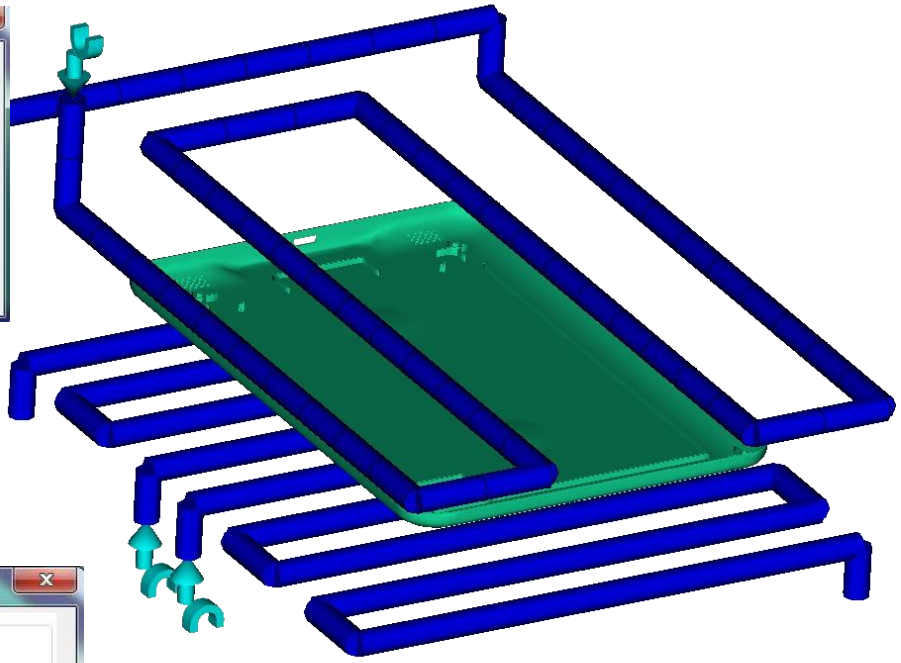


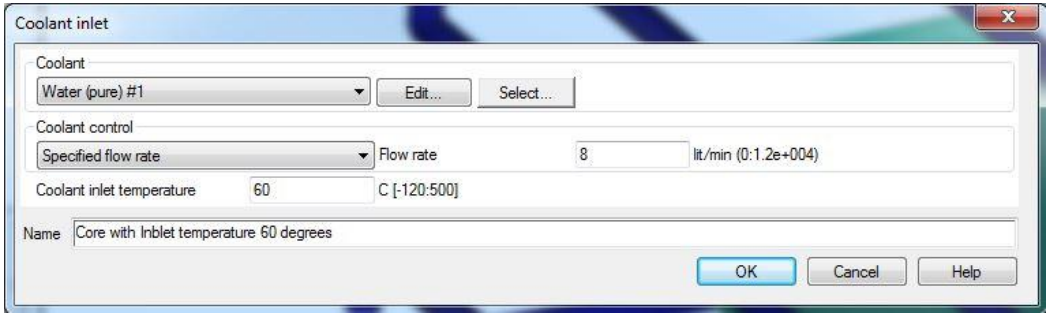




Simulation technology- Boundary conditions

- 냉각채널은 달라 진 것이 없음





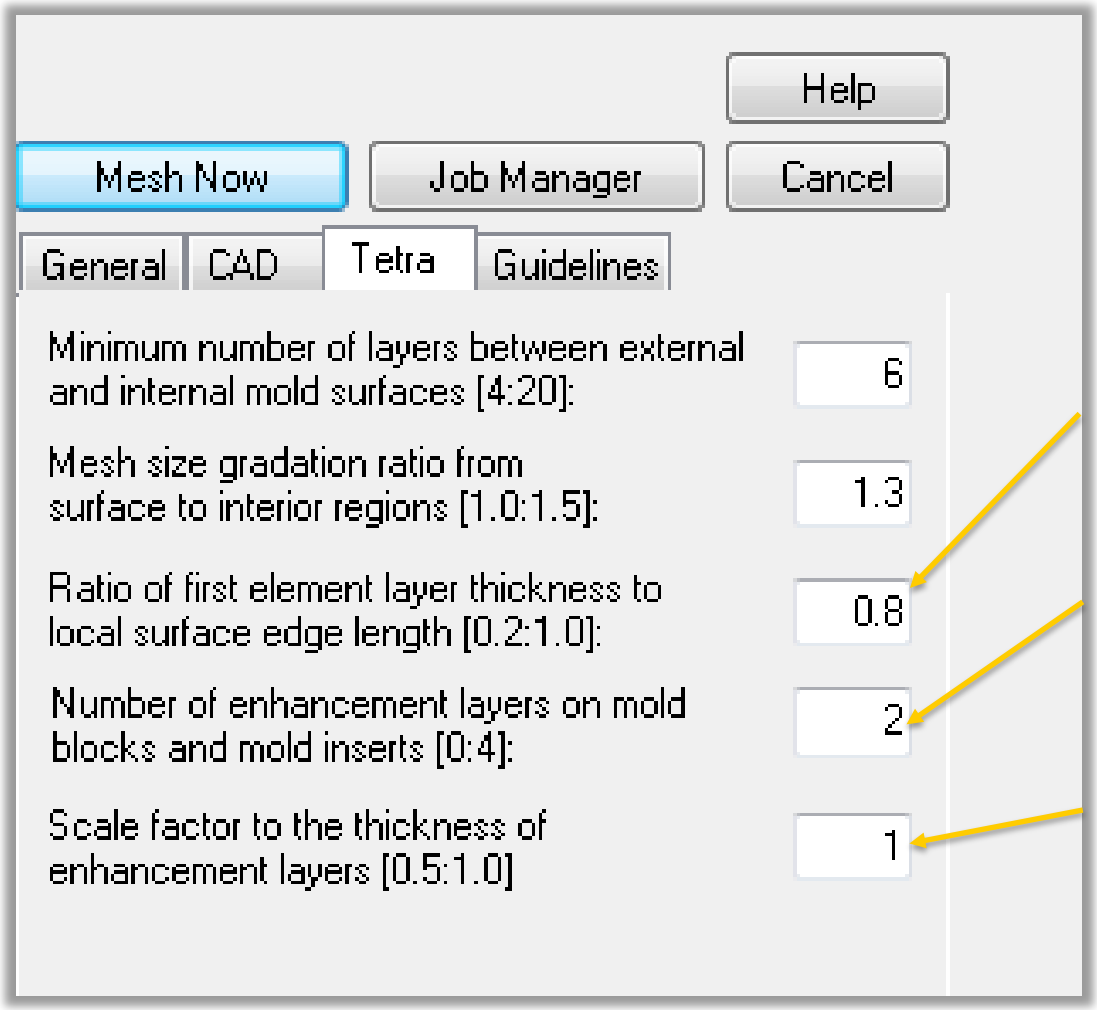
Mesh for induction heating

- 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



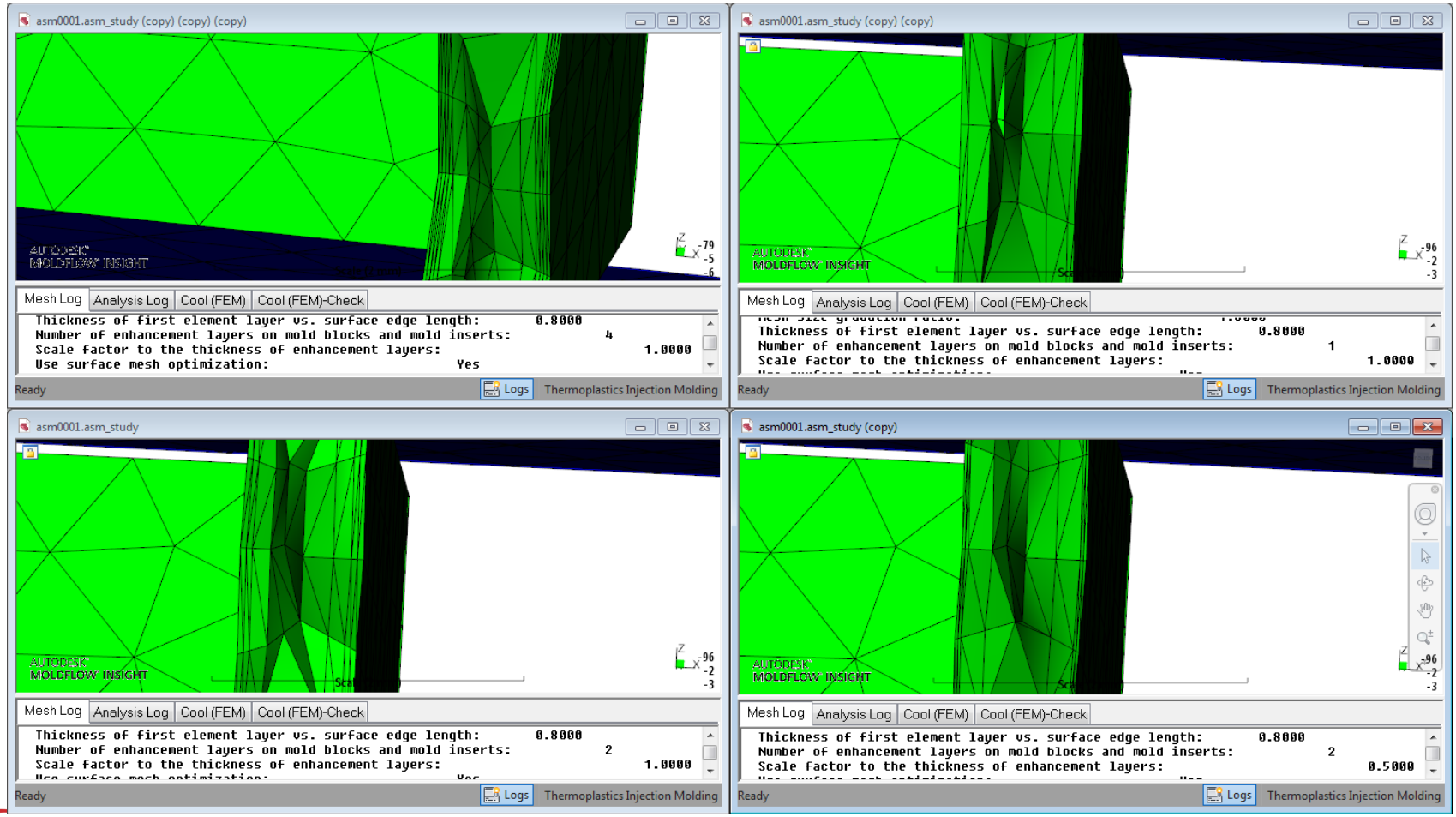
첫번째 Layer 두께 사이즈 결정

첫번째 Layer를 추가로 나누기

추가 Layer의 얇은 정도 설정

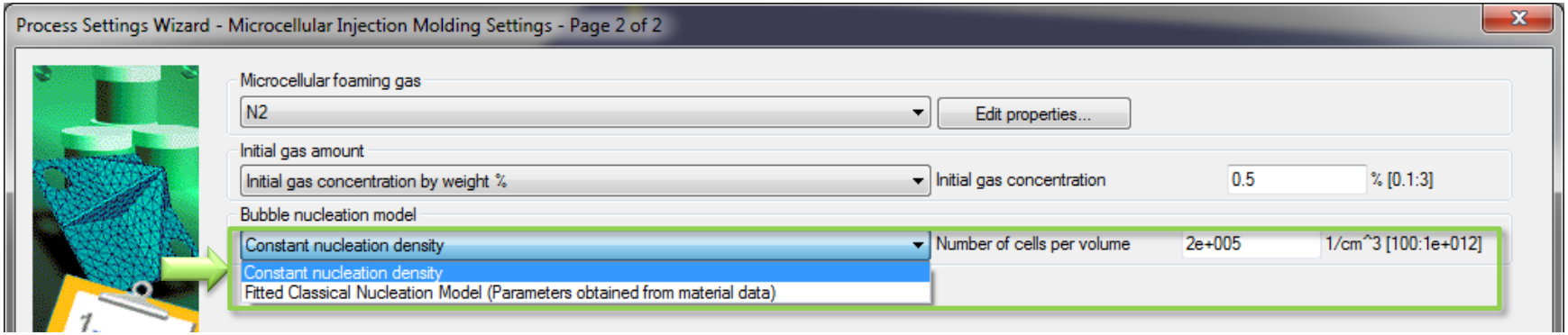
Induction - Meshing

- 목표 : Skin의 두께를 여러 Layer로 나누는 것



Microcellular injection molding

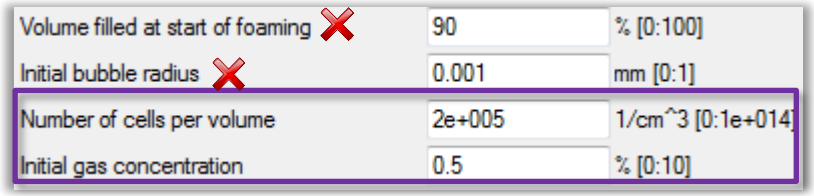
- Mucell이 (trexel technology의 상품명) Microcellular로 변경 됨
- 3D mesh도 가능
- mid/DD/3D에서 2종의 Bubble 결정핵 생성 모델이 가능
  - Constant nucleation density model
  - New Fitted Classical Nucleation model



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

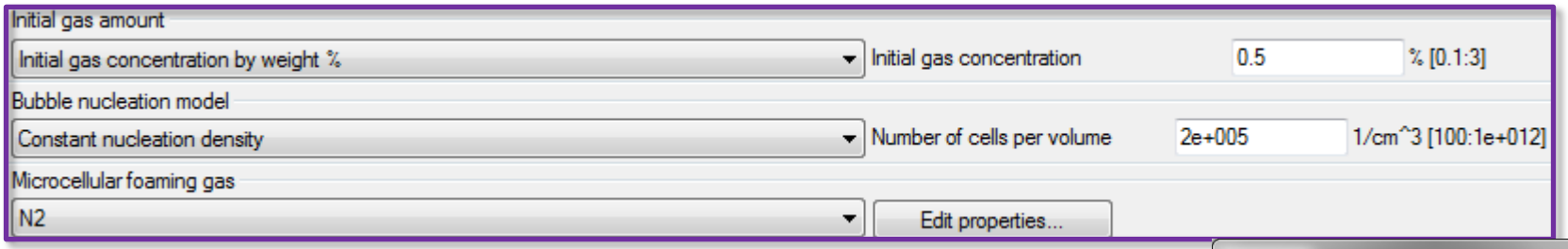
Microcellular Process Settings Page 2



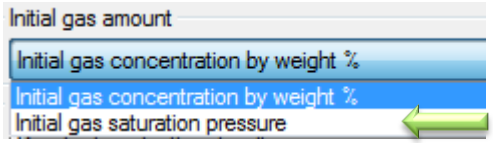
2015

Slightly different!

2016



- 초기 가스의 량 1

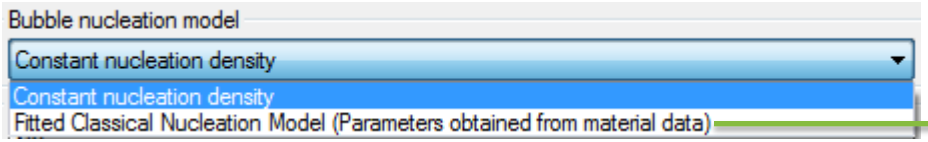


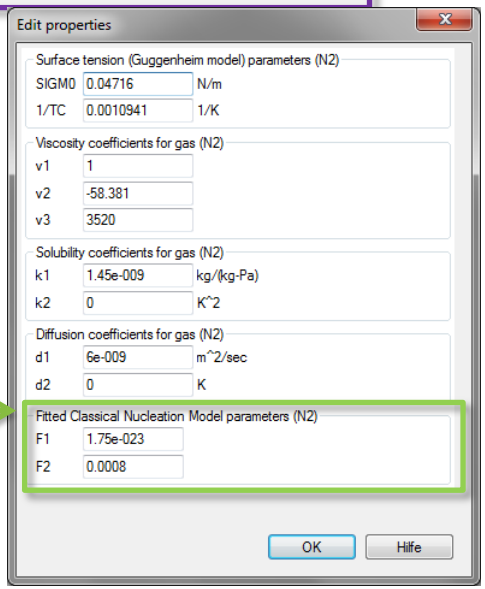
NEW

- 기포의 결정핵 생성모델 ⟵ NEW

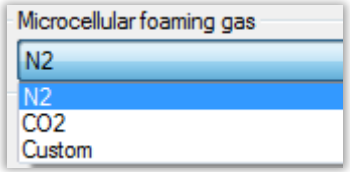
(see next slide)

2





- 발포 가스 3



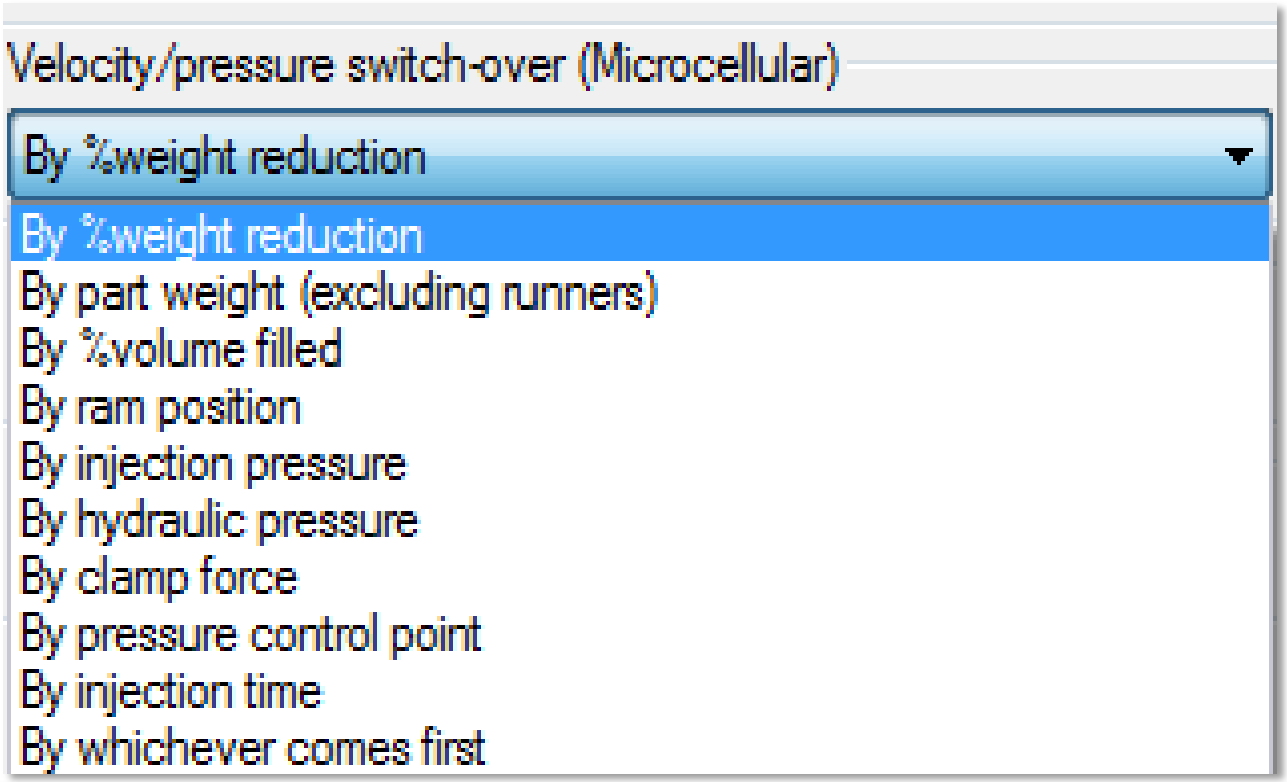
Properties needed

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

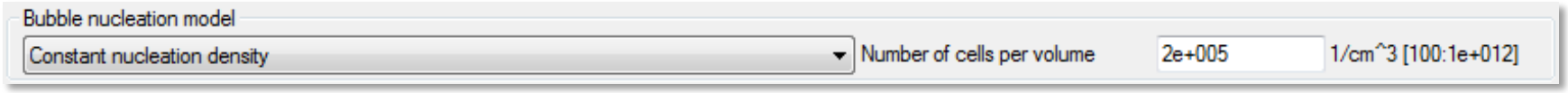
Microcellular Process Settings new options

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

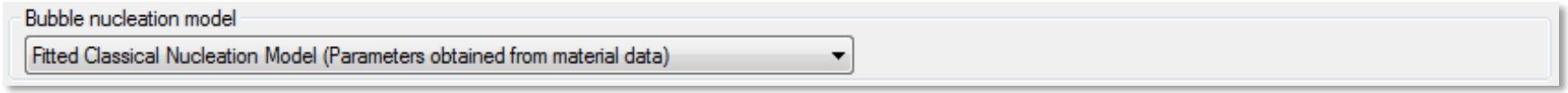


Microcellular Process Settings

- **Bubble number density**



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



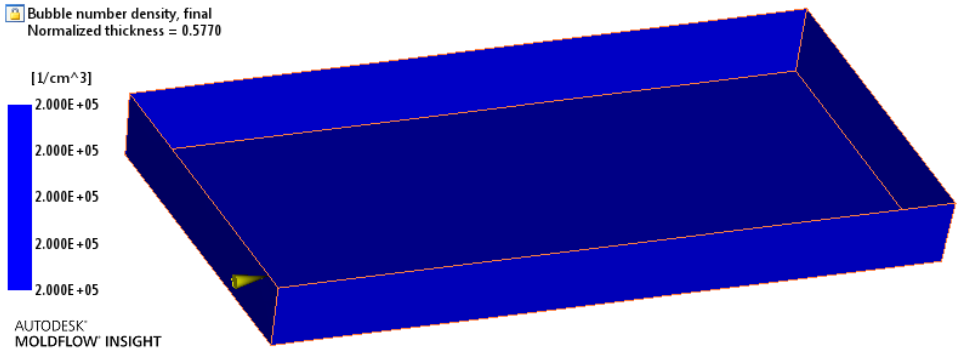
  - 기포의 수를 예측 함
  - 기포수의 밀도가 계산됨
  - 이 계산에 사용된 값은 Microcellular material data로 부터 얻어짐
  - 이 단계에서는 재료의 데이터를 얻기 힘듬

Microcellular Process Settings

- **Bubble number density**

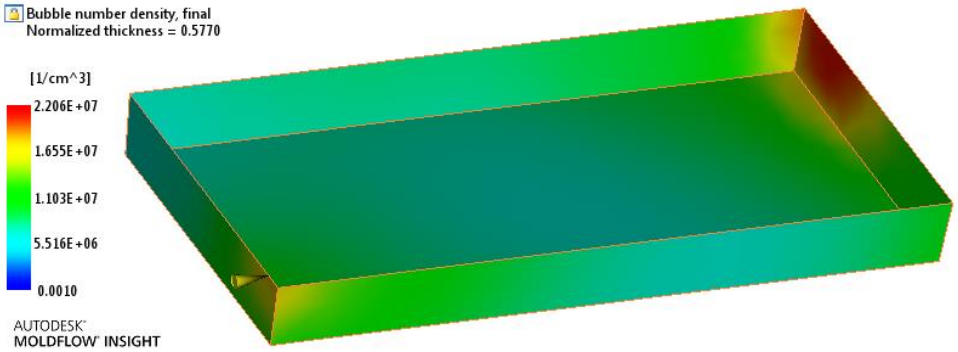
Bubble nucleation model

Constant nucleation density | Number of cells per volume | 2e+005 | 1/cm^3 [100:1e+012]



Bubble nucleation model

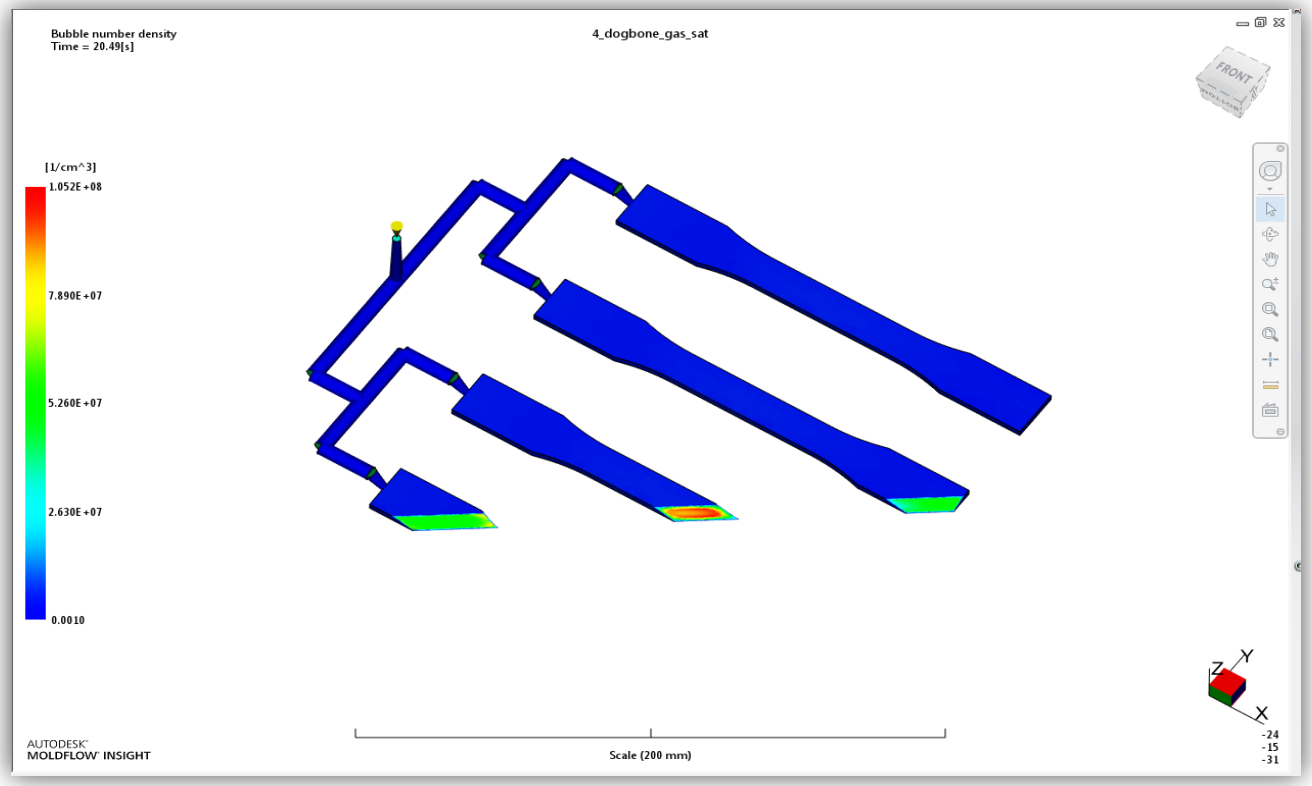
Fitted Classical Nucleation Model (Parameters obtained from material data)



Microcellular new results

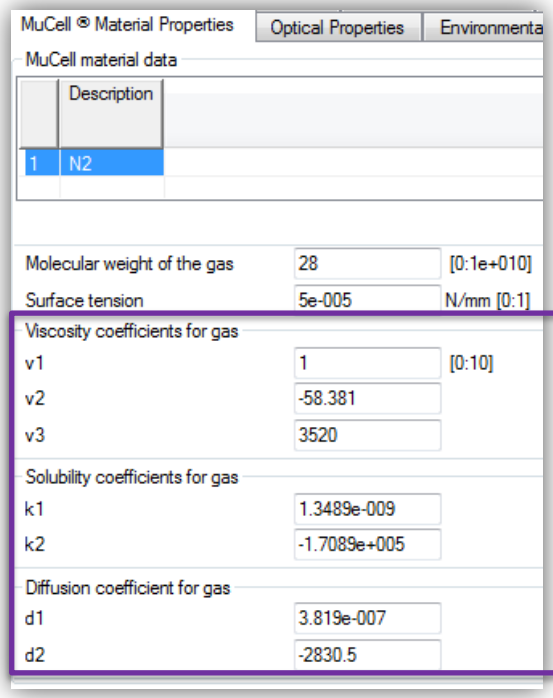
- Bubble number density
- Bubble number density, final

(Midplane과 Dual-Domain만 나옴)



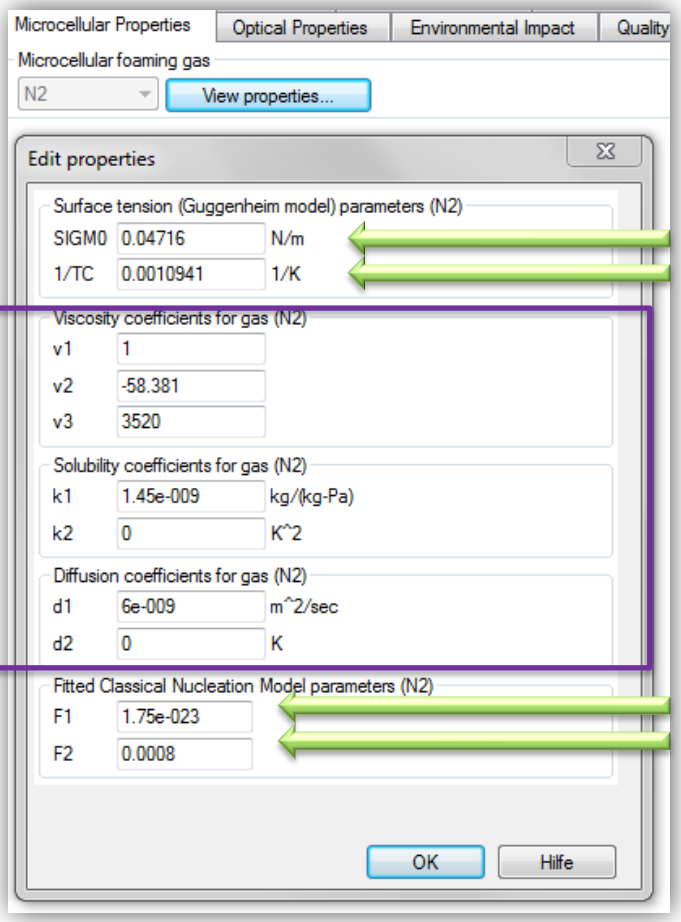
Microcellular foaming Gas properties

2015



Same settings

2016



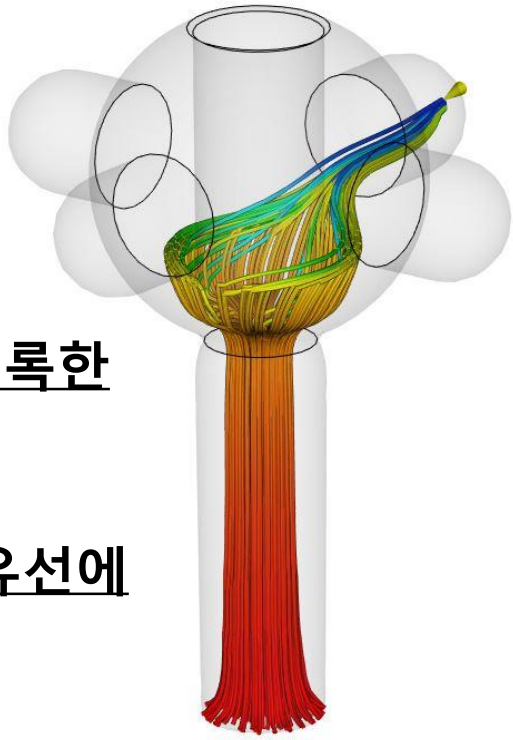
새로운 온도 의존적 모델에 대한 Data

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

σ 표면 장력
σ_0 각각의 재료 상수
T 온도
T_c 임계온도

새로운 핵 분열 모델에 대한 데이터

Pathlines: Description

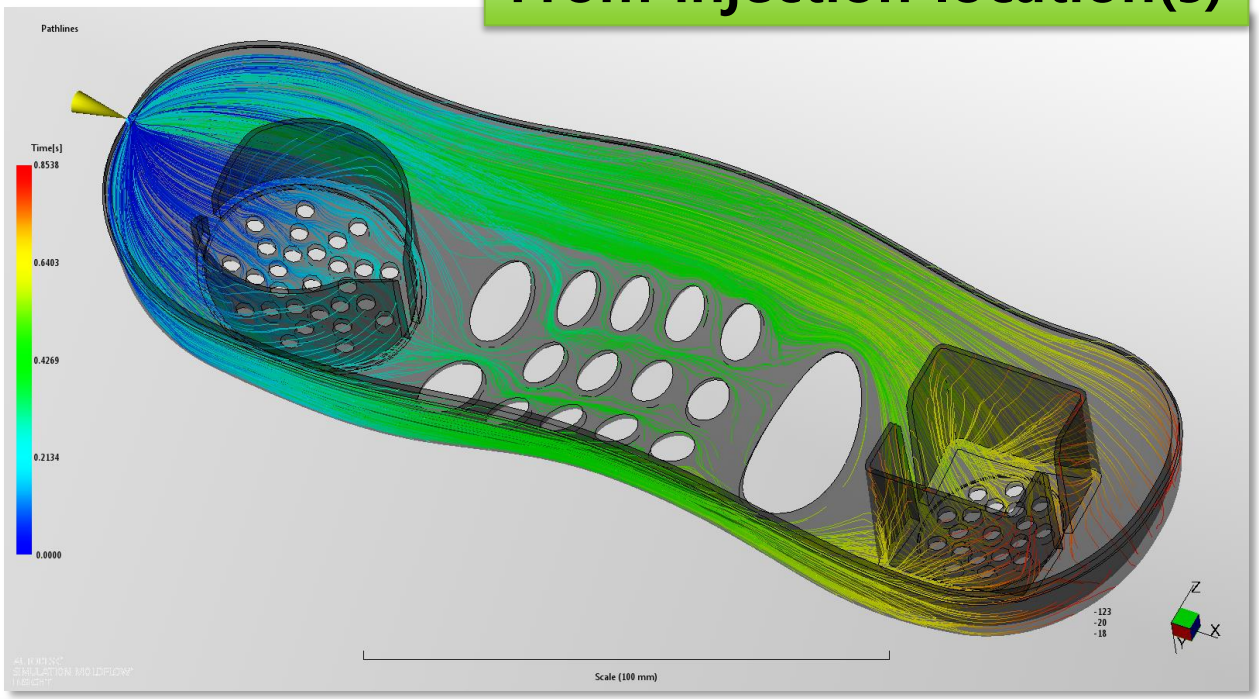


- Pathlines는 각각의 유동입자들의 궤도
  - 일정기간 동안의 흐름에서 유동입자의 통로를 기록한 것이라고 생각 하면 됨
  - 통로가 갈리는 방향은 각각의 시간에서 유동의 유선에 의해 결정
- Note: Pathlines은 Flow lines/Streamline과 다름 (Good definition on Wikipedia)
- 가끔 표면결함의 원인이 결함 위치로부터 멀리 떨어져 있을 수 있음

Pathlines plot

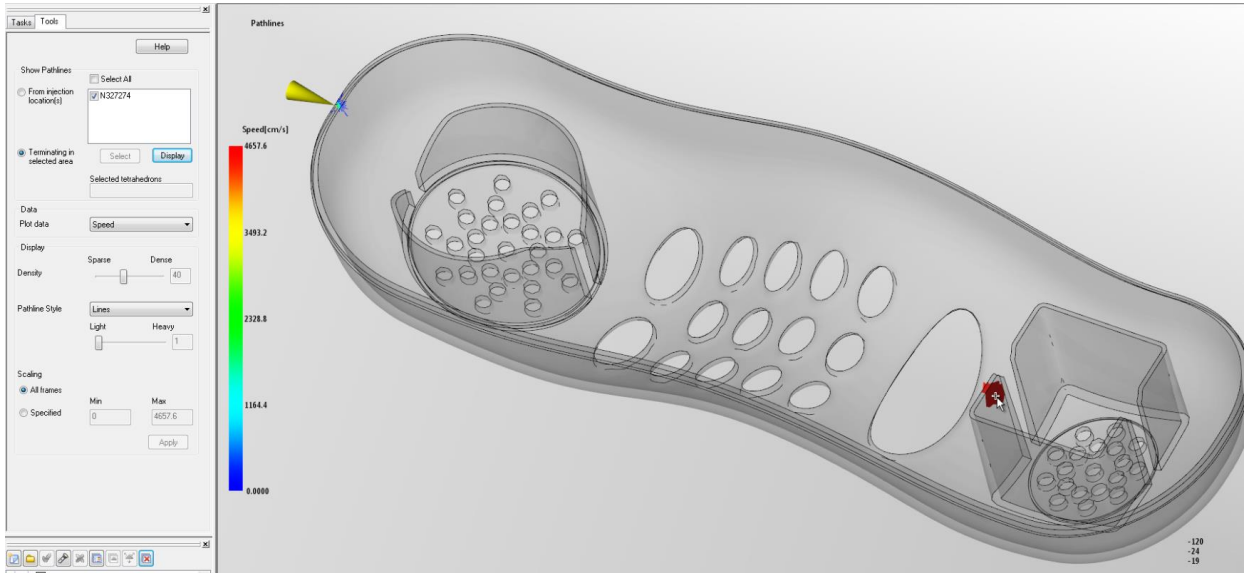
- 두가지 옵션:
  - Injection 위치에서 시작(s)
  - 선택한 영역까지
- 결과
  - Pressure
  - Temperature
  - Shear rate
  - Time
  - Speed

From injection location(s)

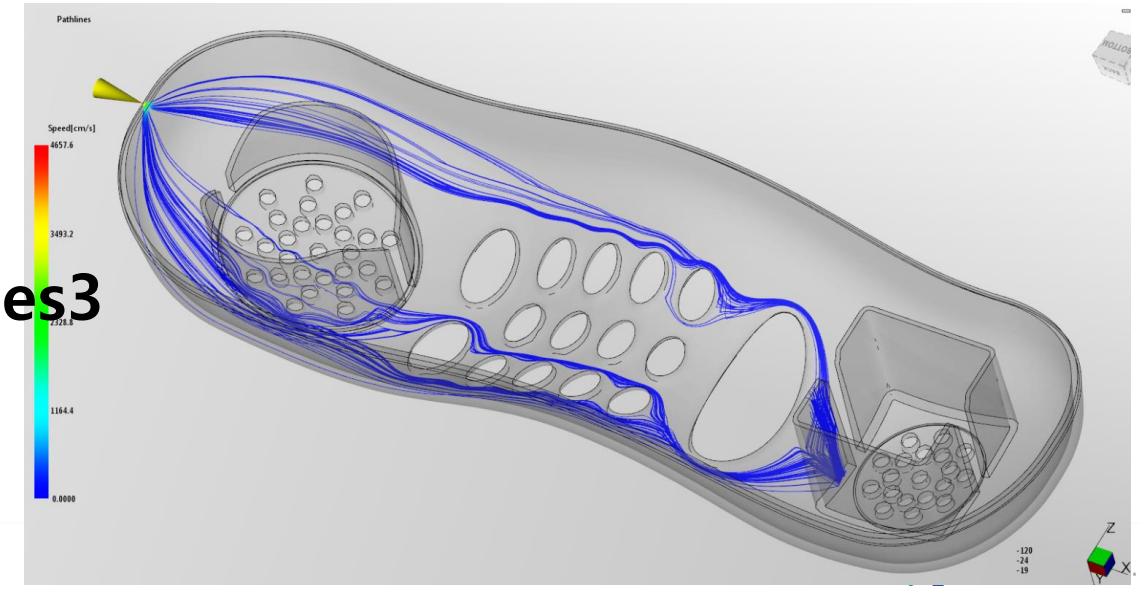


Pathlines plot

- 선택한 영역 까지

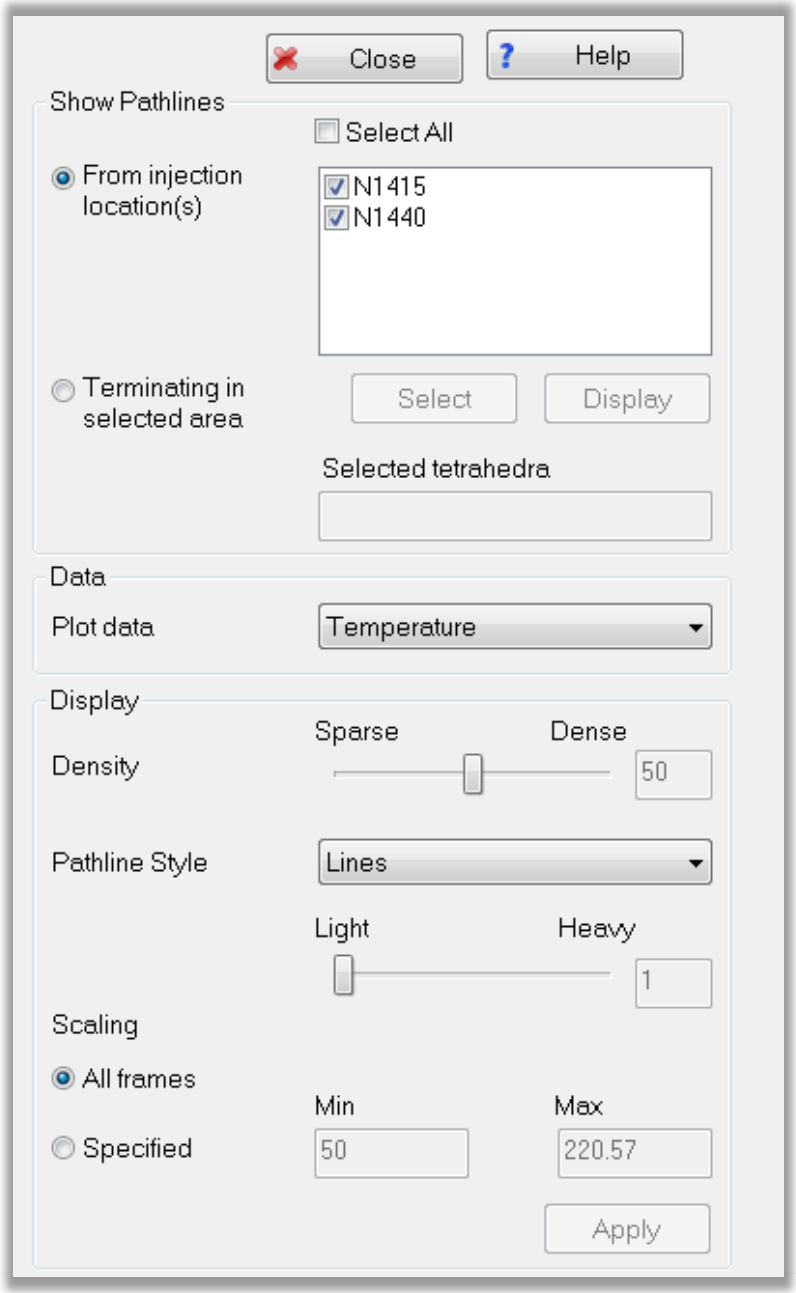


- 특정 위치에 도달한 유동입자들의 Pathlines3



Pathlines UI

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



The smaller improvements

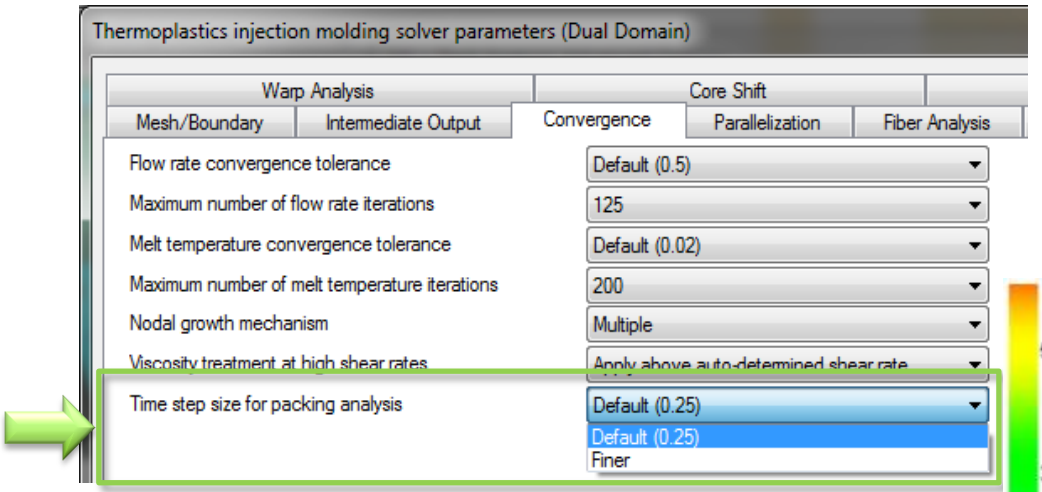
3D Automatic injection time

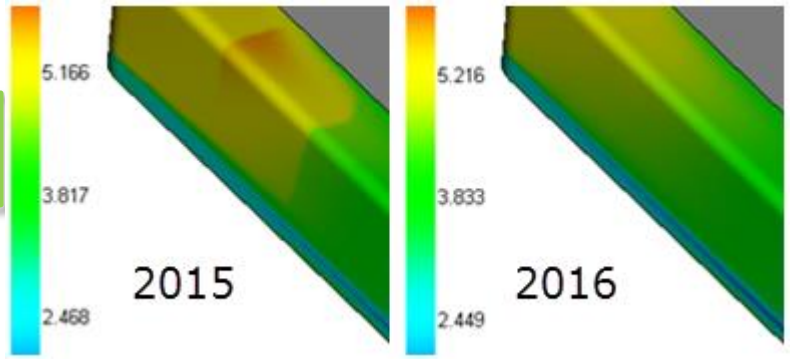
- 3D 해석을 위한 Automatic injection time의 계산이 개선됨

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

Packing Time Step Control

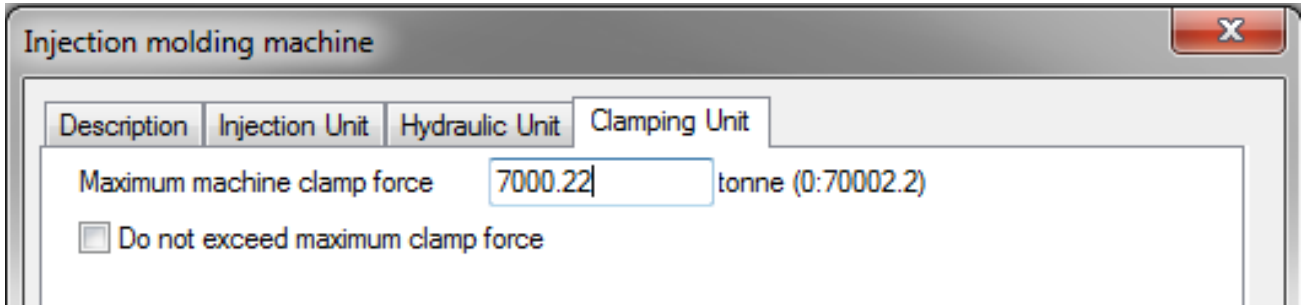
- **Midplane 과 DD 에서 Packing timestep size을 사용할 수 있음**
  - **Banded 결과로 나타남**

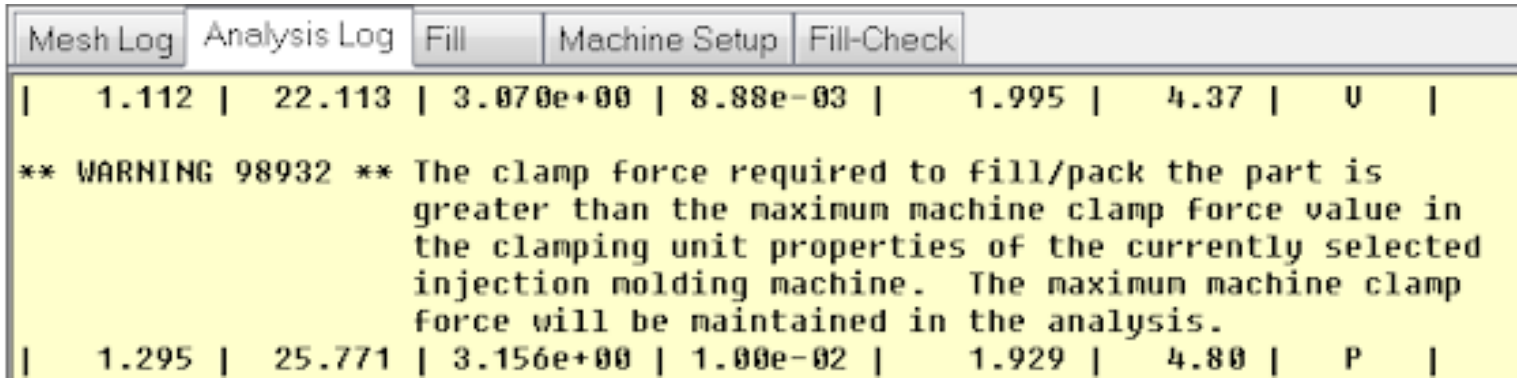




Do not exceed maximum clamp force implemented for 3D solver

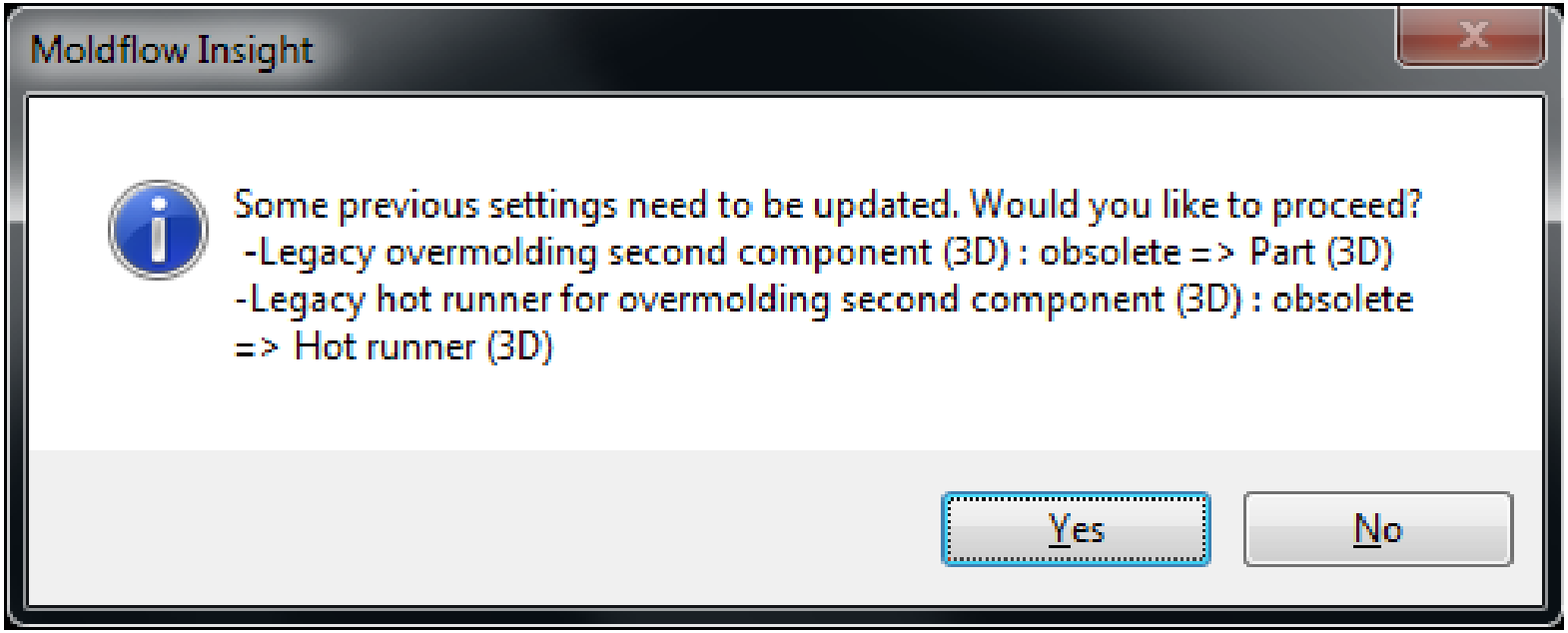
- "Do not exceed maximum clamp force" 기능을 3D에서도 사용 가능함
  - Midplane과 DD에서는 이미 존재 했음





3D overmolding

- **legacy overmolding elements 지원 안함**
  - **사용자는 2015버젼에서 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

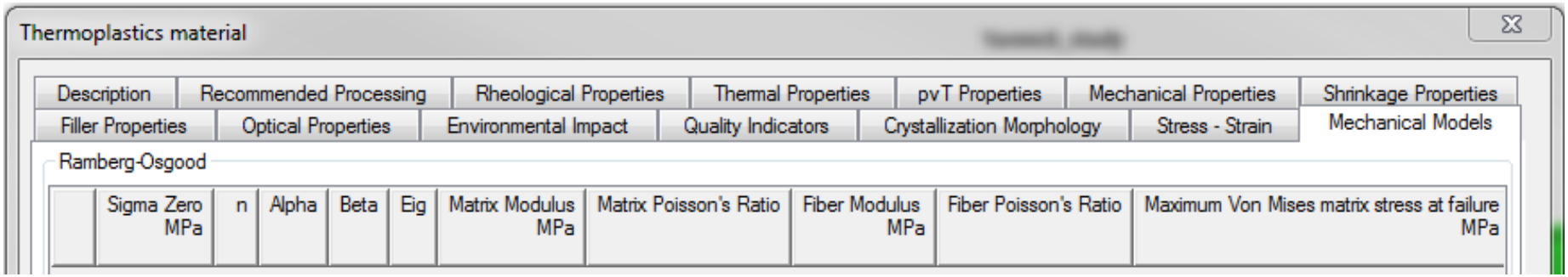
Reactive molding

Analysis sequence	Midplane	Dual Domain	3D
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

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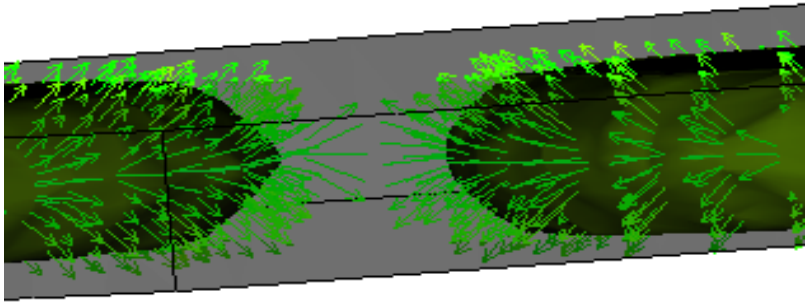
3D Weld Surfaces: Definition

- 다음 식으로 정의 됨

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



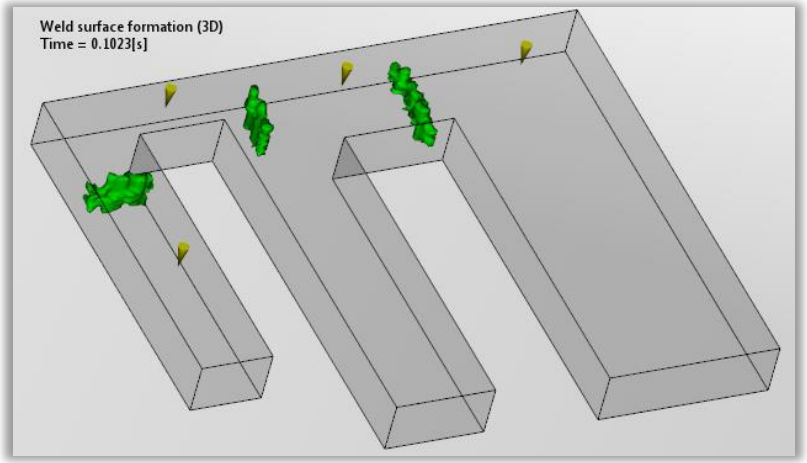
  - **Where**
    - ✓ S = distance to the flow front
    - ✓ T = time
    - ✓ $\vec{U}$ = Velocity Vector

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

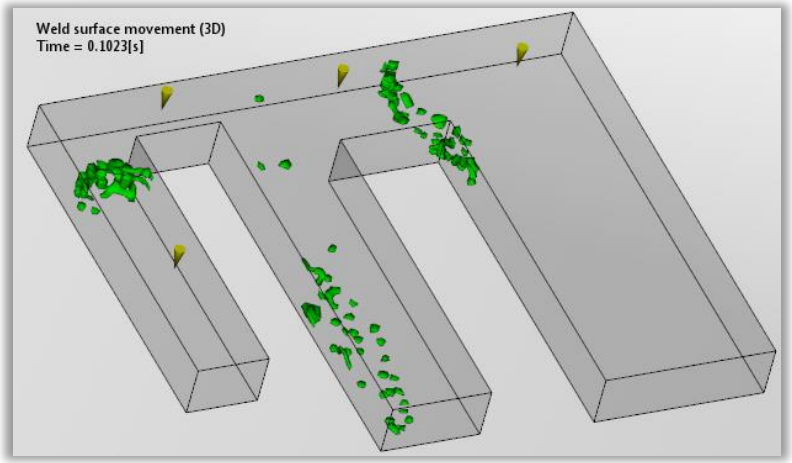
Weld surface 3D results

- 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)

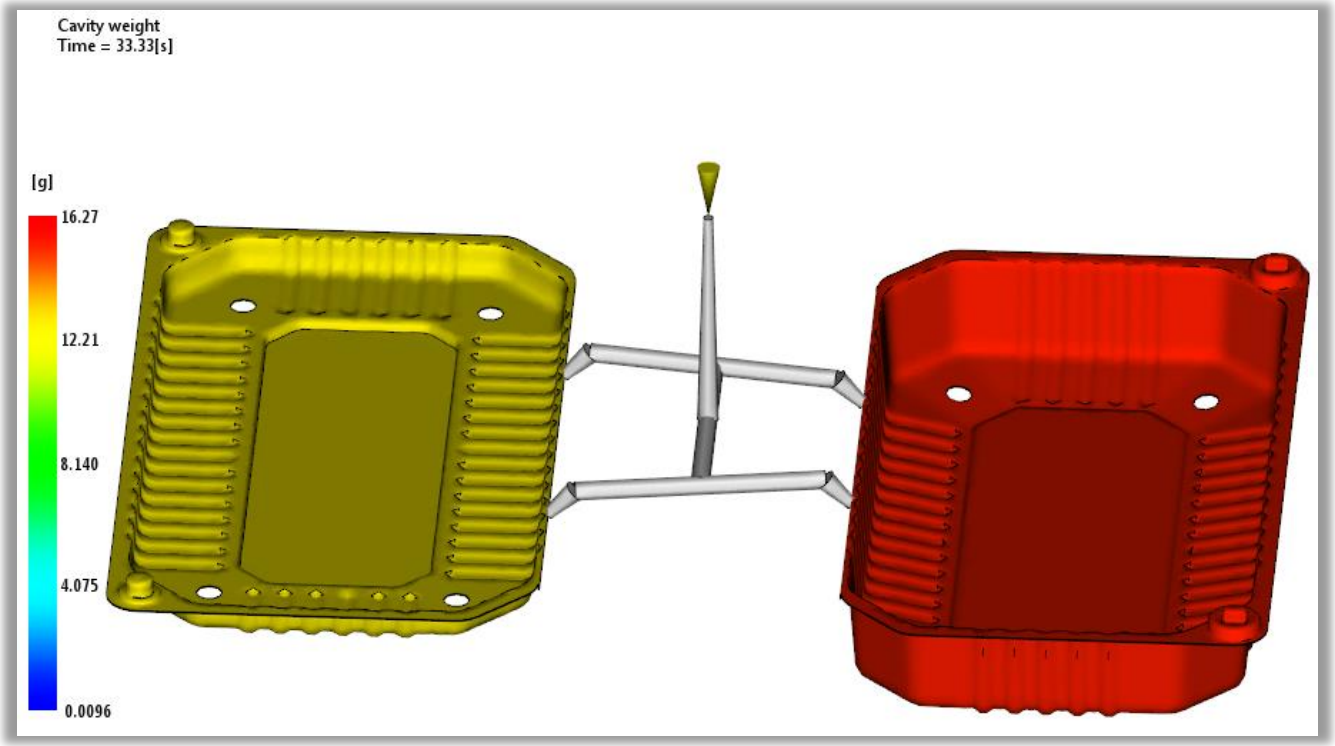


Weld surface movement (3D)



New cavity weight result

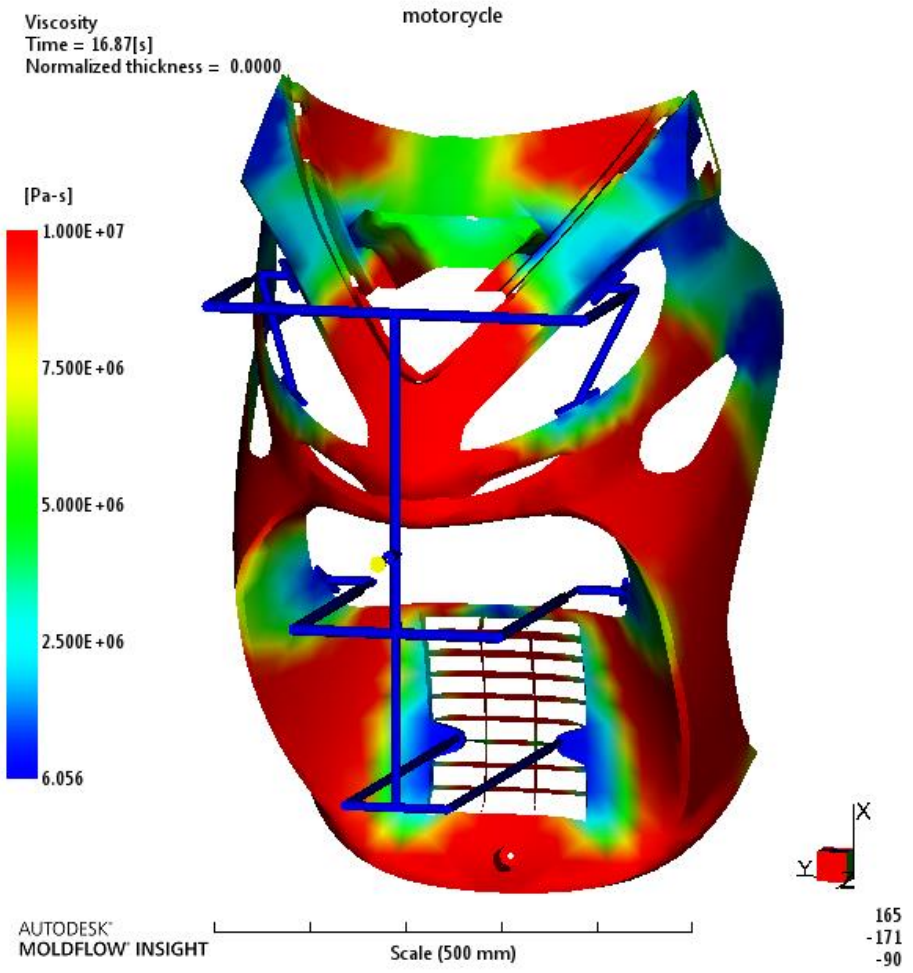
- Midplane, DD, 3D의 Cavity무게 확인 가능
- 시간에 따른 Animation 결과



Example: 각 개별 캐비티의 무게

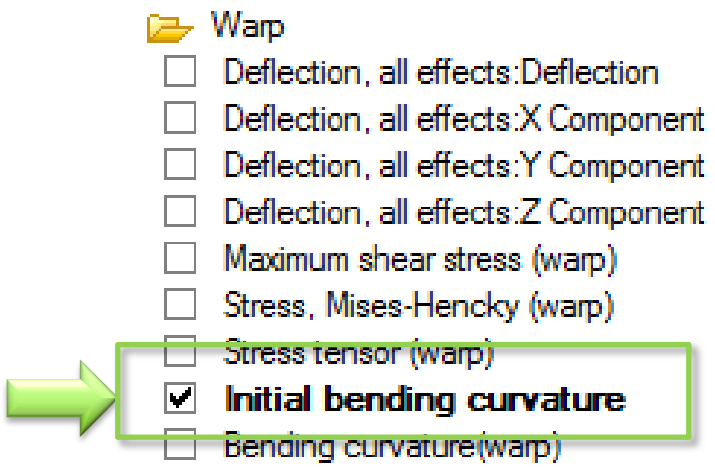
Viscosity result for all mesh types

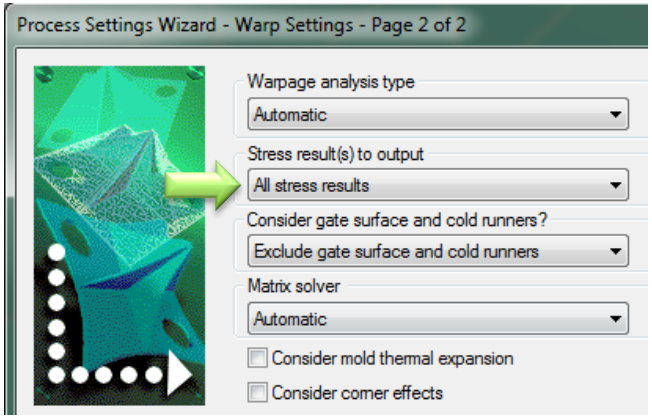
- 점도결과 추가 (Midplane and DD)
  - 3D는 이미 적용
  - 시간에 따른 Animation 결과
  - Layer 별 결과 확인



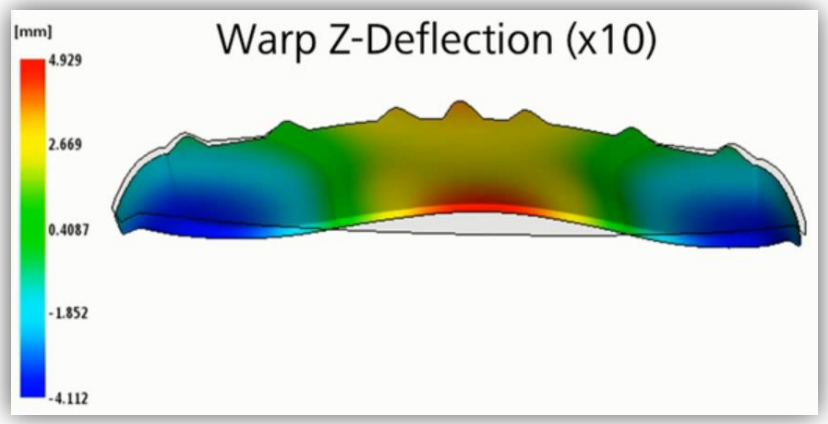
Initial bending moment

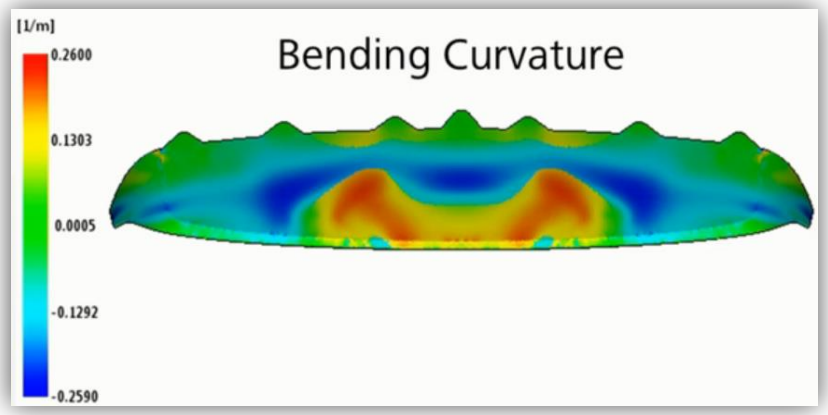
- 신규 결과: Initial bending moment (midplane; warp)





응력결과 선택 필요

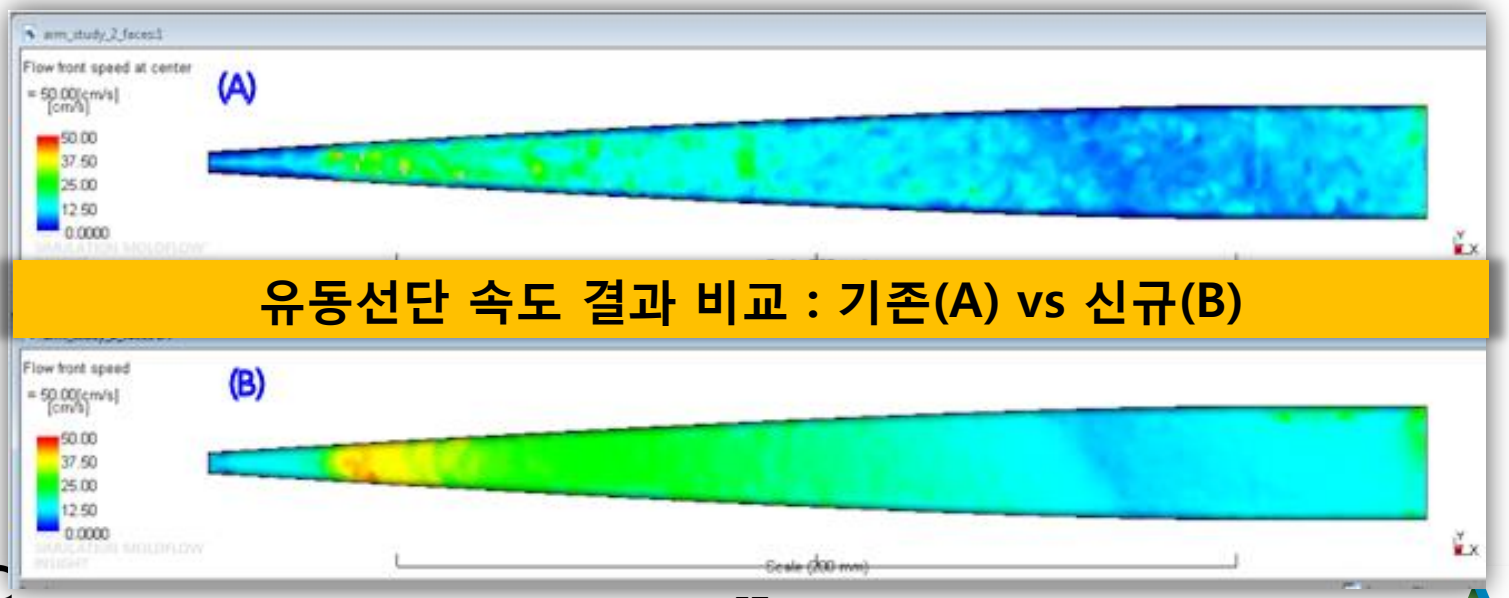




Model courtesy of HRS – Inglass S.p.A

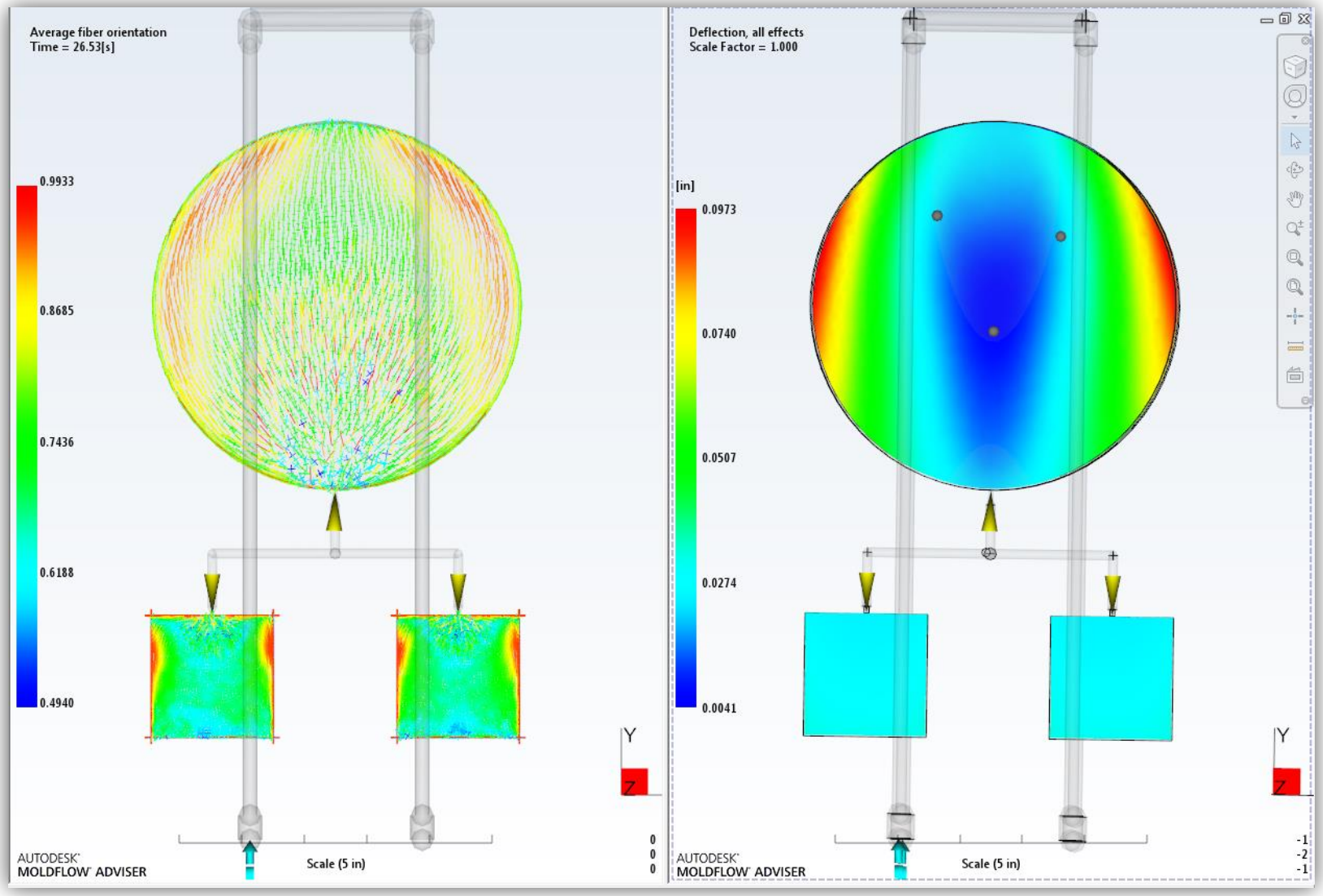
Flow front speed result

- 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

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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

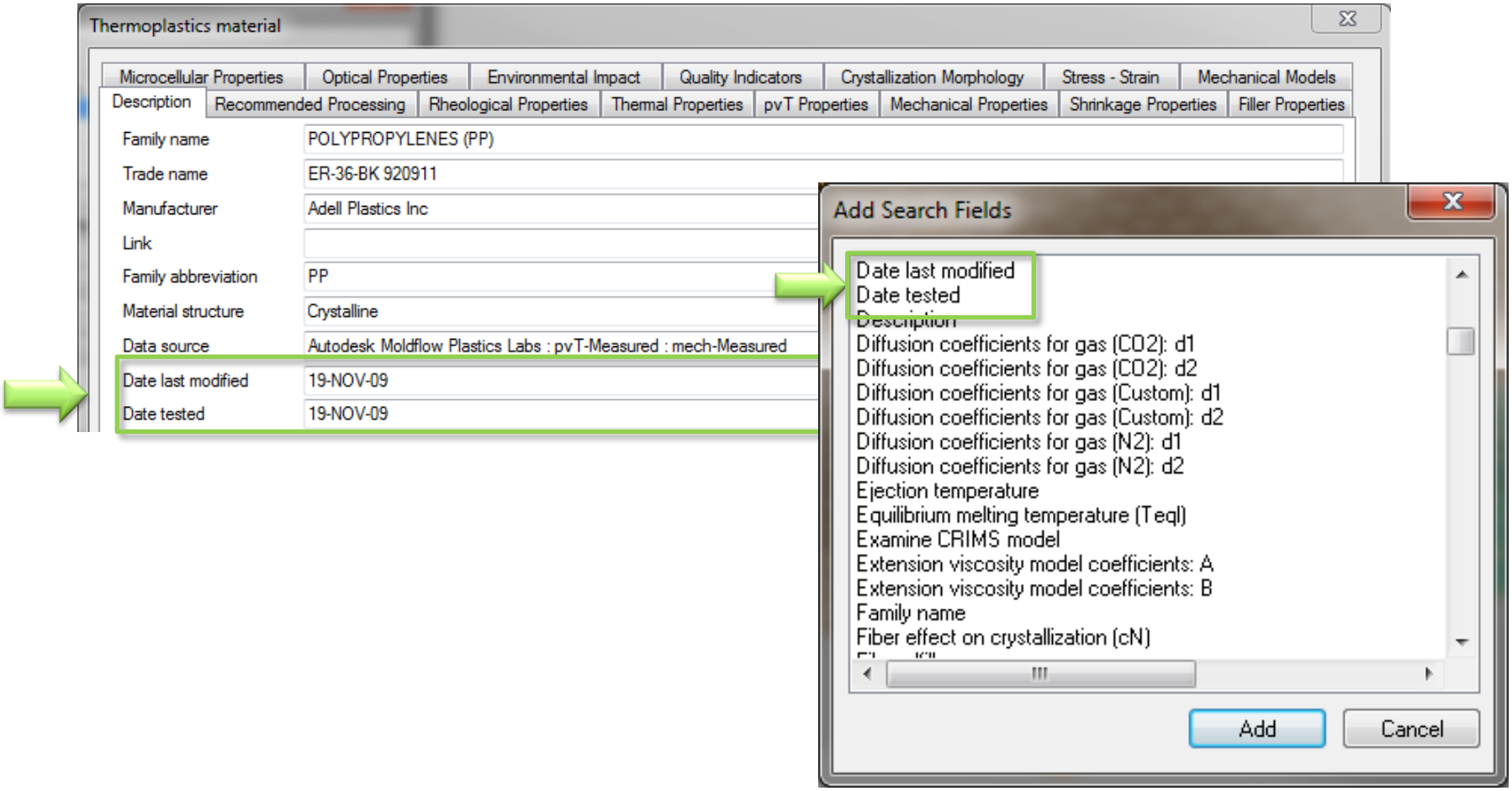
  Since the 2015 release

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

Supplier added to the database	Supplier deleted from the database
A Schulman Thermoplastic Compounds Sdn Bhd	The Matrixx Group
Autotech Polymers India Pvt Ltd	Styron APAC
Citadel Plastics	Styron EUR
Cool Polymers	Styron NA-LA
Initz	BASF
Lotte Chemical	BASF Customer Specific Grades
Nanjing Julong Science & Technology Co Ltd	Celanese (Europe Revised)
Nilit Plastics Europe GmbH	Celanese (Europe)
Samsung SDI Co Ltd	DuPont Fluoropolymers
Teijin Chemicals	DuPont Kabushiki Kaisha
Tosaf Compounds Ltd	Solvay Engineering Plastics
VI Compounding	
BASF Engineering Plastics	
Trinseo APAC	
Trinseo EUR	
Trinseo NA-LA	

Search fields

- 수정 또는 테스트 진행 날짜 기준 검색 가능



Expiry date for Material quality indicator

- 품질 인디케이터가 만료되는 시점