Molding products with Cooling pipe

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contents

- Subject
- Methodology
- Study Result

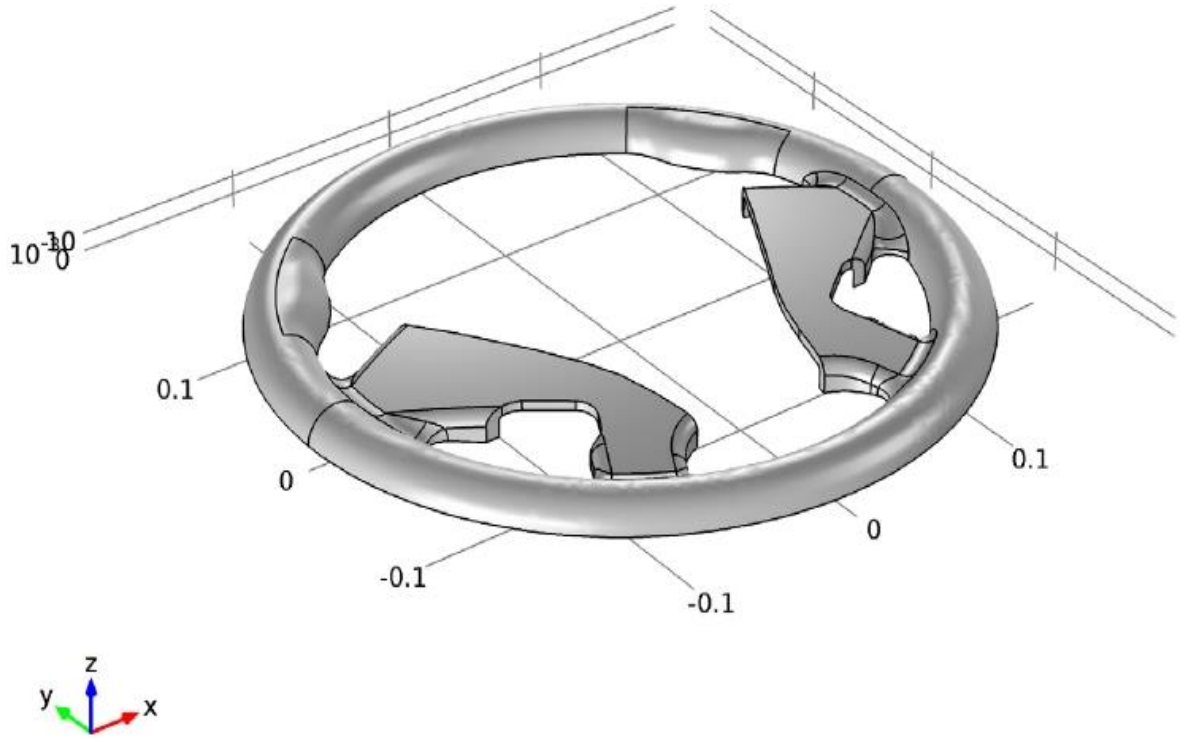
Subject (motive)

MOLD COOLING
simulation

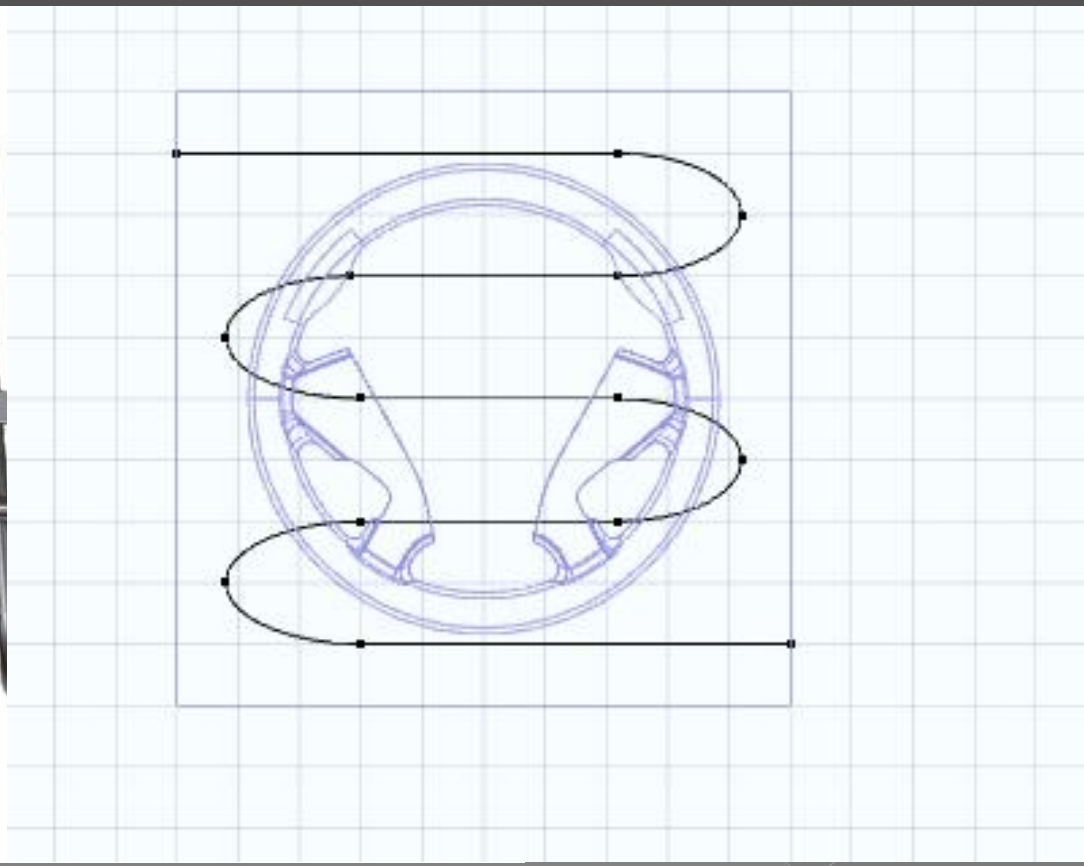
- 냉각은 in 인어서 매
- 3차원 래 결리기 때 서 시뮬레이션 하도록 하였

Subject (간략화)

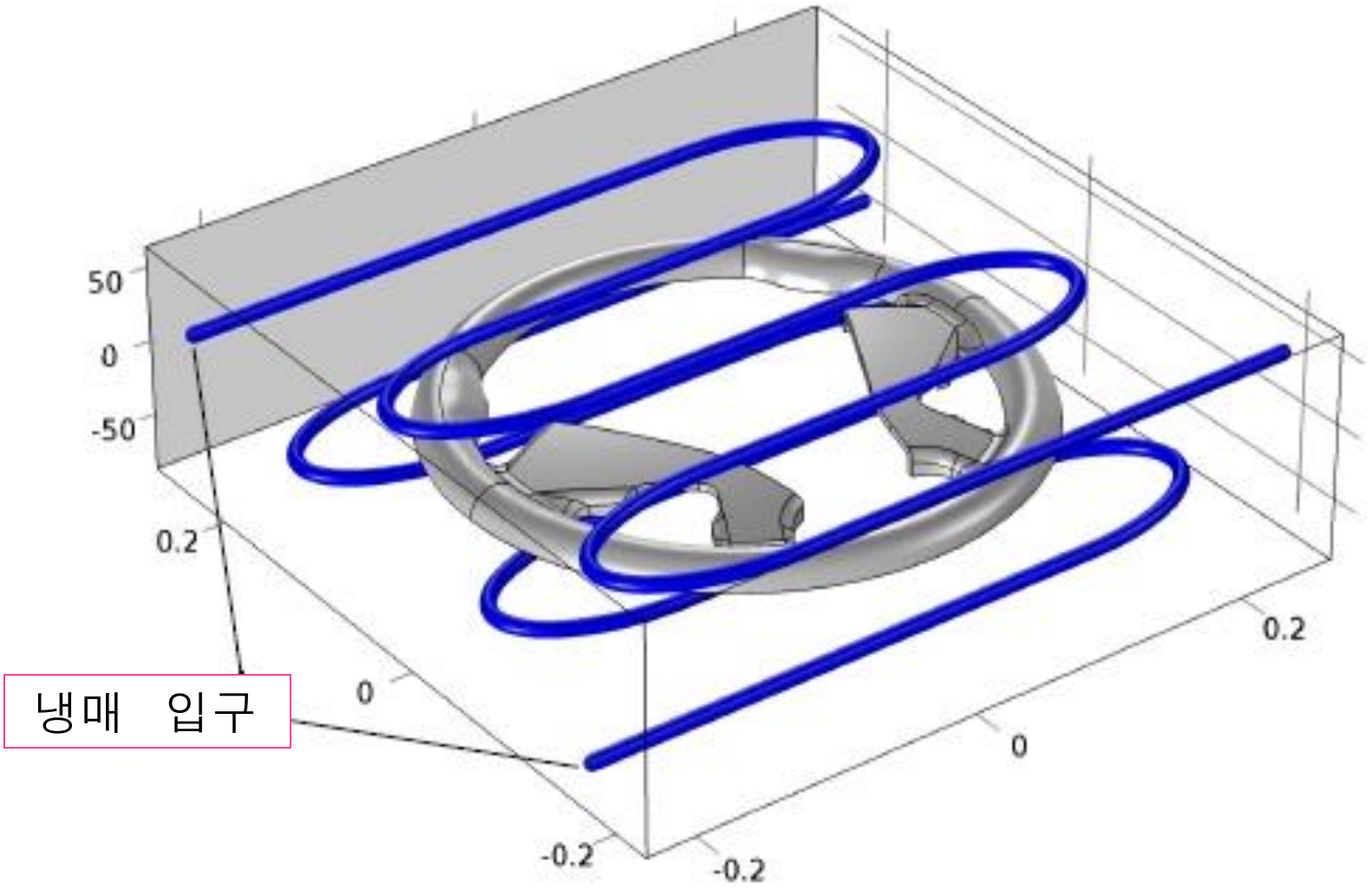
핸들 상반부분의 그립 분석



Subject (간략화)



Subject (간략화)



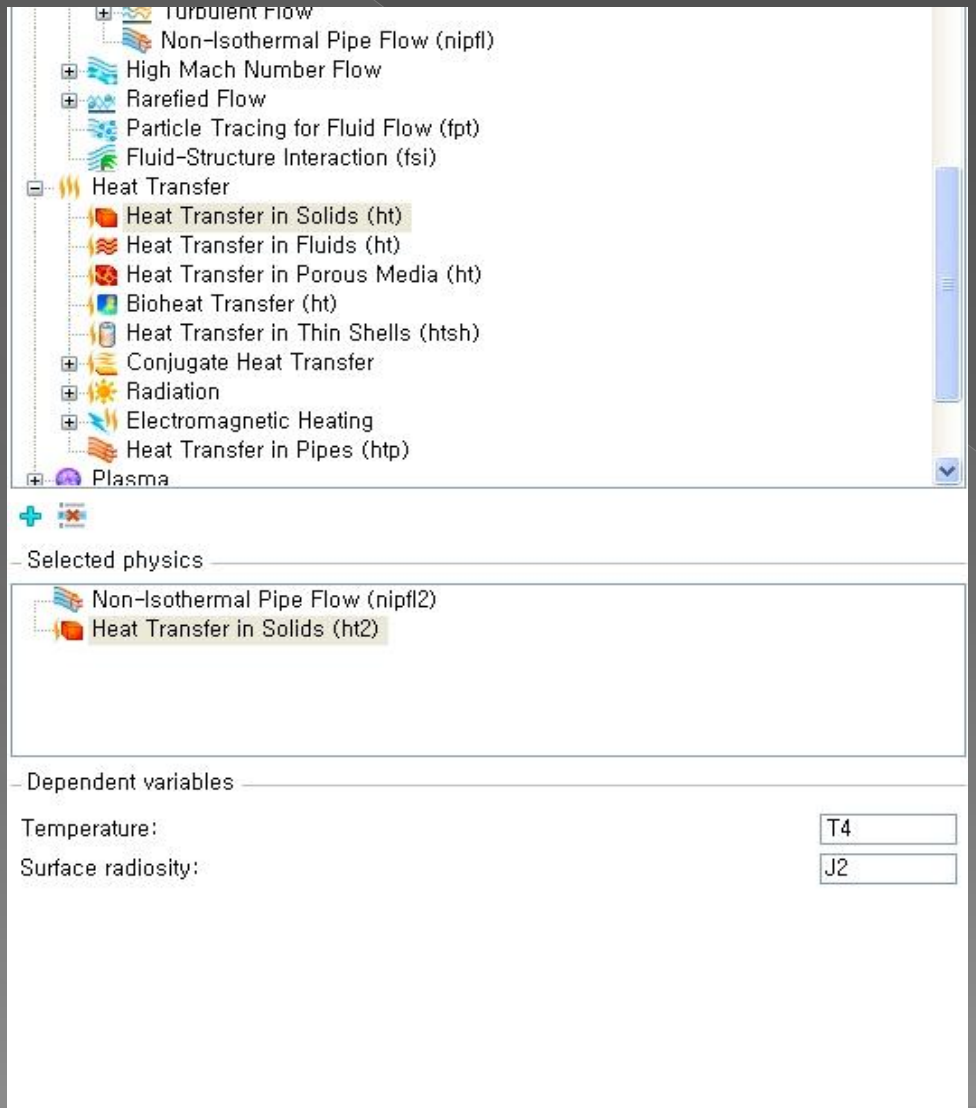
Methodology

<Pipe & Mold 부여조건>

- Heat Transfer in Pipes
- 냉매의 이동
- Wall heat transfer
- Non- isothermal Pipe Flow

- Heat outflow
- Material
- Model geometry

Model Set up


Turbulent Flow
Non-Isothermal Pipe Flow (nipfl)
High Mach Number Flow
Rarefied Flow
Particle Tracing for Fluid Flow (fpt)
Fluid-Structure Interaction (fsi)
Heat Transfer
Heat Transfer in Solids (ht)
Heat Transfer in Fluids (ht)
Heat Transfer in Porous Media (ht)
Bioheat Transfer (ht)
Heat Transfer in Thin Shells (htsh)
Conjugate Heat Transfer
Radiation
Electromagnetic Heating
Heat Transfer in Pipes (htp)
Plasma
Selected physics
Non-Isothermal Pipe Flow (nipfl2)
Heat Transfer in Solids (ht2)
Dependent variables
Temperature:
T4
Surface radiosity:
J2


Stationary
Time Dependent
Custom Studies

Parameter, variable 지정

Parameters

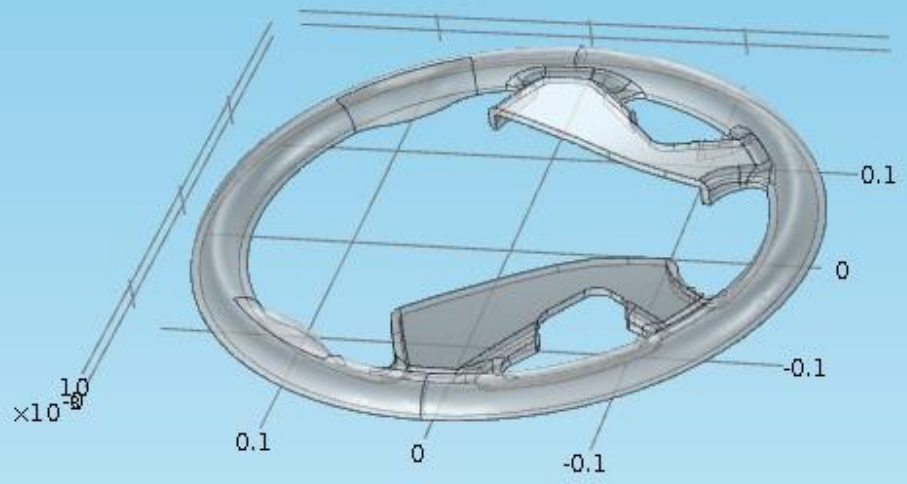
Name	Expression	Value	Description
T_init_mold	473.15[K]	473.15 K	Initial temperature, mold
T_coolant	288.15[K]	288.15 K	Steady-state inlet tem...

Variables

Name	Expression	Unit	Description
T_inlet	T_coolant+(T_init_mold-T_coolant)...	K	Ramped inlet tempera...

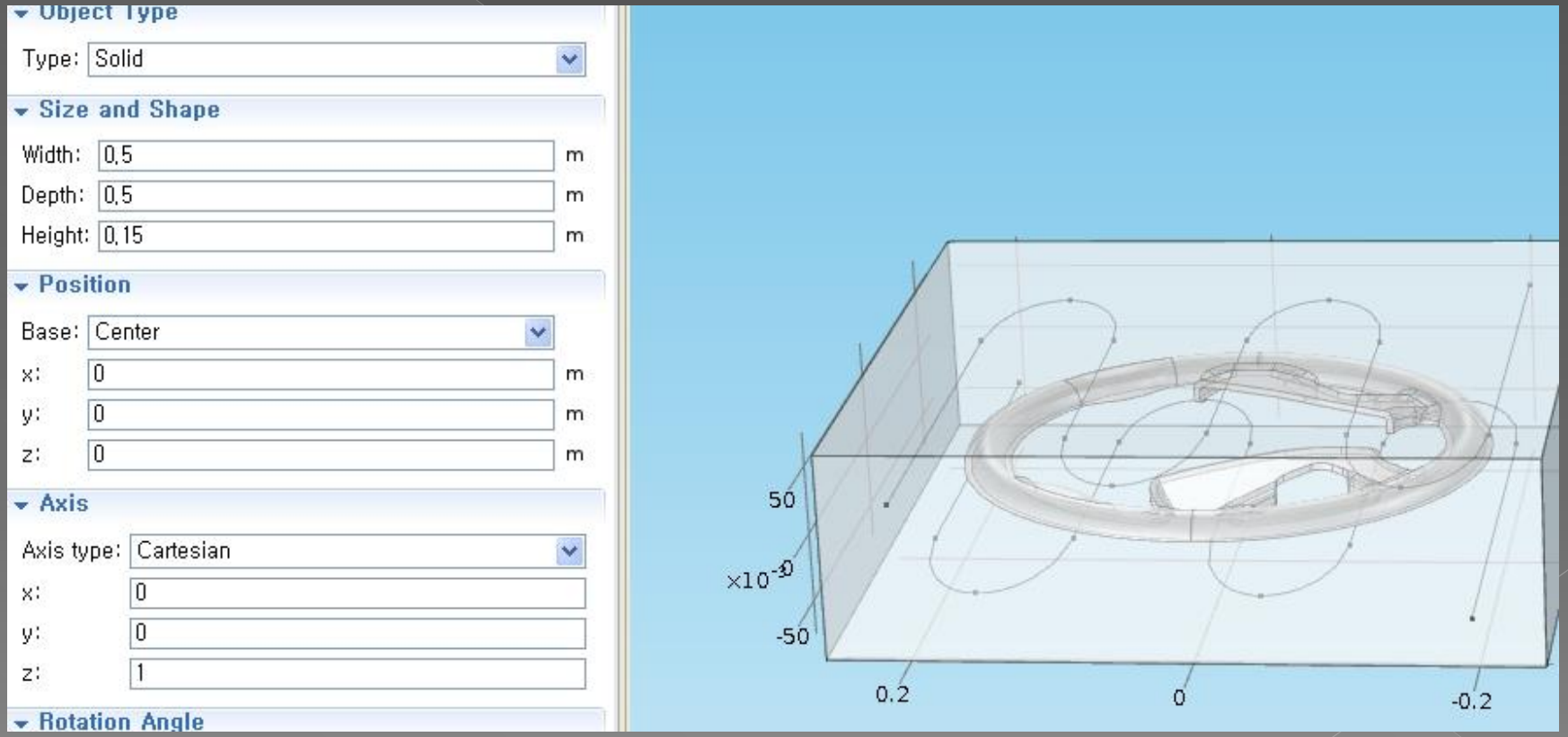
CAD파일 불러오기

CAD에서 작성후 Comsol에서 축척 맞춘 후 mphbin 파일로 저장했음

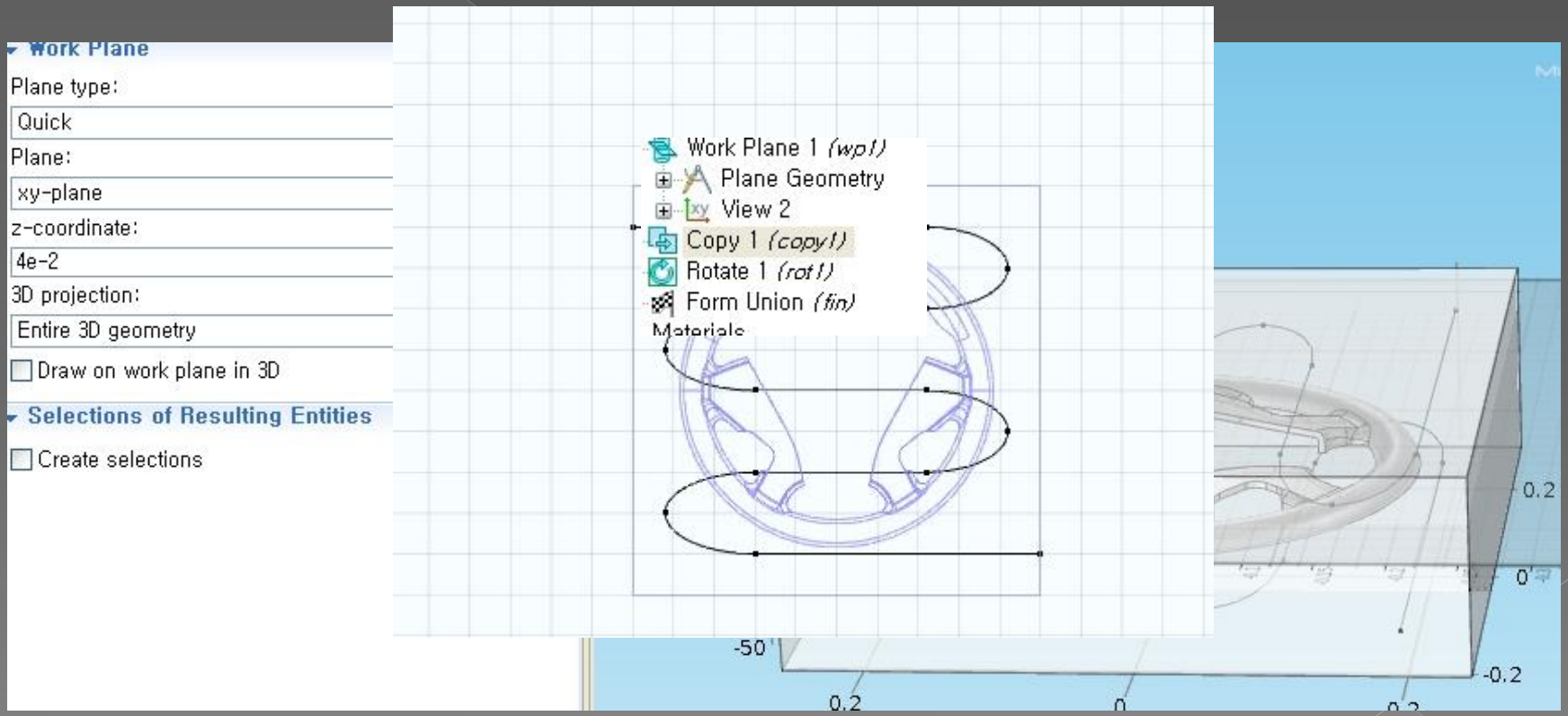


Dialog Box 생성

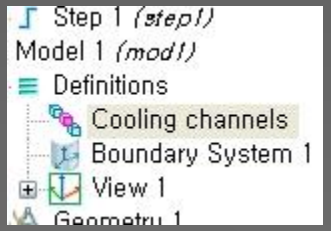
(사용자로부터 인터페이스에서 입력을 받아들이기 위해 표시되는 임의의 장치)

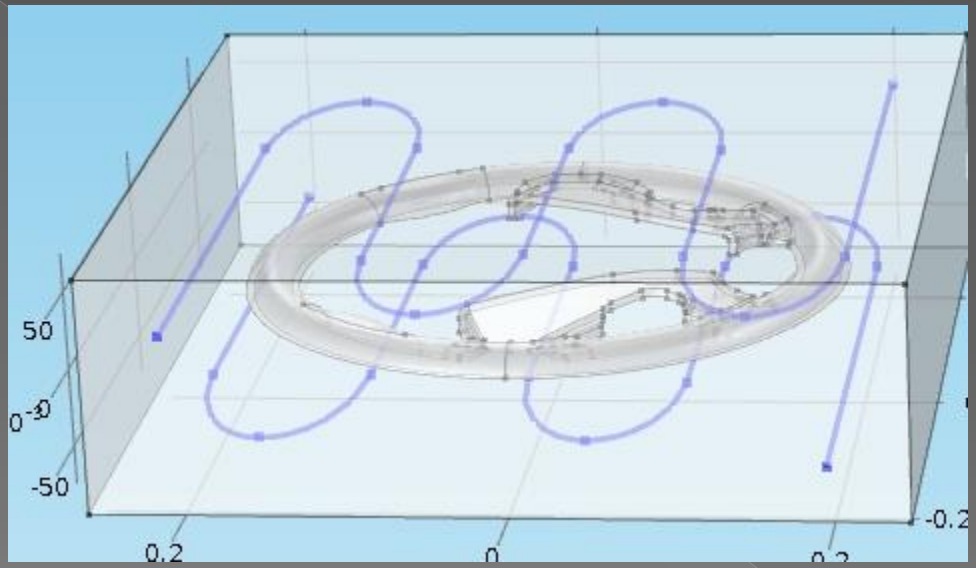


Work plane에서 cooling pipe 작성

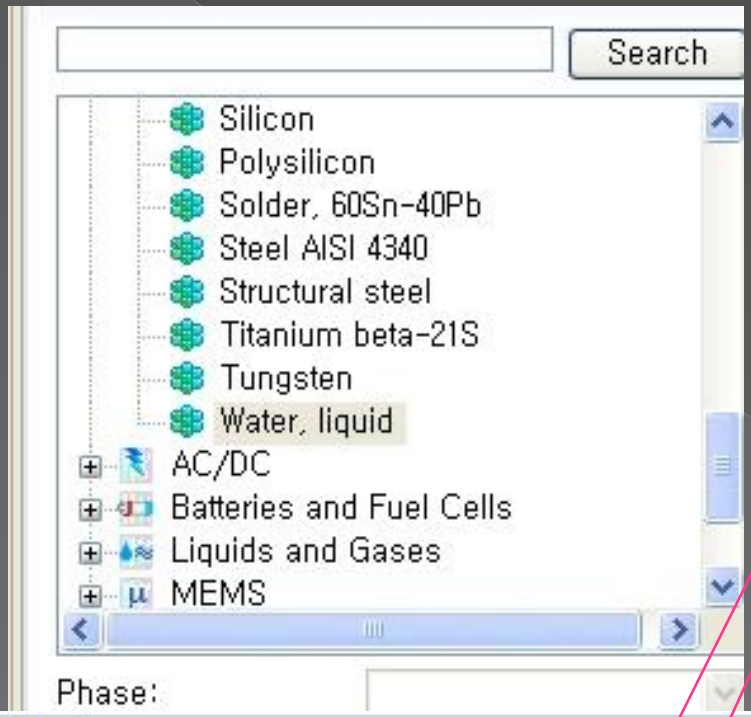


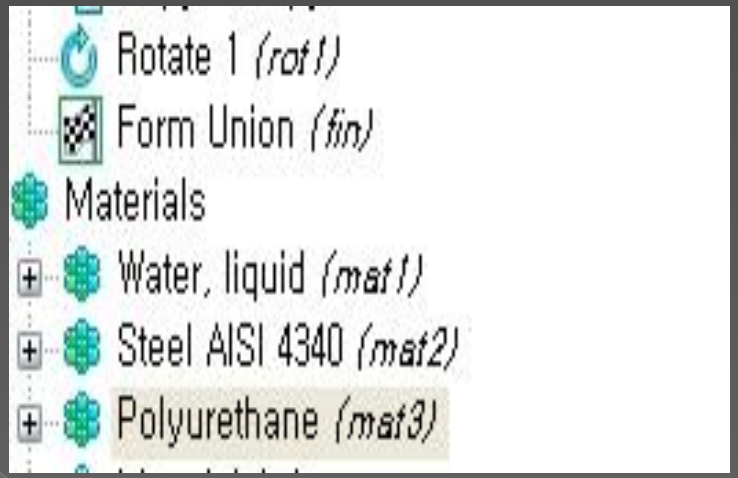
Definition에 cooling pipe 추가





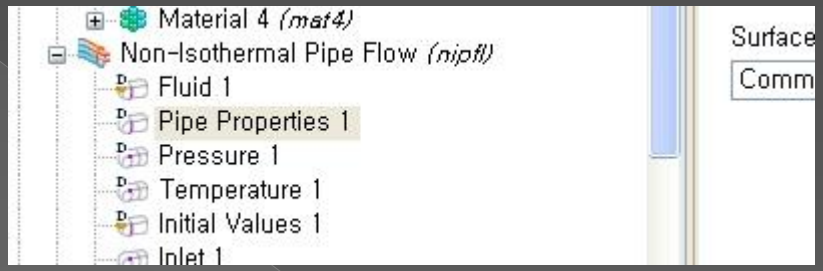
Material 설정



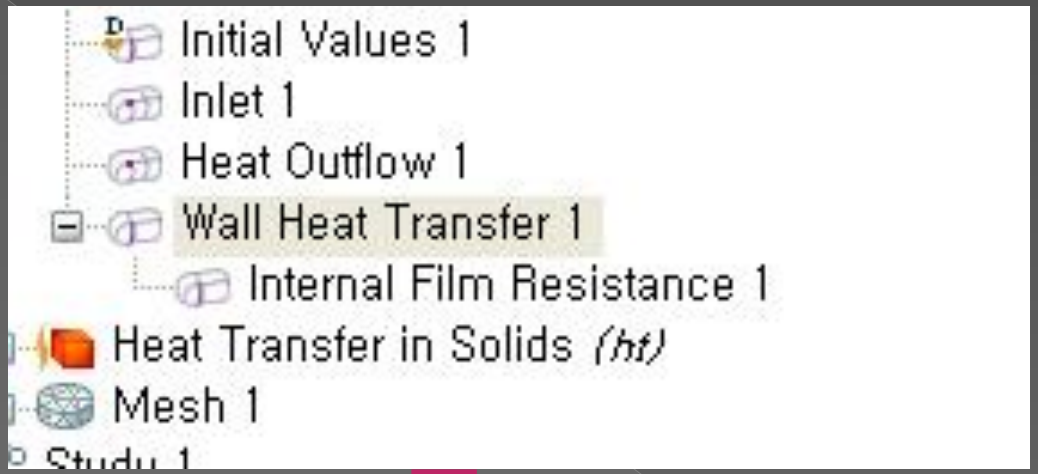


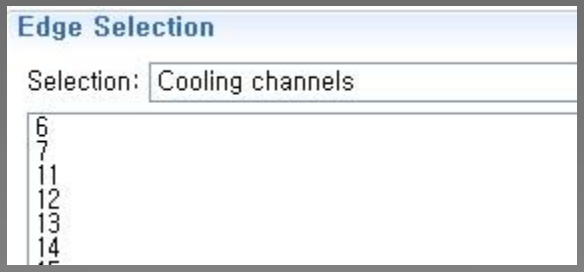
Property	Name	Value	Unit
Thermal conductivity	k	0.32	W/(...
Density	rho	1250	kg/...
Heat capacity at constant ...	Cp	1540	J/(k...

Cooling pipe 의 특성 직접 작성

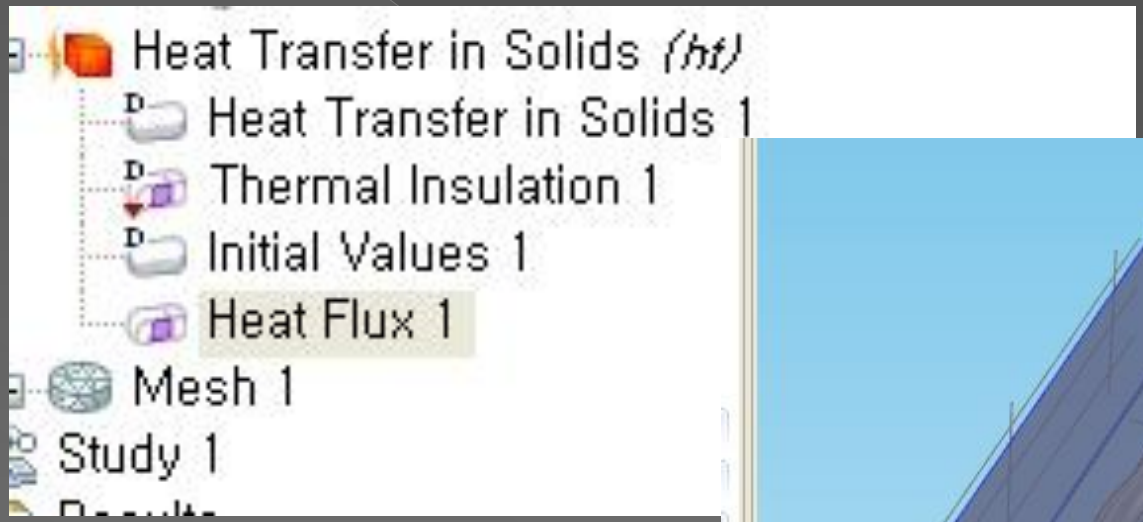


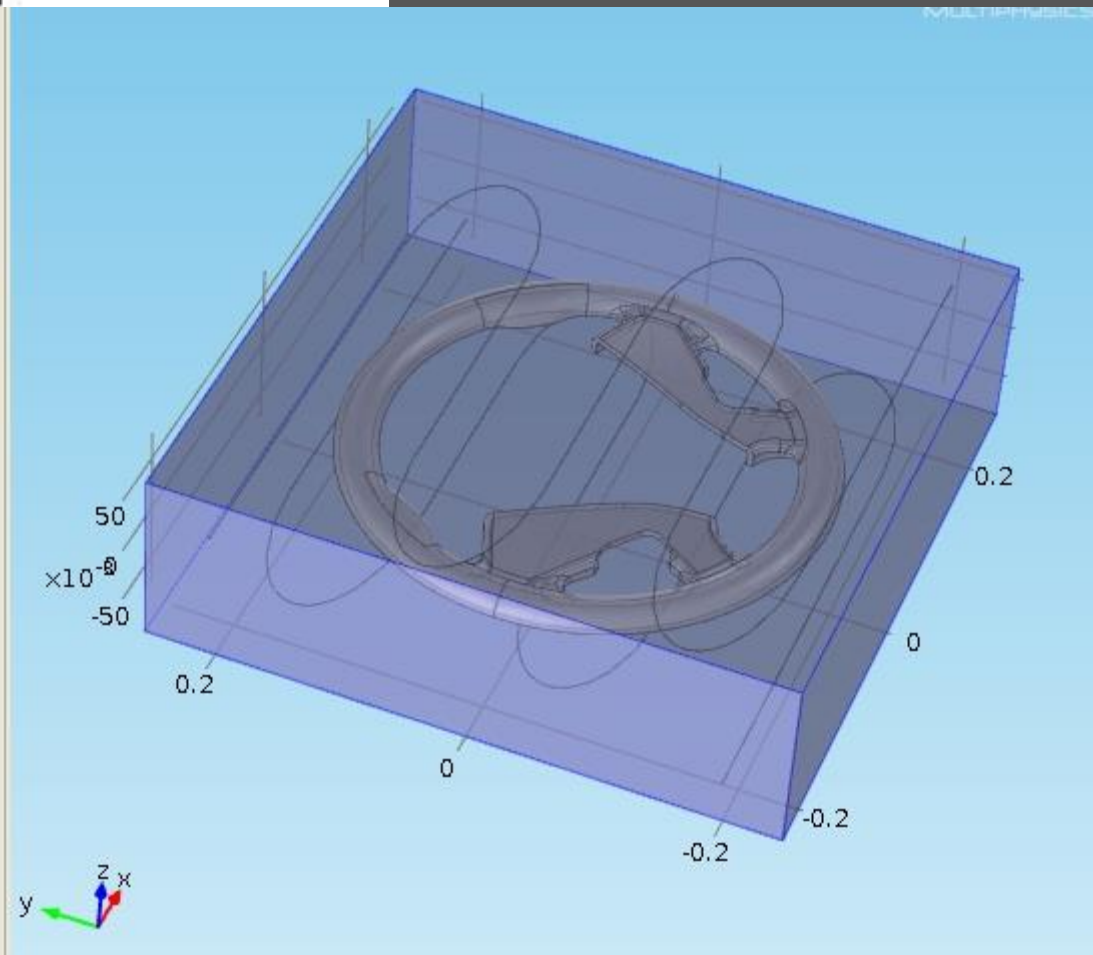
파이프 내부의 저항 직접작성



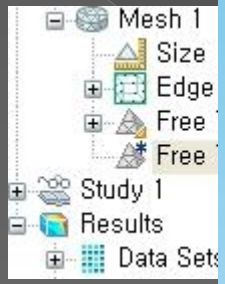


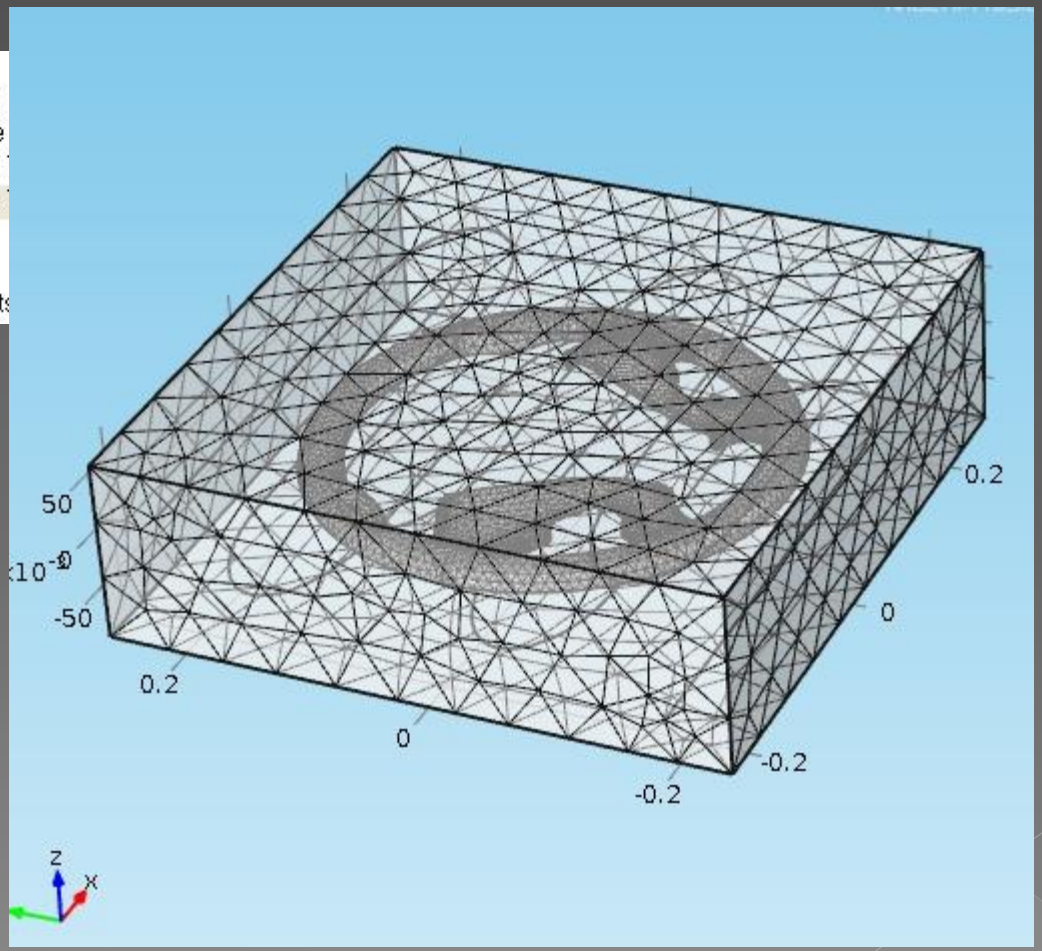
열 유속을 알기 위해 dialog box 를 선택



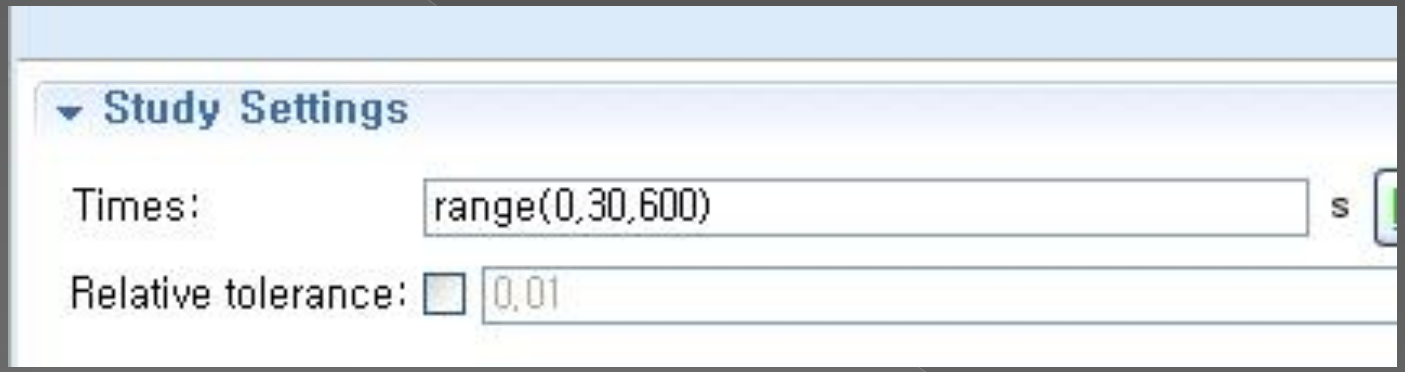


Mesh 생성


Mesh 1
Size
Edge
Free
Free
Study 1
Results
Data Sets

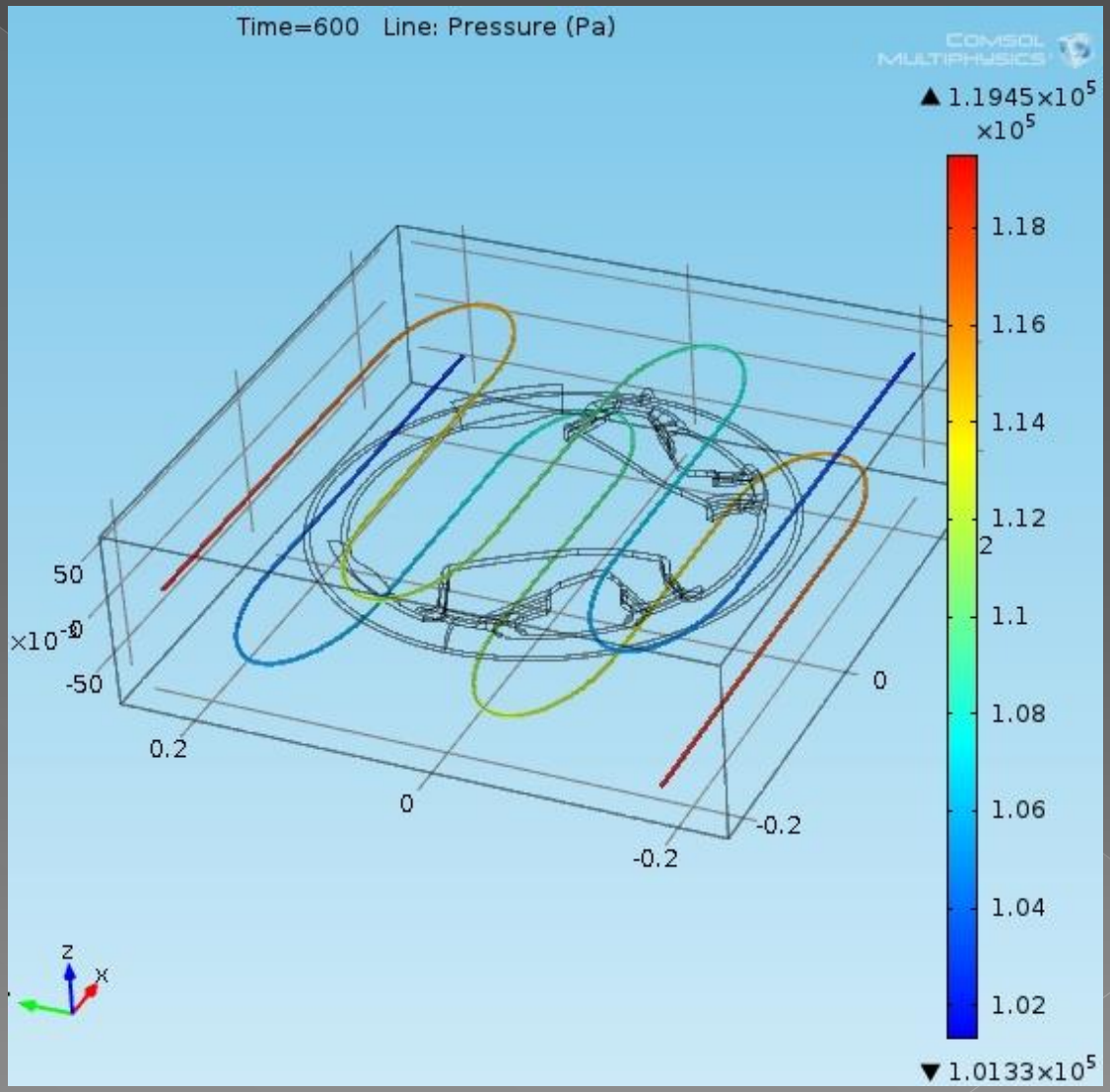

50
-50
0.2
0
-0.2
0.2
0
-0.2
z
x

시간 범위 설정


Study Settings
Times:
range(0,30,600)
s
Relative tolerance:
0,01

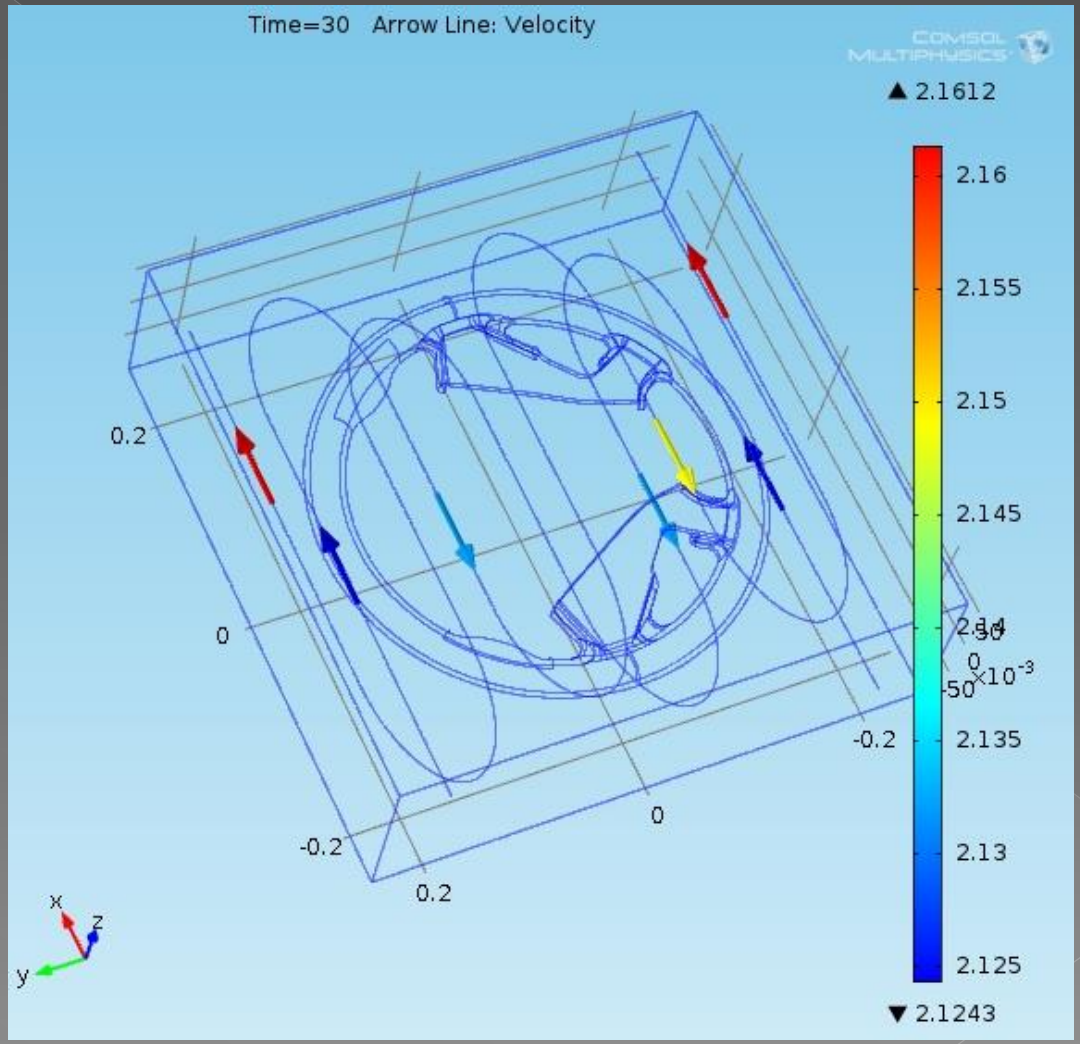
Study Result

10분 후 cooling pipe에 압력 분포

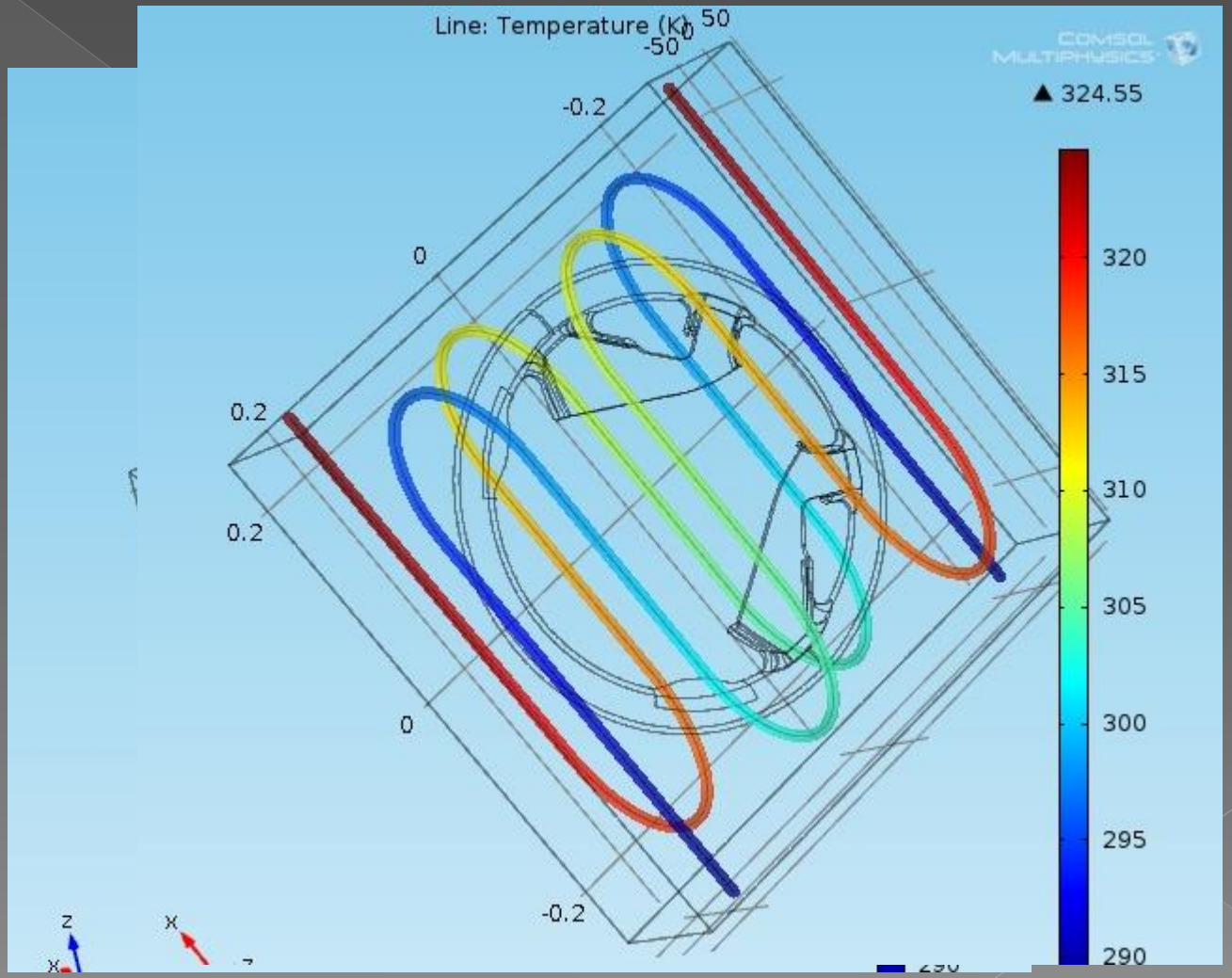


30초에 파이프에 흐르는 냉각수의 속도

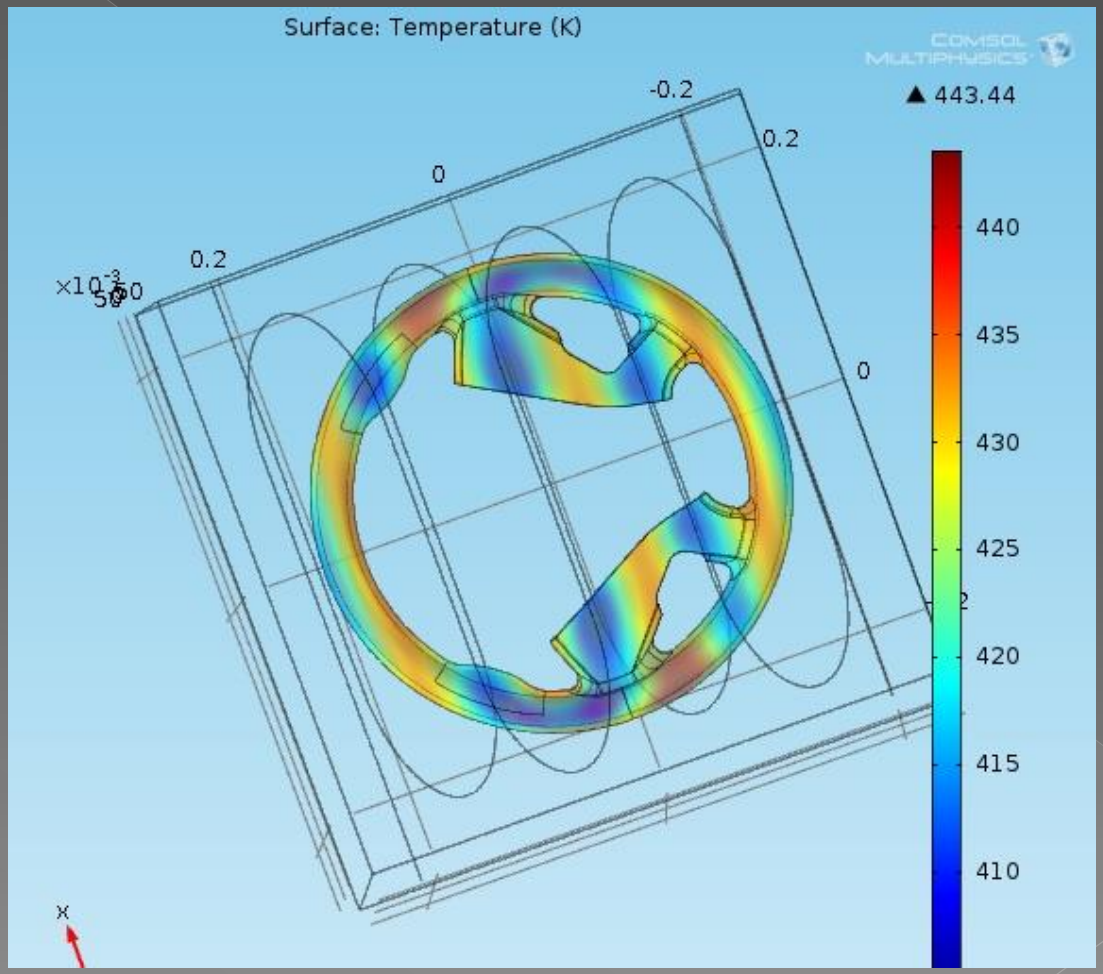
측정 결과
시간 흘러도
별 차이 없음



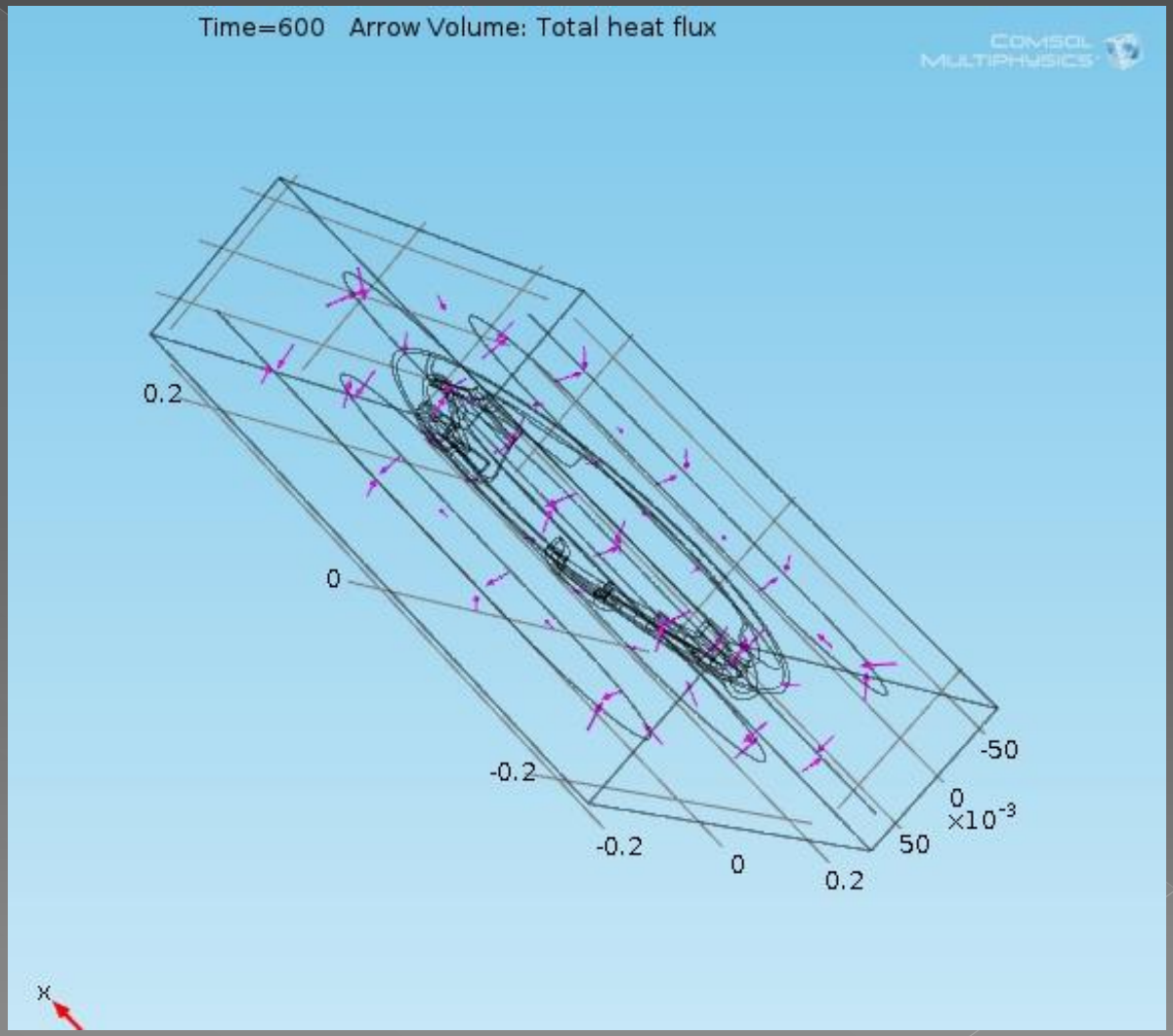
파이프에 냉각수 온도 변화분포



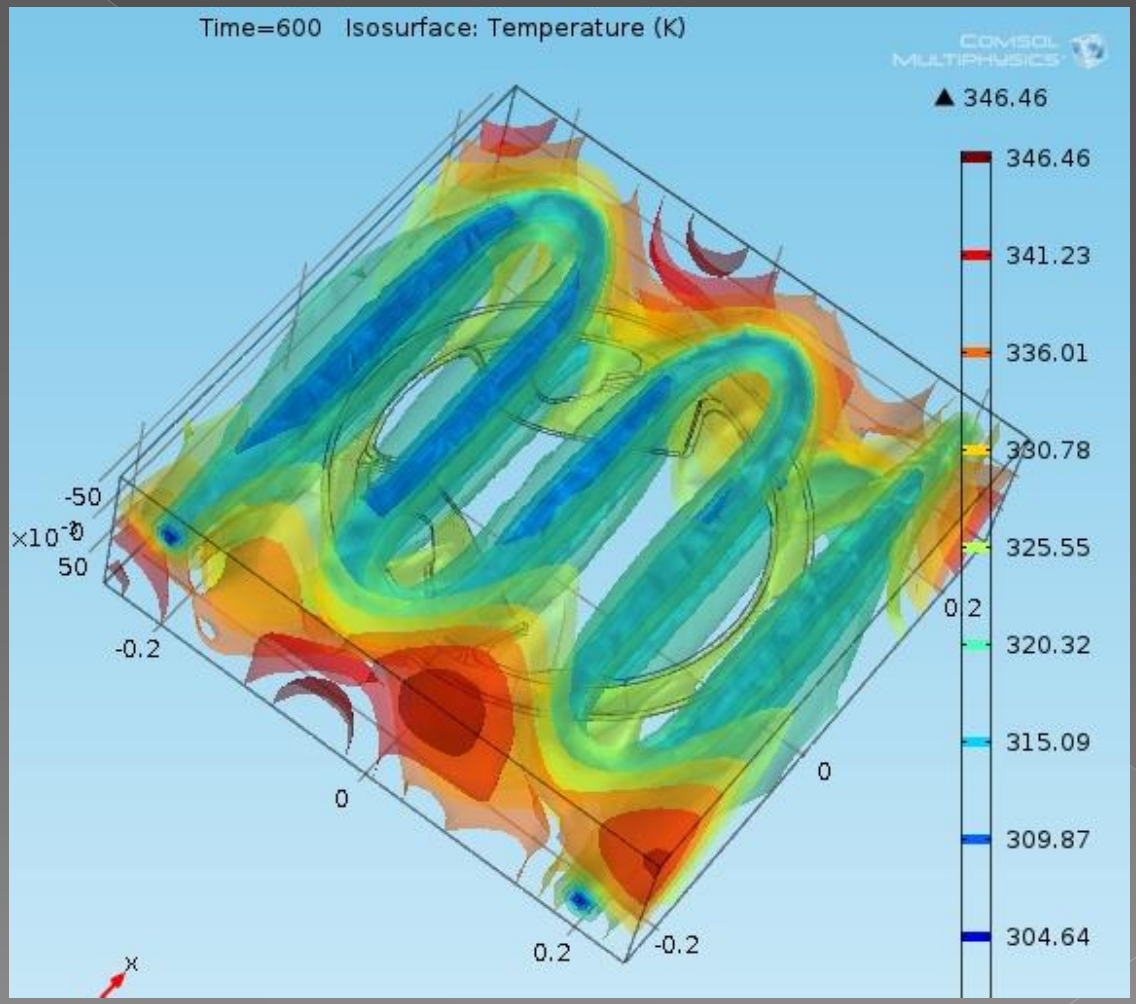
Mold product의 온도 분포



Heat flux 파이프로 향하는 것 관찰 가능

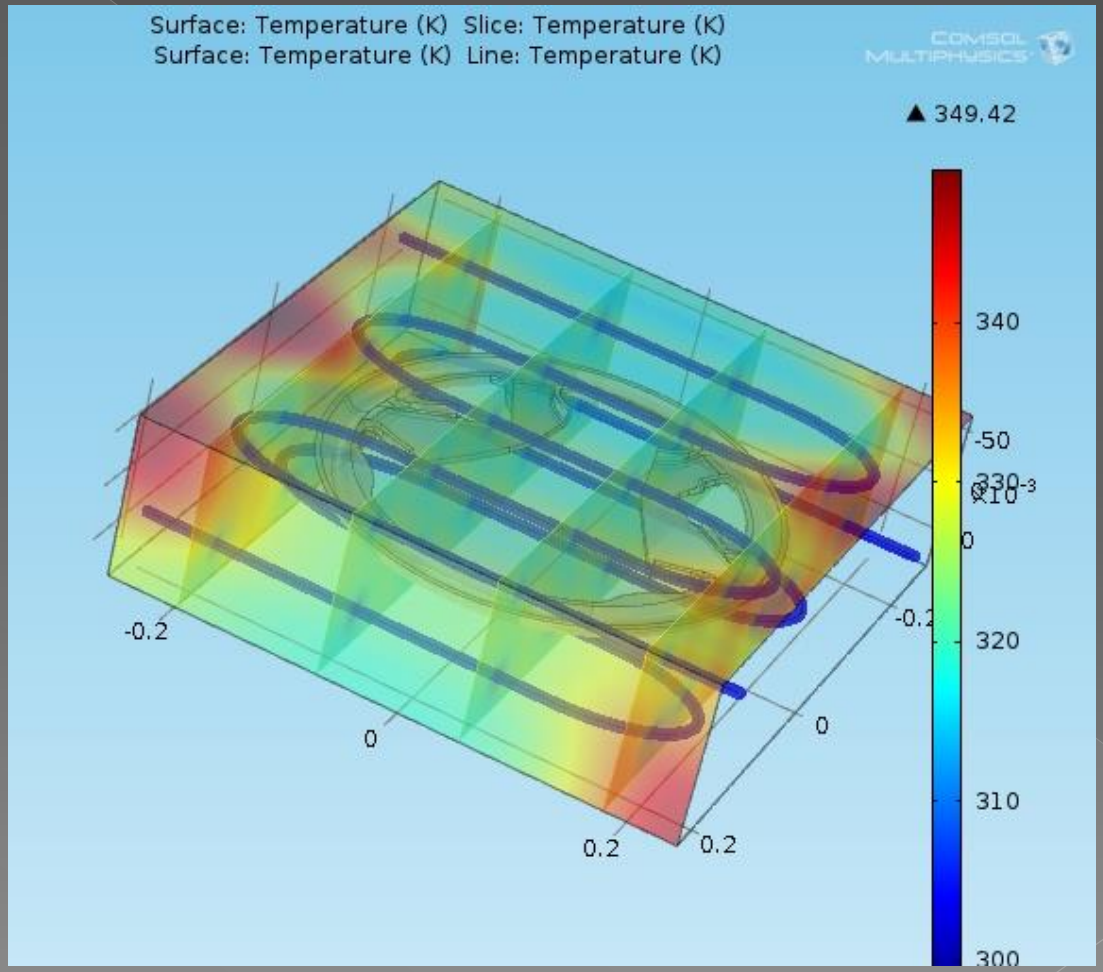


등위면으로 본 온도 그래프

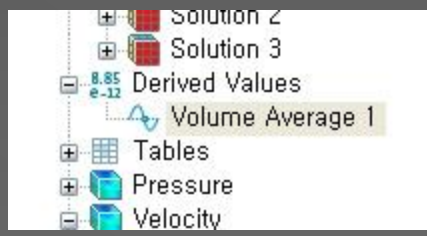


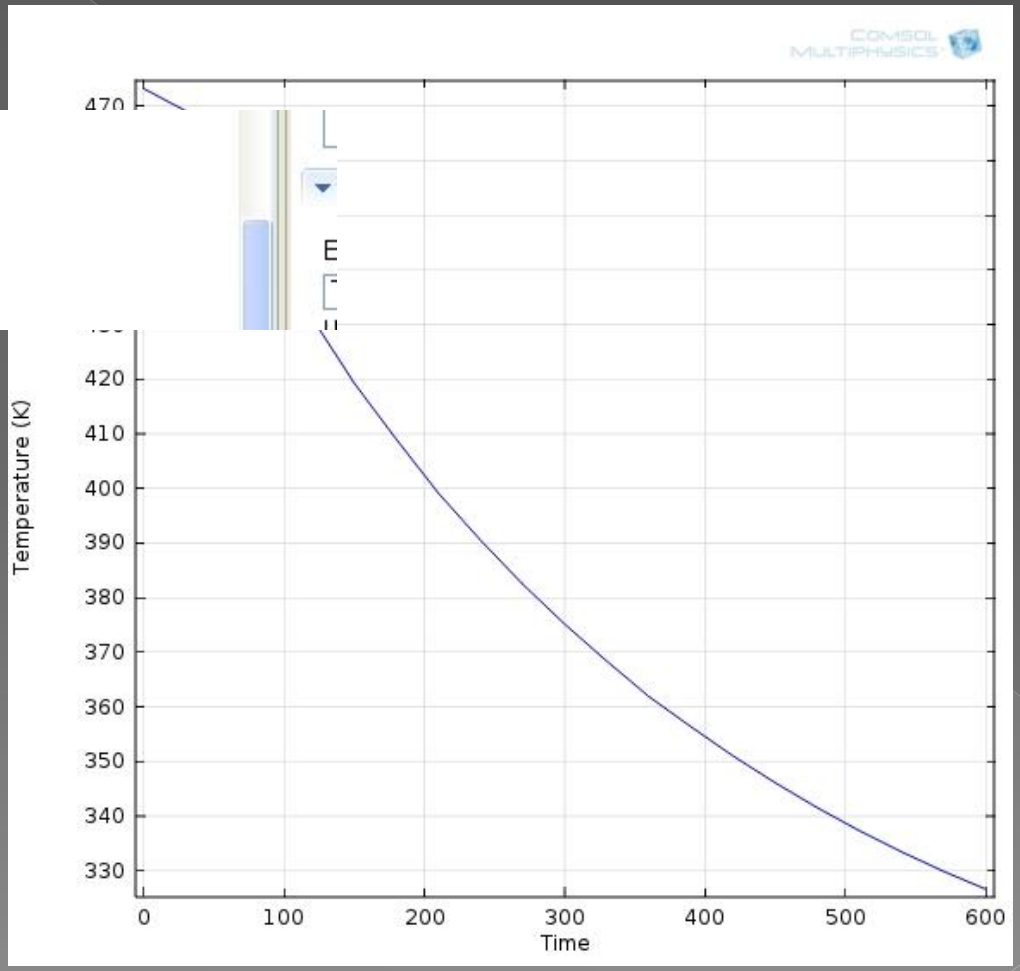
강철 mold block을 쳐놨을 때의 온도 분포

(block을 세워놓고 온도 분포의 변화가 있나를 살펴봄)

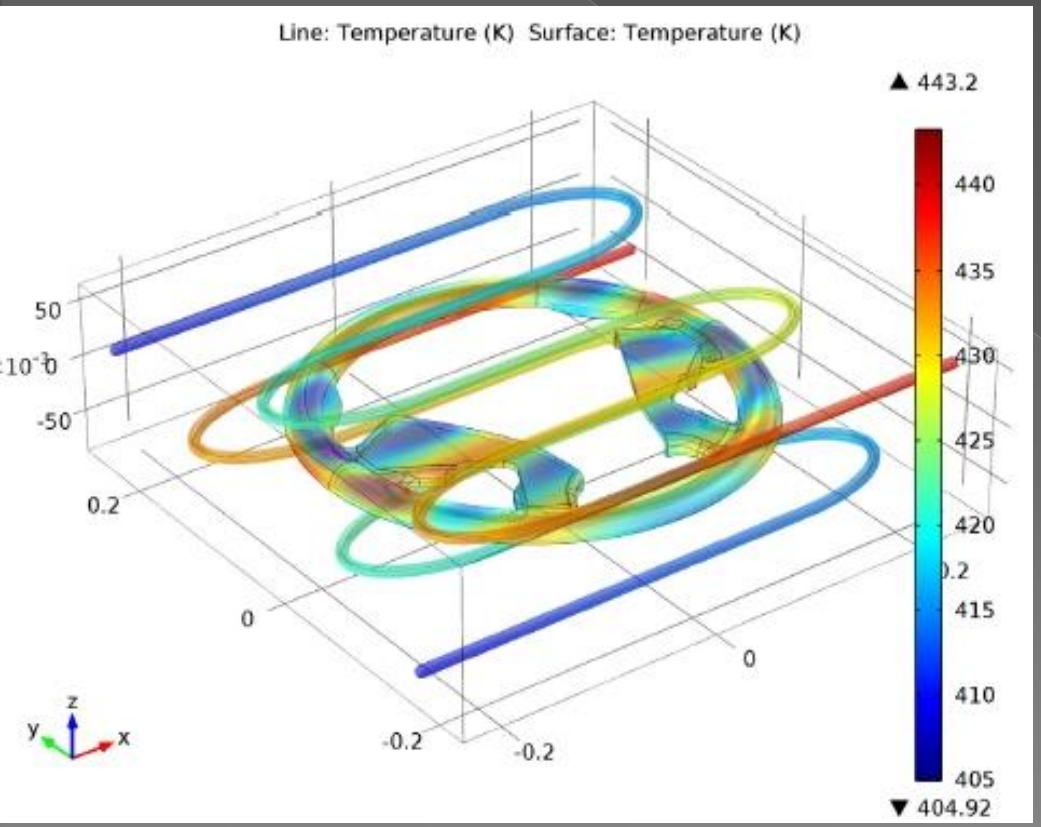


시간에 따른 평균 온도 분포

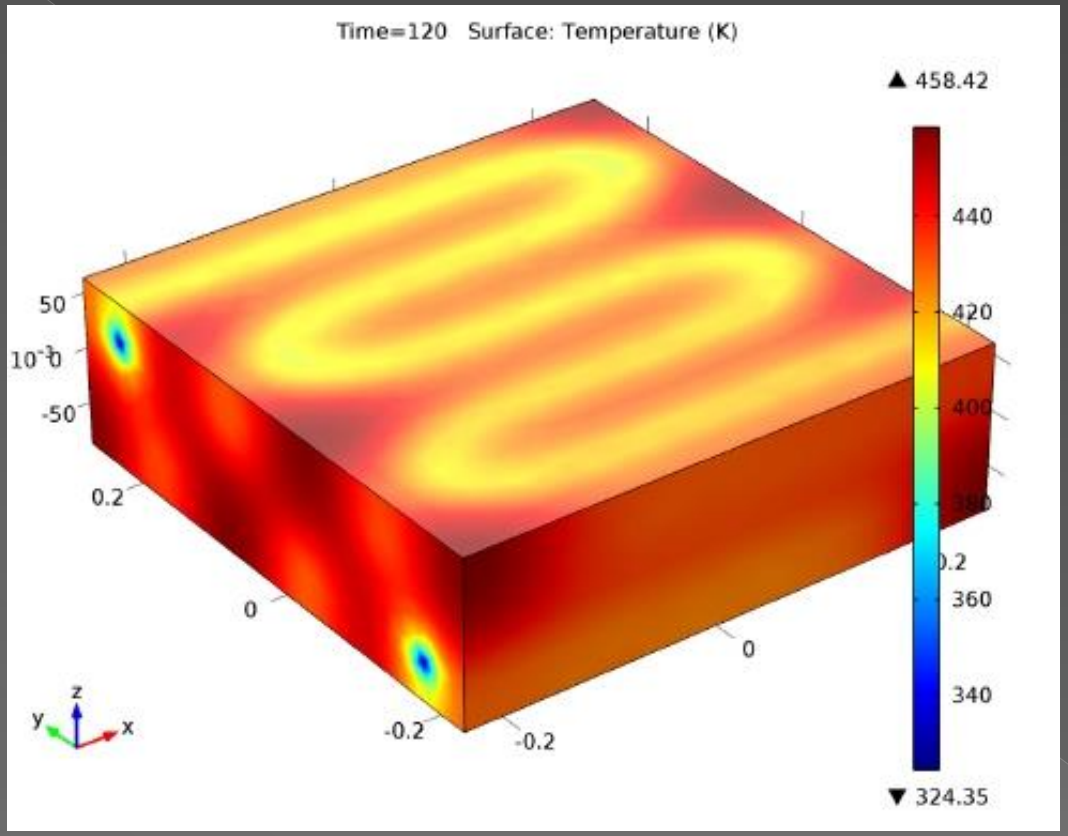




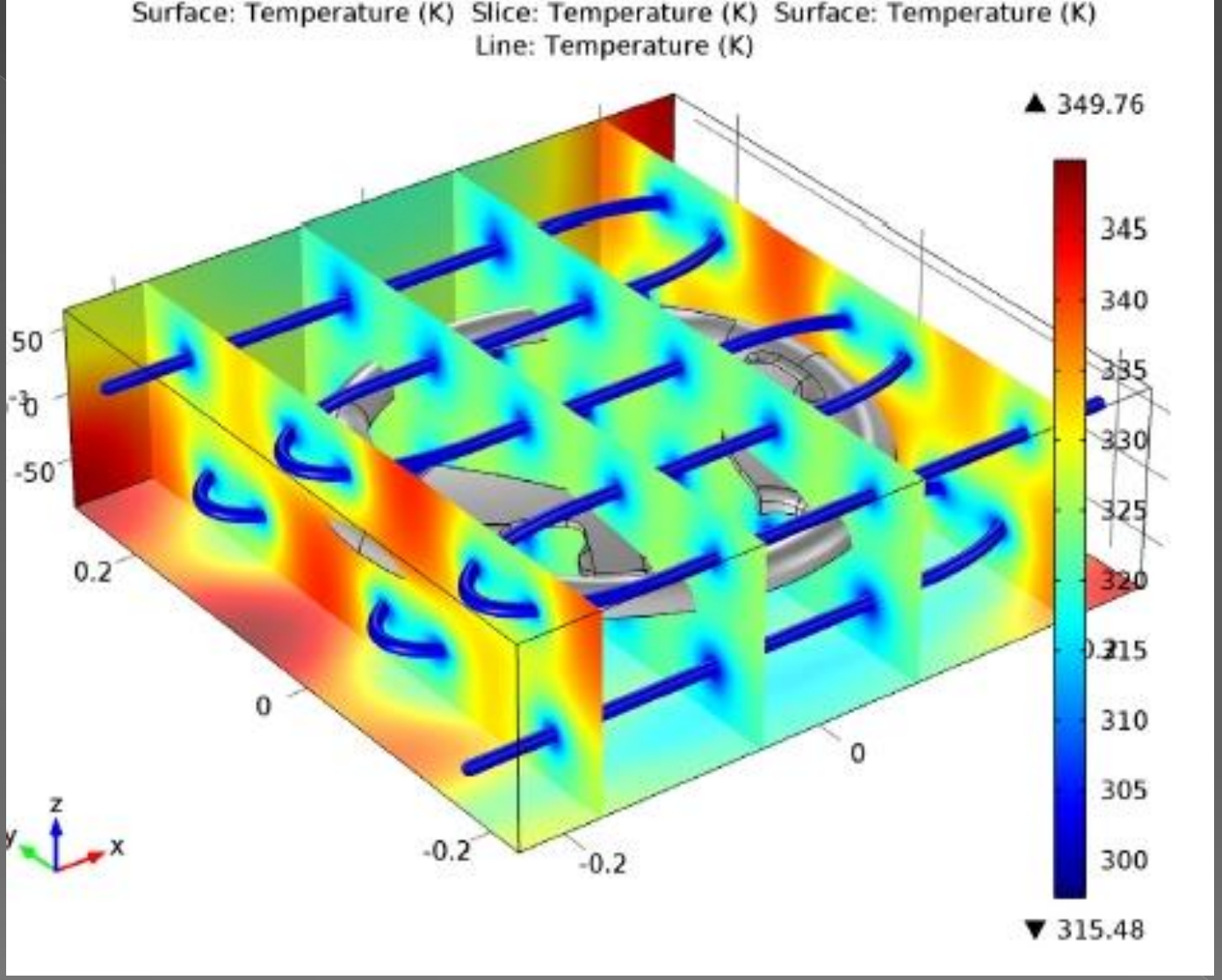
폴리우레탄 핸들 모델에 473K 온도, 10L/min의 냉각수 속도 , surface roughness 46um 초기조건을 부여함.



2분 후에 대략 최고 온도 지점과 최저 온도 지점이 40도 정도 차이남.



2분 후 surface graph. Dialog box 에 cooling channel 의 온도 형상이 그대로 드러난다.



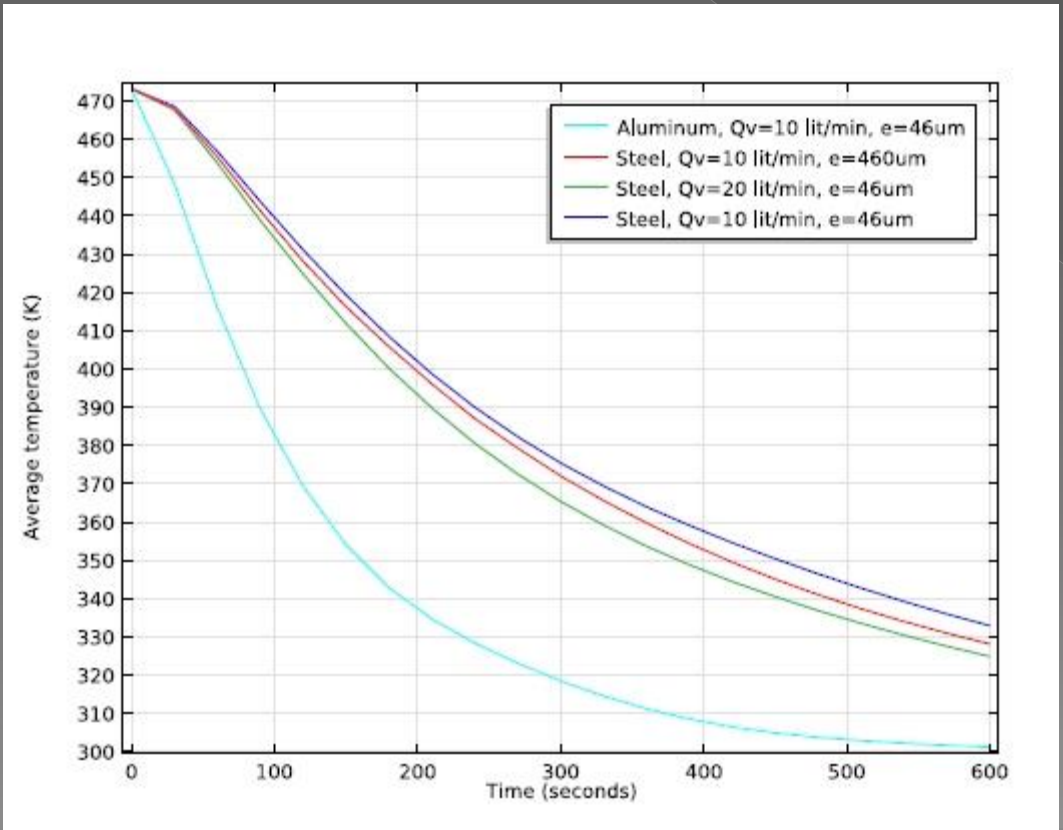
10분 냉각이 완료된 후에 (0,0,0)중심부분이 333K였다.
냉각수 출입 부분이 다른 boundary 보다 20K 정도 높은 것도 관측할 수 있었다.

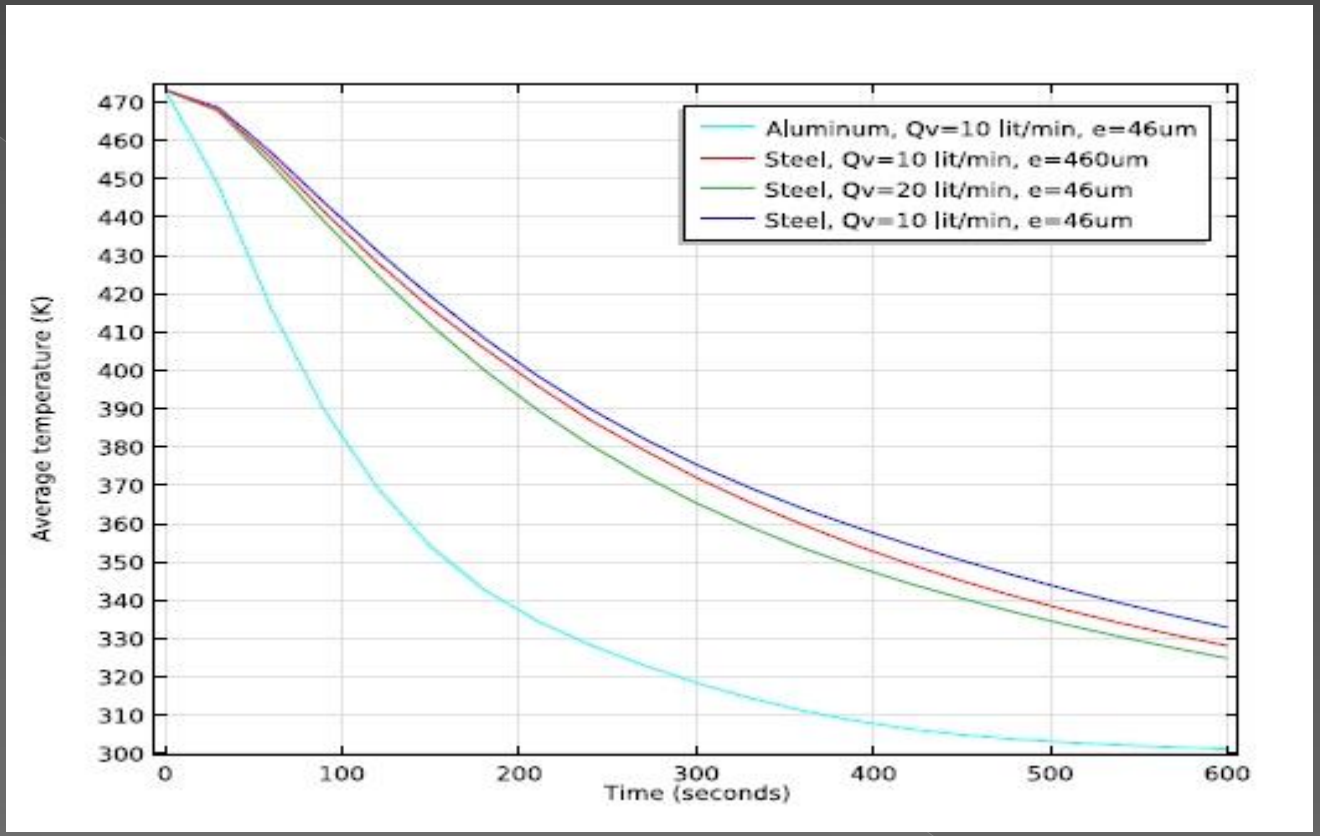
- 냉각 시간에 영향을 끼치는 인자를 확인하기 위해 추가 실험을 해보았다.

Cooling condition 에서 영향을 끼치는 또 다른 인자가 있을까 찾아보았는데
냉각수의 유속, 파이프 내부의 roughness, mold 소재 등이 있었다.

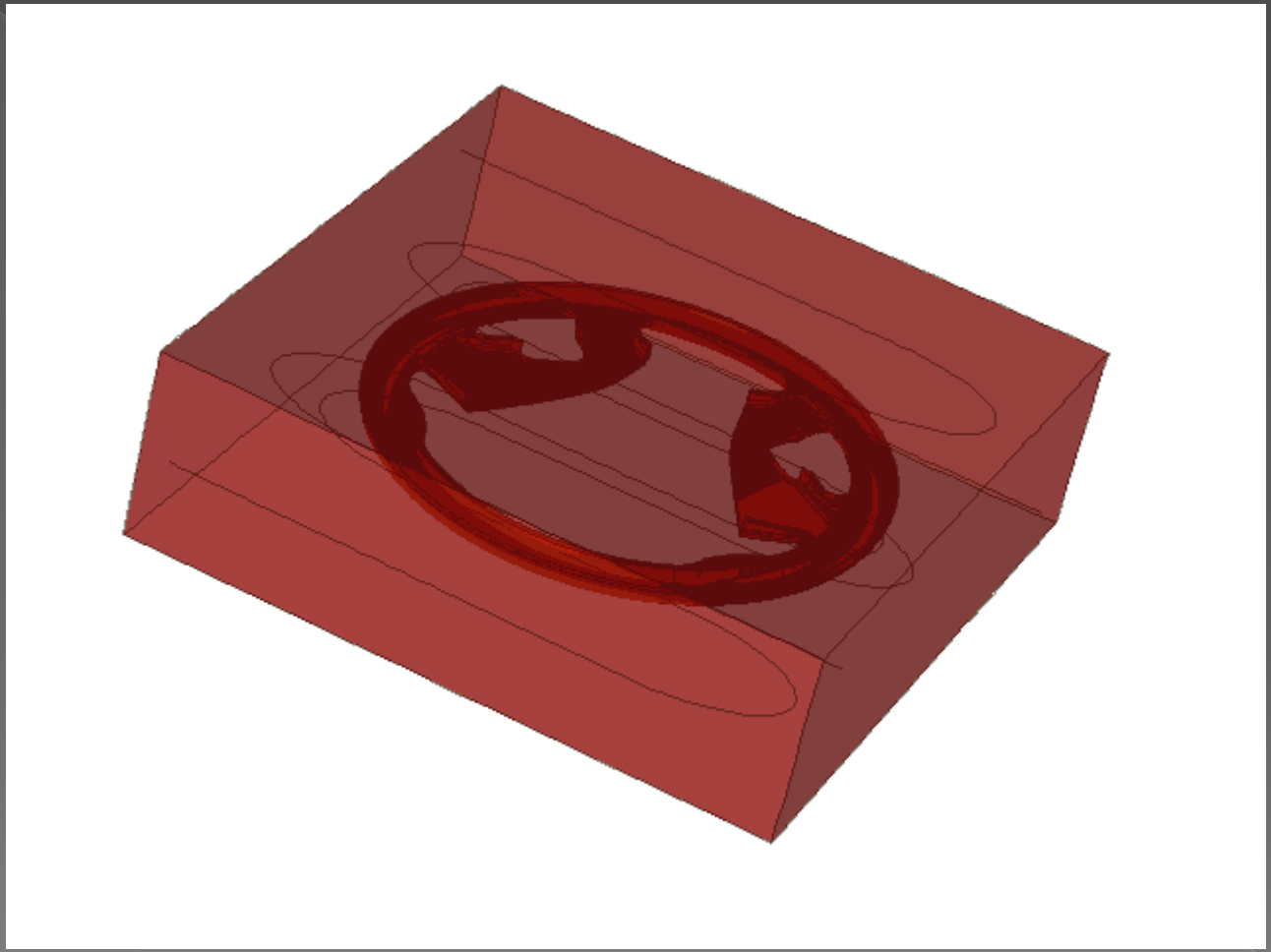
<출처:*Fundamentals of Heat and Mass Transfer (5th ed.). Hoboken: Wiley.*>

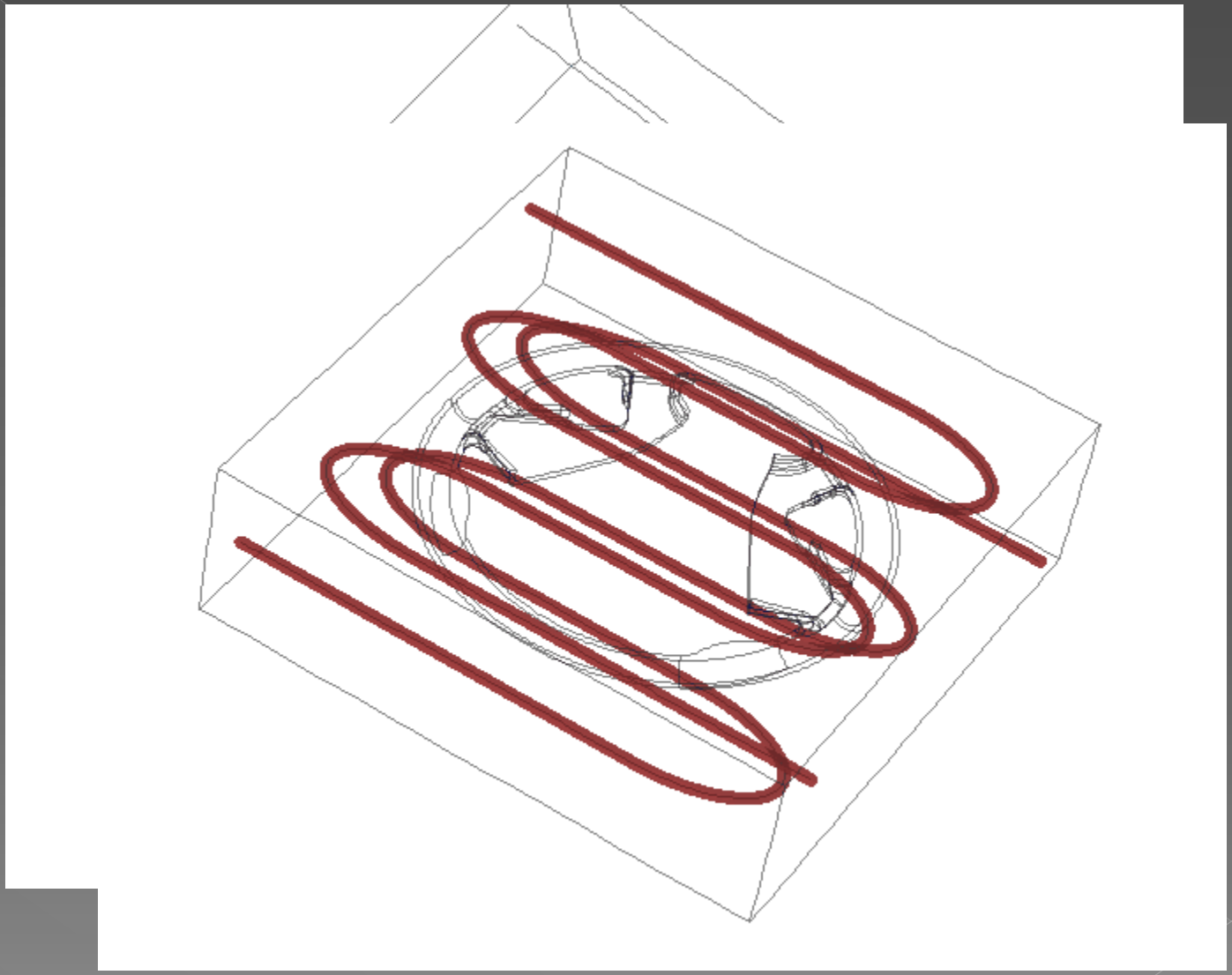
Mold Material	water flow rate(L/min)	surface rougness(MM)	10분후 T (K)
Steel	10	0.046	333
Steel	20	0.046	325
Steel	10	0.46	328
Aluminium	10	0.046	301

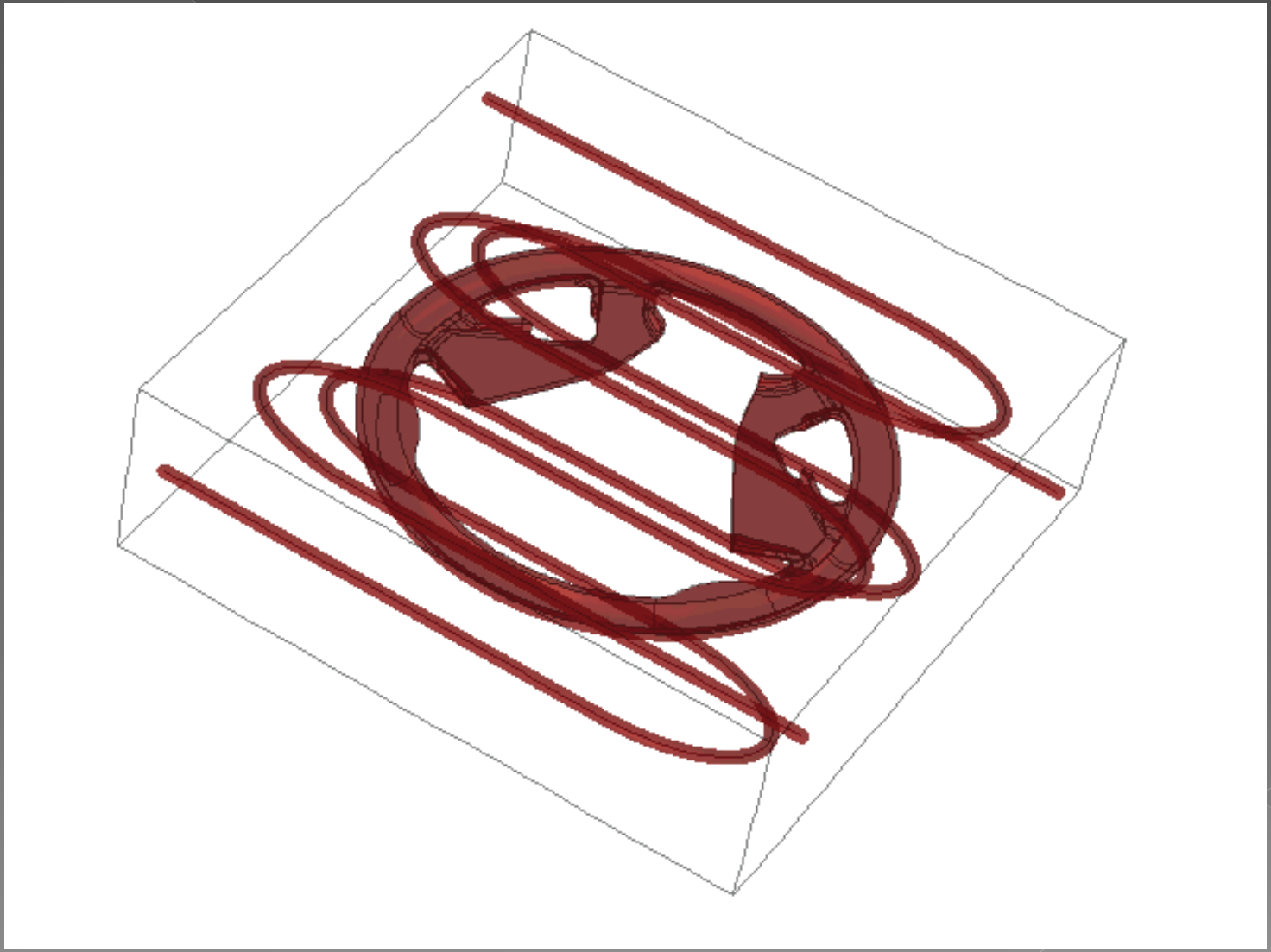


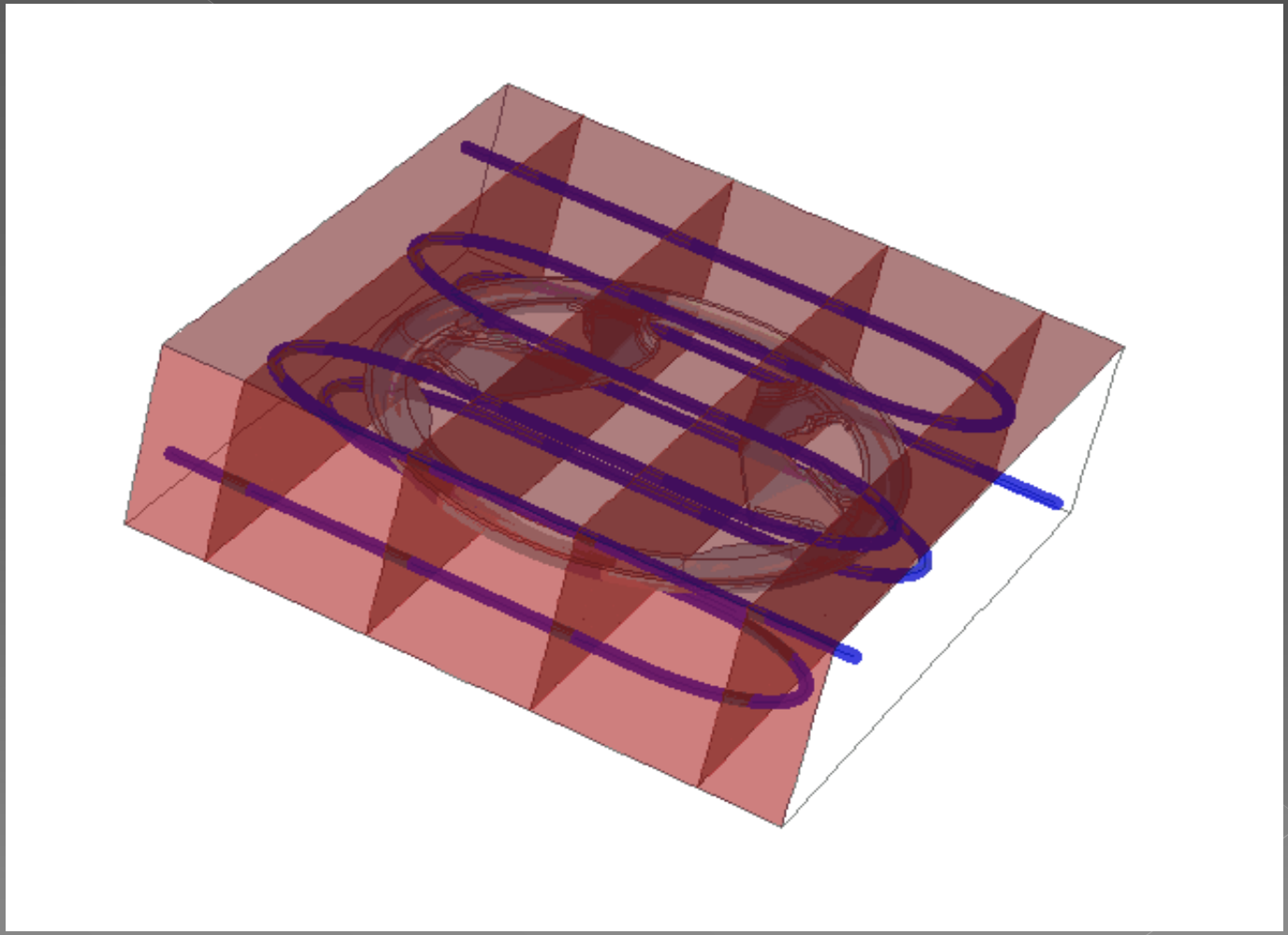


위의 그래프로부터 340K 가 목표하는 온도라고 가정하면,
Cooling time이 Mold material을 바꿨을 경우 67%
Flow rate을 바꿨을 경우 17%
Surface roughness를 바꿨을 경우 11% 감소한다.

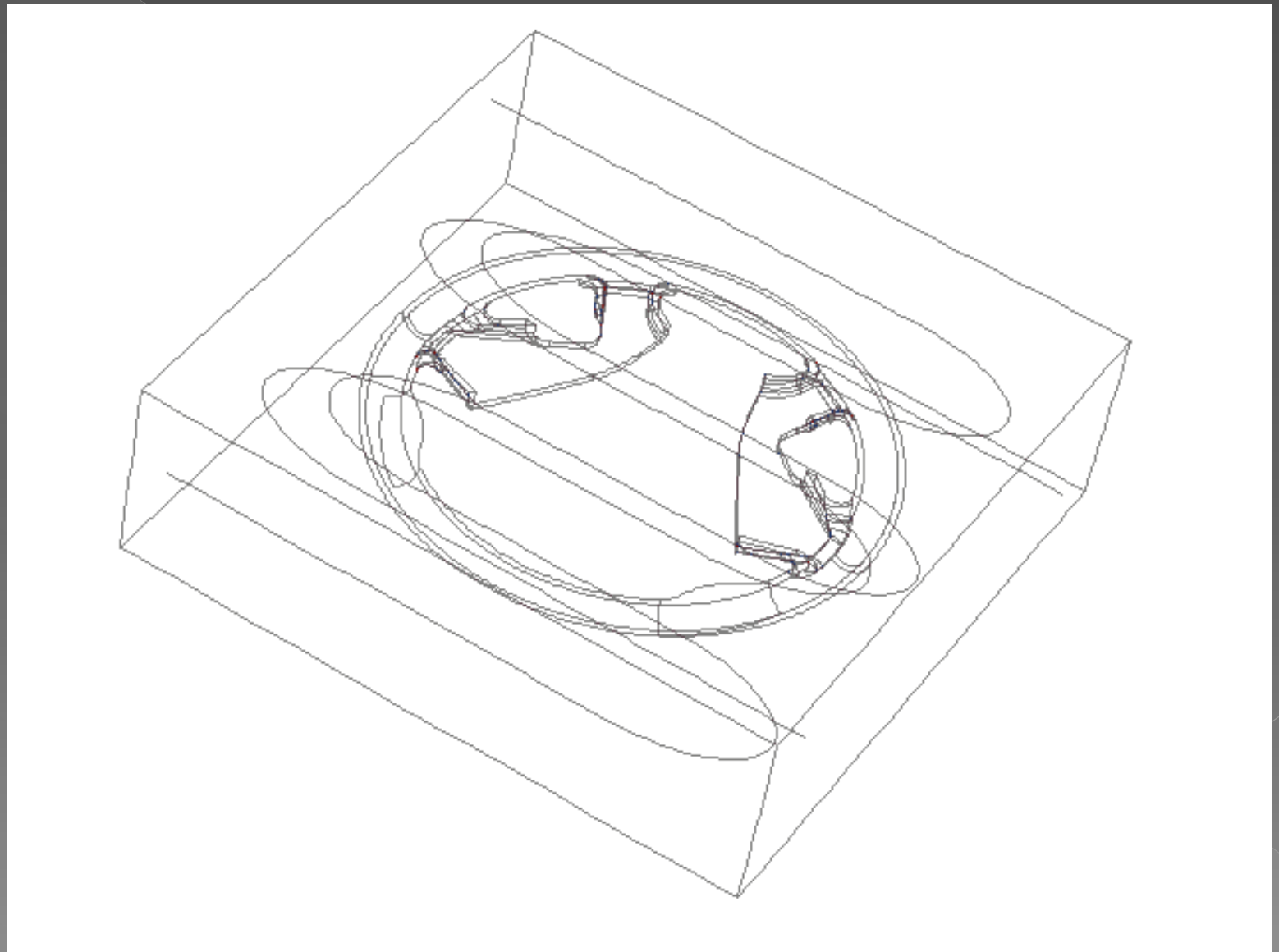








isothermal



Thank you for listening!