Arbitrary interface

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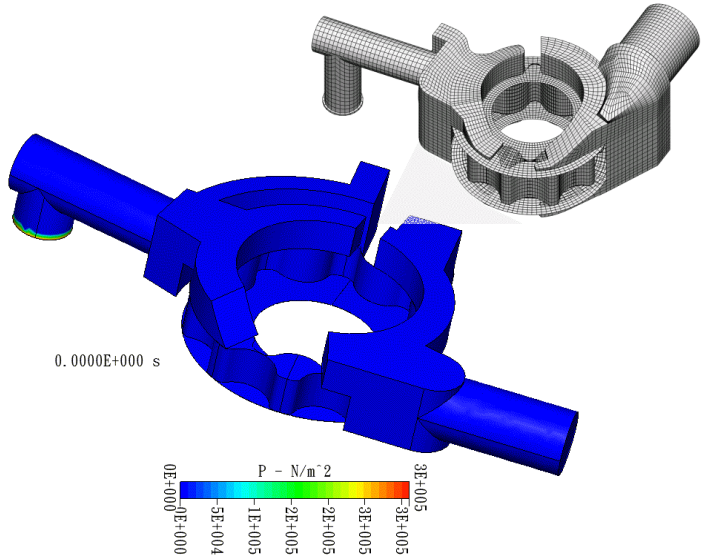
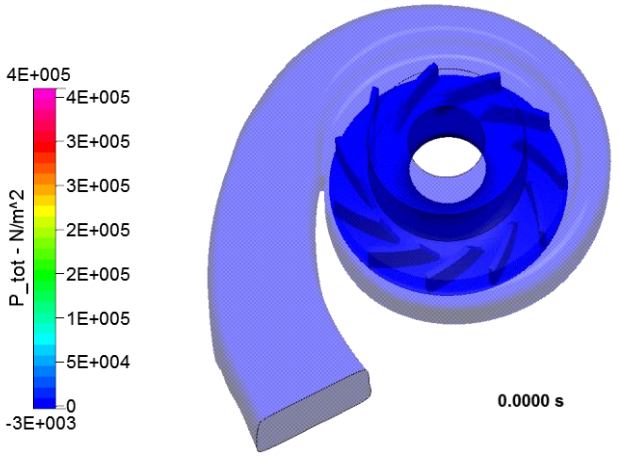
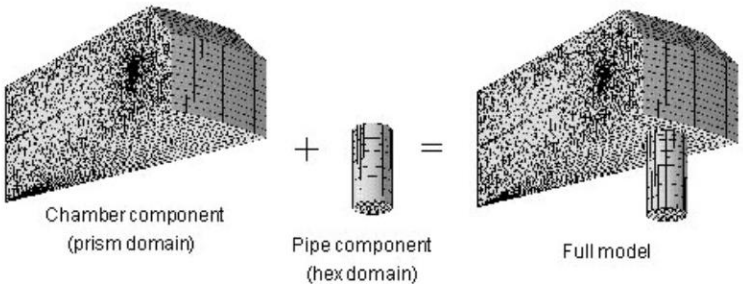
◆ Arbitrary Interface

Example of the Use of Component Libraries

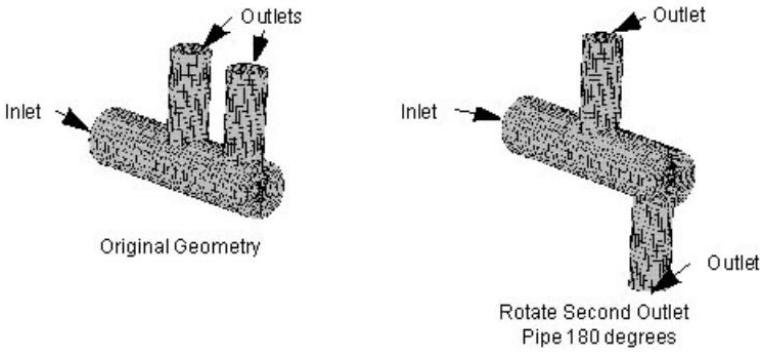




Arbitrary Interface를 이용한 Impeller의 회전 구현



Example of the Use of Component Libraries



Example of a Parametric Part Study

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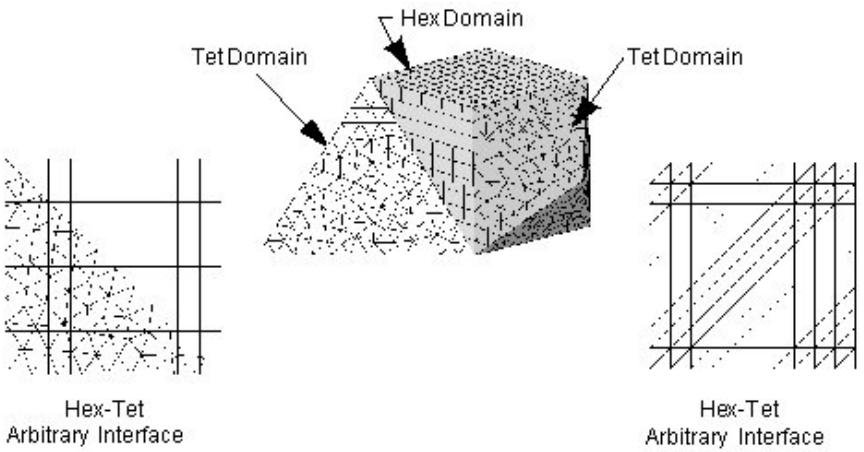
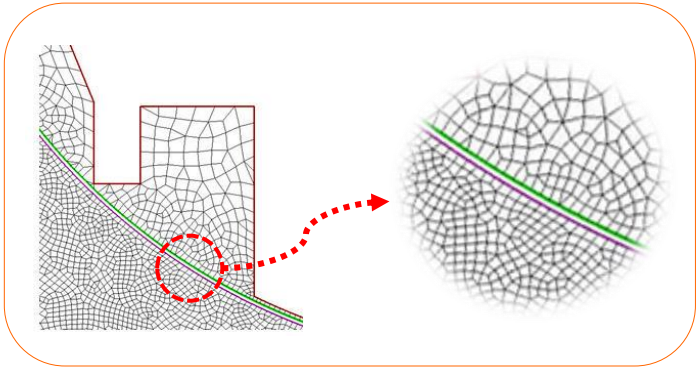
◆ Arbitrary Interface

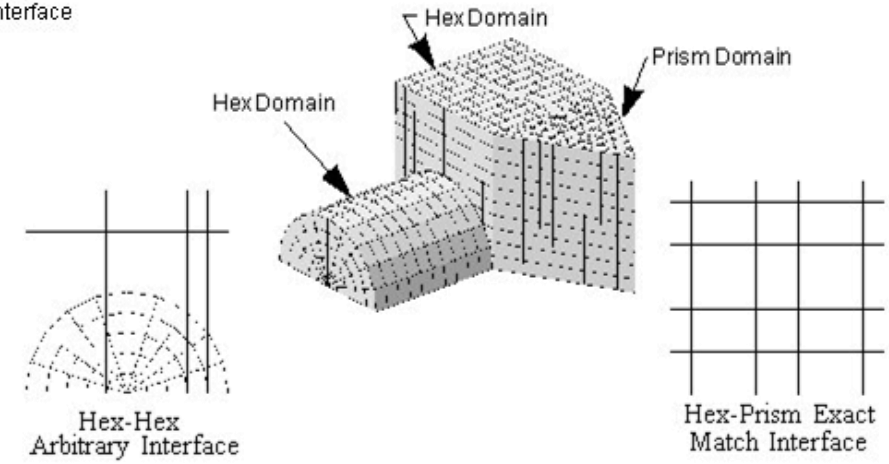
Grid systems

- 격자 생성에 있어 각 노드가 일치하지 않아도 해석 가능



Example of a Hex-Tet Grid System

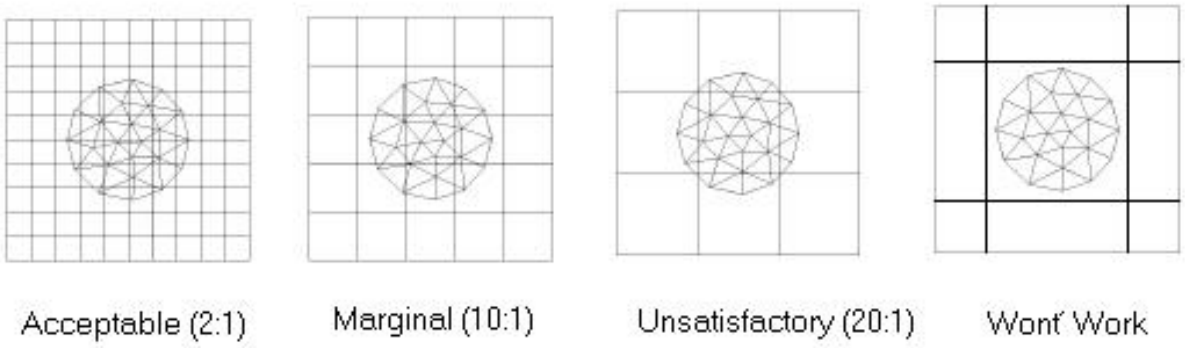




Example of a Hex-Hex and Hex-Prism Grid System

Grid Generation-Grid Resolution at Arbitrary Interface

- Arbitrary interface가 적용되는 면의 Cell은 비슷한 수준으로 생성해야 정확도를 높일 수 있음



- Arbitrary interface가 적용되는 gap의 크기는 인접 격자의 1/10 이하로 생성

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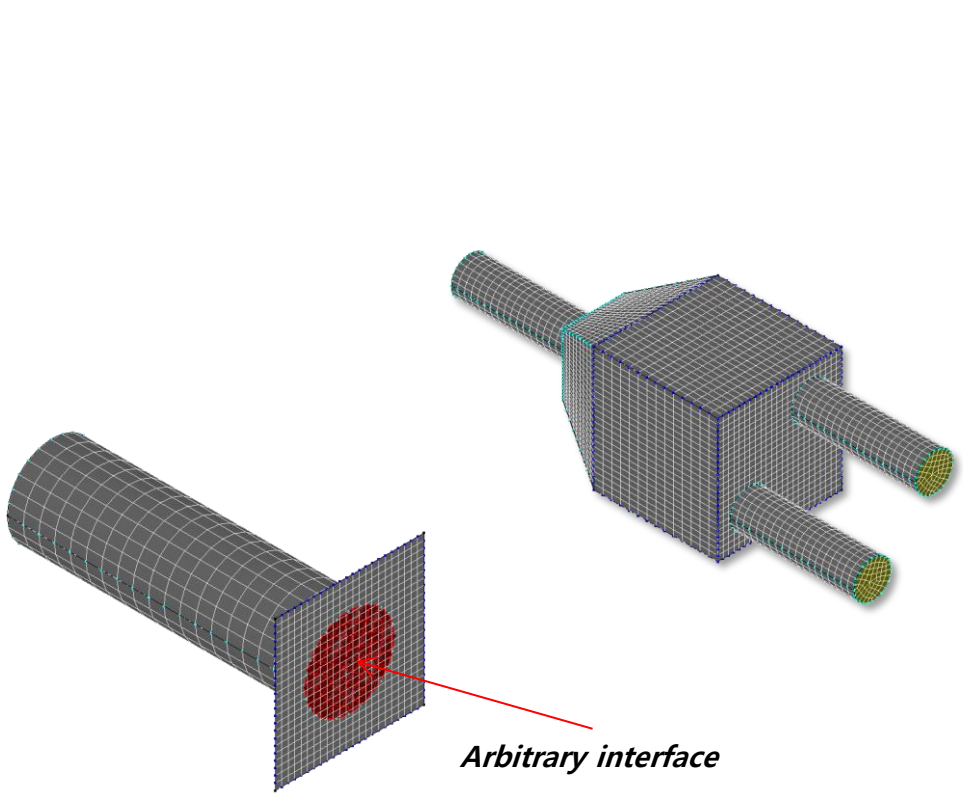
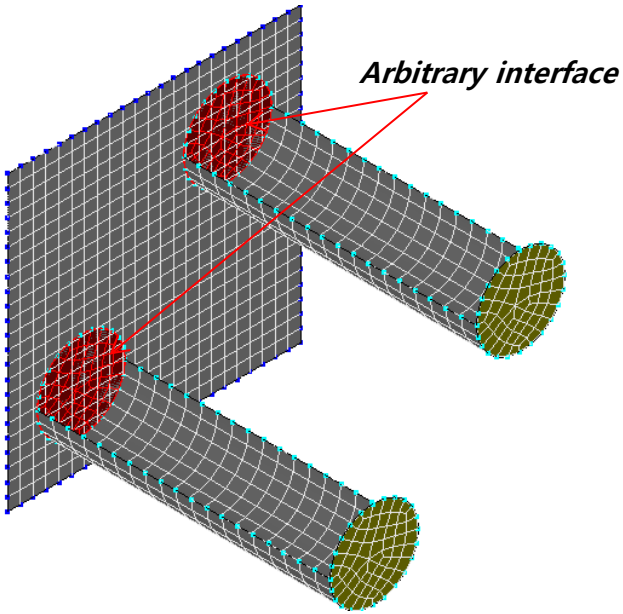
Implementation – Example1 (Grid Generation)

Structure block 생성

– Structure block과 연결된 면 생성 시 structure face와 동일한 평면에 생성 또는 약간의 gap을 주어 생성 (Gap의 크기는 인접 격자의 1/10 이하로)





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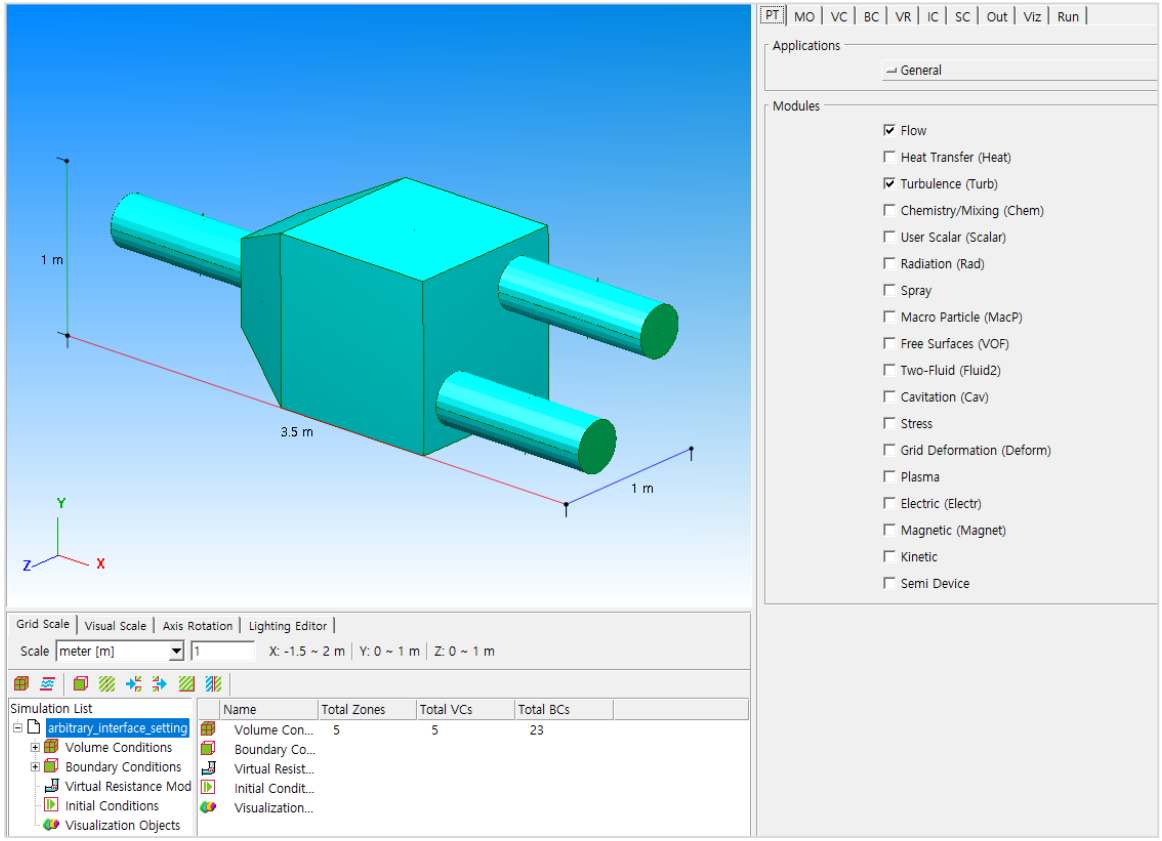
Setup, CFD-ACE-GUI

- **Scale을 meter[m]로 설정**

  ⇨ **CFD-GEOM에서 scale 설정을 한 뒤 DTF 파일로 저장하면 설정 값 그대로 CFD-ACE-GUI에 적용**

1. File → Open

2. PT(Problem Type) : Flow, Turbulence 선택



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Setup, CFD-ACE-GUI

- **Scale을 meter[m]로 설정**

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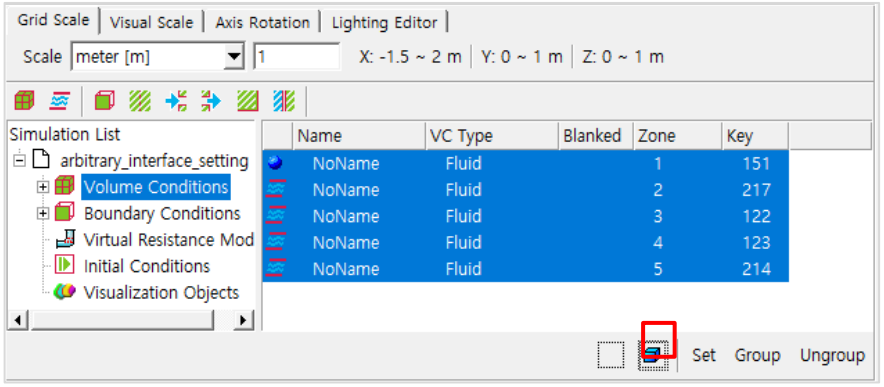
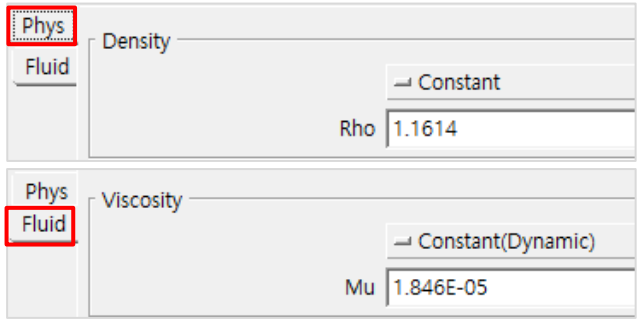
3. VC(Volume Conditions)
   - 전체 선택 후 group 지정
   - Fluid subtype : Gas

     Physics : density = 1.1614 kg/m3

     Fluid : viscosity(Dynamic) = 1.846E-05 kg/m-s





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Setup, CFD-ACE-GUI

4. Boundary conditions

→ BC Setting Mode : General

BC Type : inlet

Flow : Sub Type : Fix Vel. (Nomal)

Pressure= 0 Pa

Temperature=300K

Nomal Velocity = 5m/s

BC Type : outlet

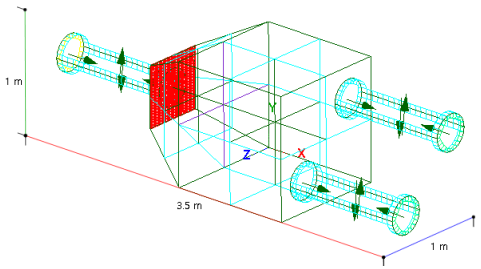
Flow : Sub Type : Fixed Pressure

Pressure= 0 Pa

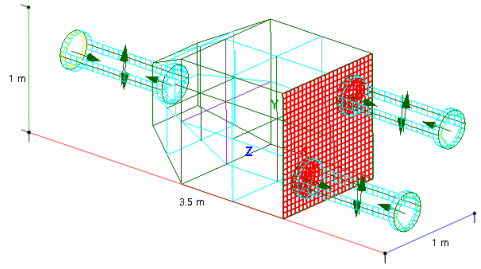
Temperature=300K

→ BC Setting Mode : ArbitrInterf. 선택

Arbitrary interface를 적용하기 위해서는 서로 대응되는 모든 면을 각각 Group으로 설정



Name	BC Type	BC SubType	Blanked
Arb_4<-Arb_3		No Slip	
Arb_2->Arb_1		No Slip	
Arb_1<-Arb_2		No Slip	
Arb_3->Arb_4		No Slip	
inlet	Inlet	Fix Vel. (Normal)	
NoName	Interface	Interface	
outlet	Outlet	Fixed Pressure	
outlet	Outlet	Fixed Pressure	

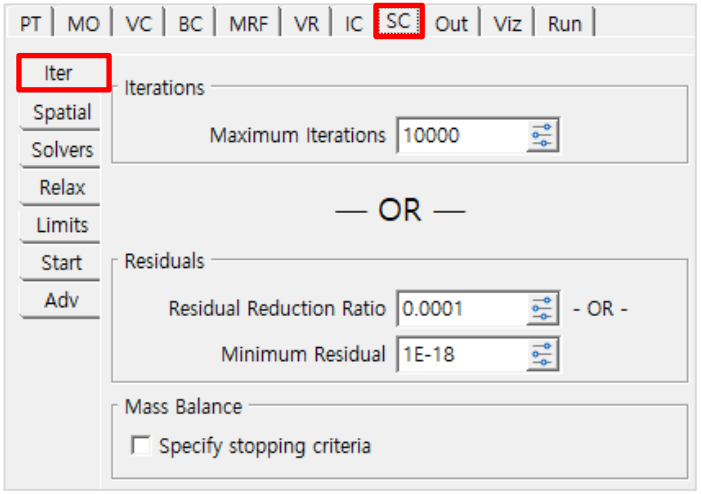


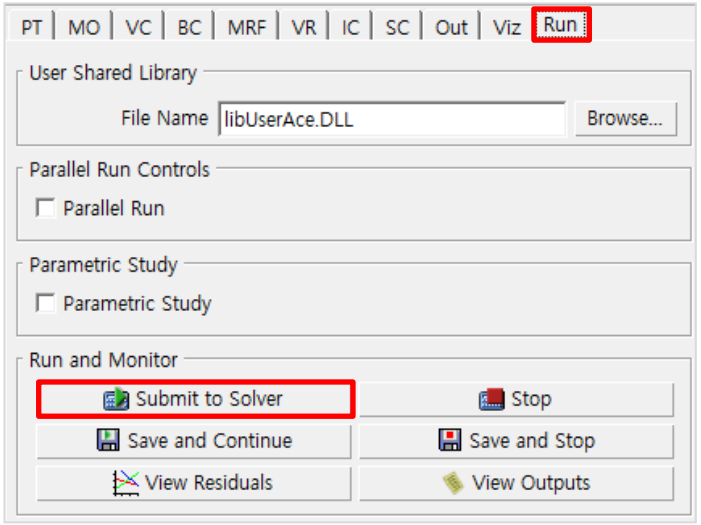
Name	BC Type	BC SubType	Blanked
Arb_4<-Arb_3		No Slip	
Arb_2->Arb_1		No Slip	
Arb_1<-Arb_2		No Slip	
Arb_3->Arb_4		No Slip	
inlet	Inlet	Fix Vel. (Normal)	
NoName	Interface	Interface	
outlet	Outlet	Fixed Pressure	
outlet	Outlet	Fixed Pressure	

Setup, CFD-ACE-GUI

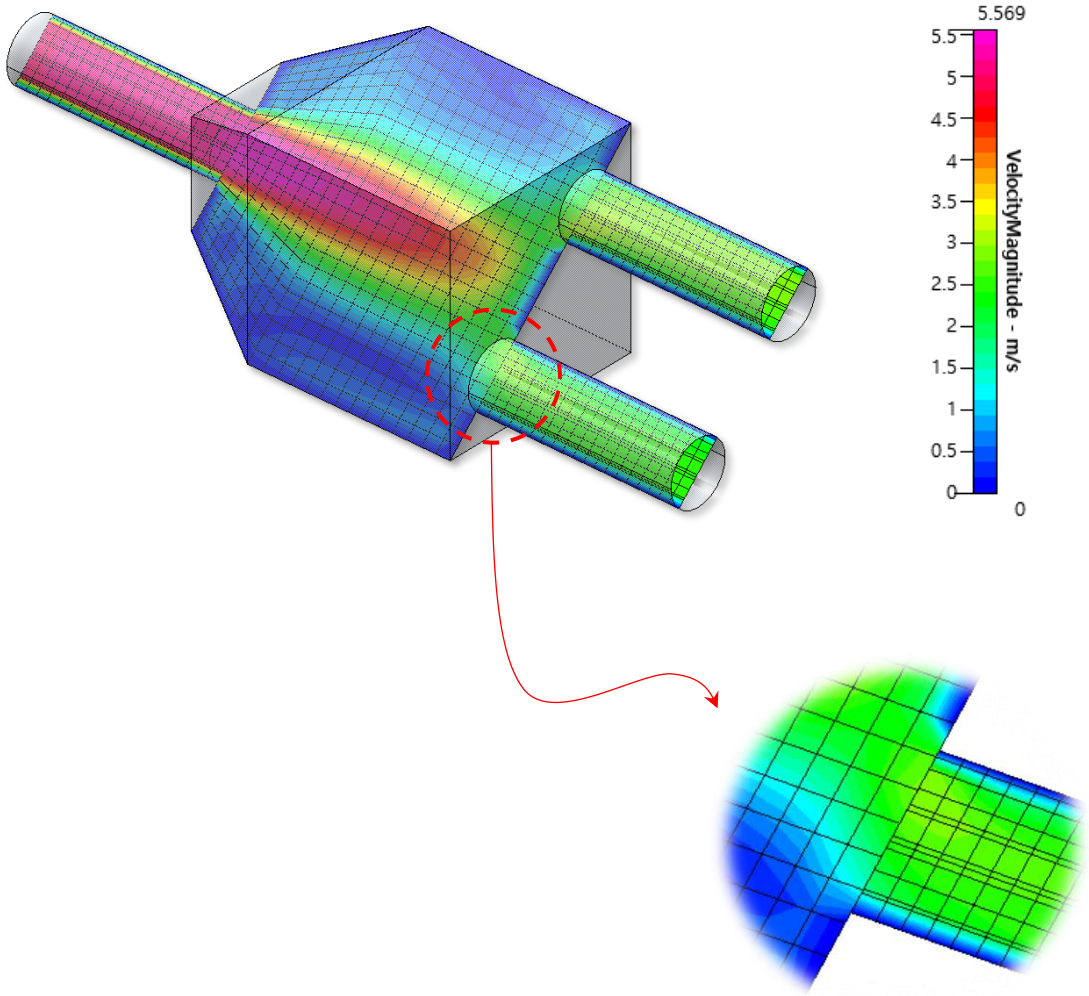
5. SC (Solver Control)
   - Max Iterations : 1000
   - Residual Reduction Ratio : 0.0001

6. Run
   - Submit to Solver





Implementation – Example1



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Arbitrary interface의 잘못된 설정으로 발생하는 오류

1. Arbitrary interface 생성을 위한 group 지정 후 Set을 지정하지 않은 경우 ; Set 생성

```
| Turb.  | Upwind  | CGS+Pre |  50 | 1.0E-04 | 2.0E-01 |  -  |  -  |  -  |
|    K   |    -    |    -    |  -  |    -    |    -    |  -  |  -  | 1.0E-30 | 1.0E+20 |
|    D   |    -    |    -    |  -  |    -    |    -    |  -  |  -  | 1.0E-30 | 1.0E+20 |
 ==========================================================================

 Arbitrary Interface set Arb_3  processed with maximum gap =   8.333749979726354E-003

Interface not properly assigned for Arbitrary interface No. Arb_5
Error Exit from CFD-ACE-SOLVER
```

2. 'Set'을 설정하였으나 에러가 발생할 경우

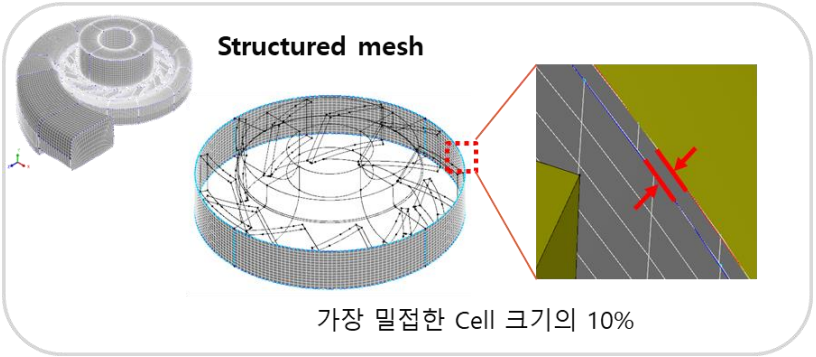
   Set의 방향이 잘못 된 경우 → 'set' 버튼을 한번 더 눌러 방향을 변경

   (arbitrary interface 형성 시 두 면간의 방향성이 존재함)

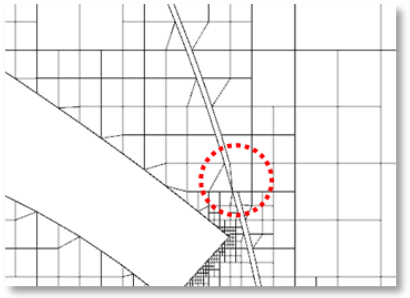
3. 두 개의 면이 교차하는 경우

   Arbitrary interface를 생성하는 면은 완전히 동일평면상에 위치하거나 gap이 존재해야 함.

   두 group에 속한 면이 조금이라도 교차(영역을 침범)할 경우 에러 발생 → 격자 수정으로 오류 해결



가장 밀접한 Cell 크기의 10%



Surface 면을 넘어선 격자 생성

기타 : T-junction 관련 에러(Arbitrary interface의 limitation 관련)

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Arbitrary interface의 잘못된 설정으로 발생하는 오류

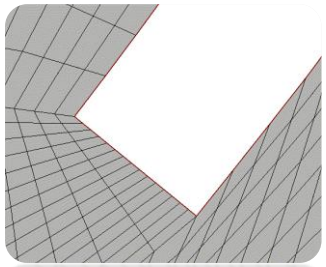
3. Model option

Remeshing Scheme Limitations

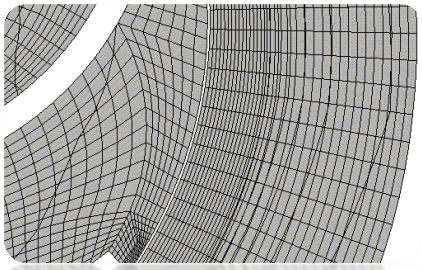
- Transfinite Interpolation(TFI)

✓ TFI scheme의 경우 정렬격자의 경우에만 적용

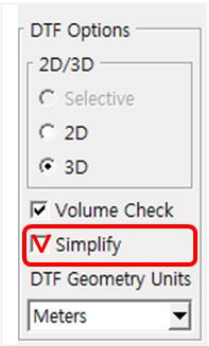
✓ Combined model에서 TFI Remeshing scheme을 사용할 경우 Negative Volume 발생



Combined model



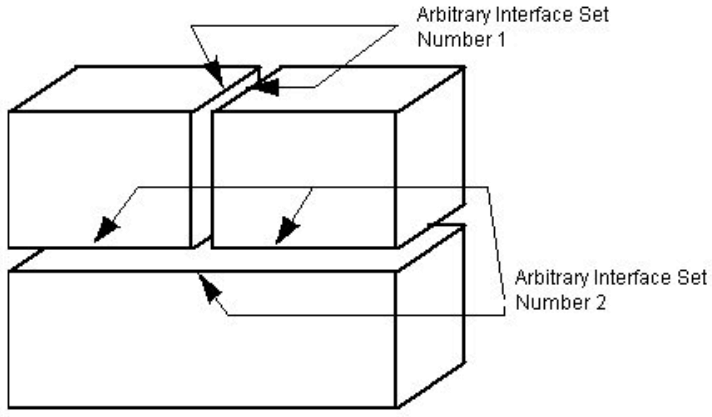
No combined model



- Solid-body Elasticity Analogy

✓ Polyhedral grid cell의 경우 지원되지 않음

Arbitrary Interface BC Limitations



Arbitrary Interface T-junction Example

- **Not Supported for 2D Grid Systems**

- **Multiple Structured Directions**
  An unstructured arbitrary interface set cannot be matched up to a structured set that has multiple directions. The structured set has to be entirely in the i, j, or k direction.

- **Not Supported For Various Modules**
  Arbitrary Interfaces are not yet supported for the following modules/options: Stress Module (not supported in stress solved volume conditions)
  Electroplating Module
  Thin-Wall Feature - you cannot have an arbitrary interface at a thin-wall boundary condition
  Degenerate Grids - the procedure is to convert the sim to all polyzones with either the dtf_make_sim_poly utility or dtf_make_sim_poly ( ) API in the DTFOL_ ACE+ library Cyclic Boundary Conditions - if a cyclic boundary condition touches an arbitrary interface, results may be incorrect.

- **Conjugate Interfaces**
  The use of an arbitrary interface at a conjugate interface (any solid-fluid, solid-solid) may lead to inaccurate results

- **Monte-Carlo Radiation**
  You may use arbitrary interfaces in Monte-Carlo radiation simulations if the arbitrary interface set does not produce any residual boundary condition faces.

- **Avoid T-Junctions**
  There have been some problems encountered when T-Junction. A T-Junction is an area where two or more arbitrary interface sets come together. Because the arbitrary interface groups are always projected, we have found some probl ems at T-Junctions because some of the cell nodes could be trying to project in two directions.

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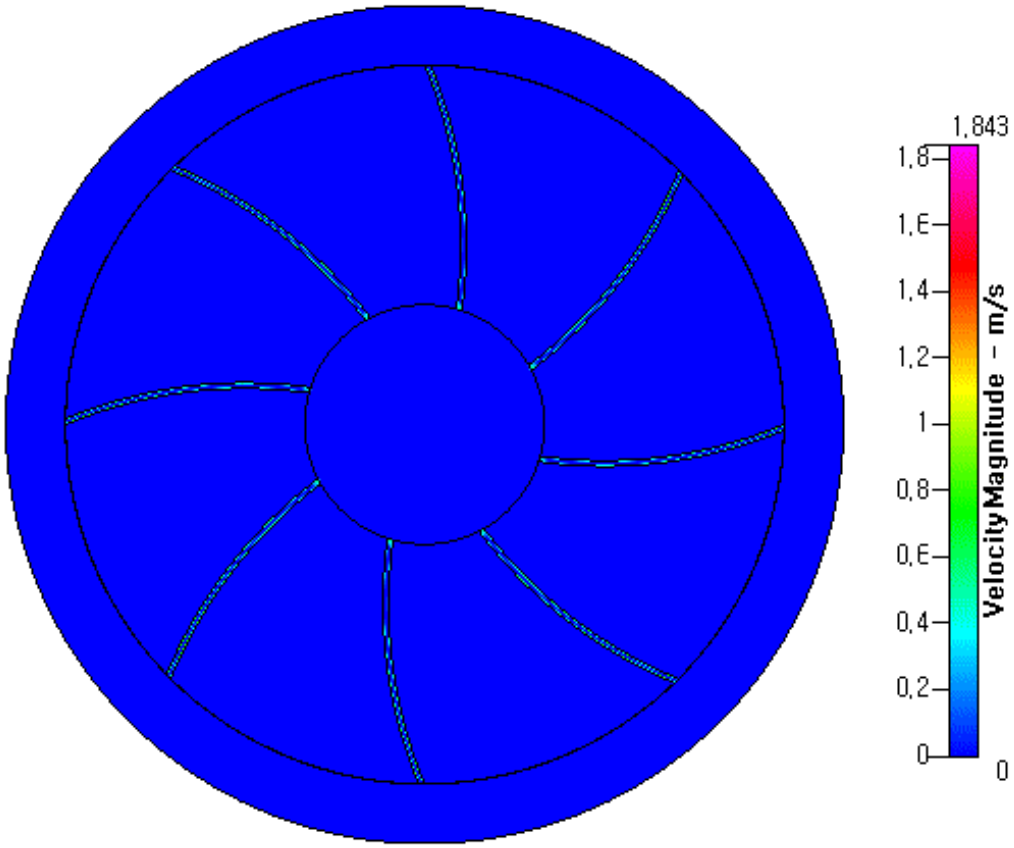
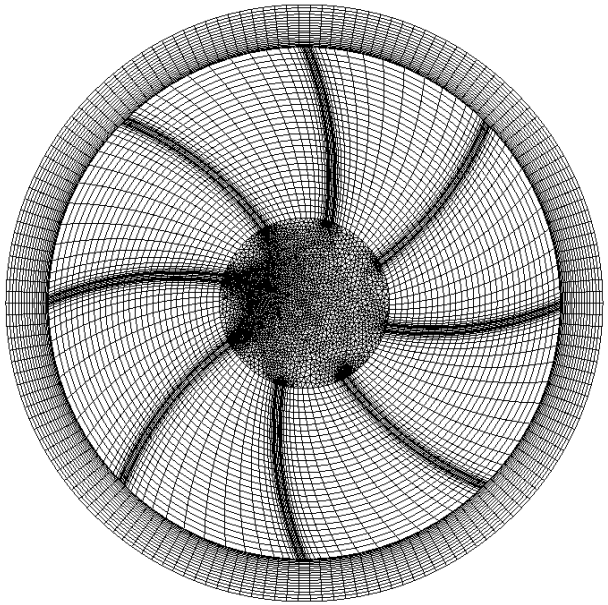
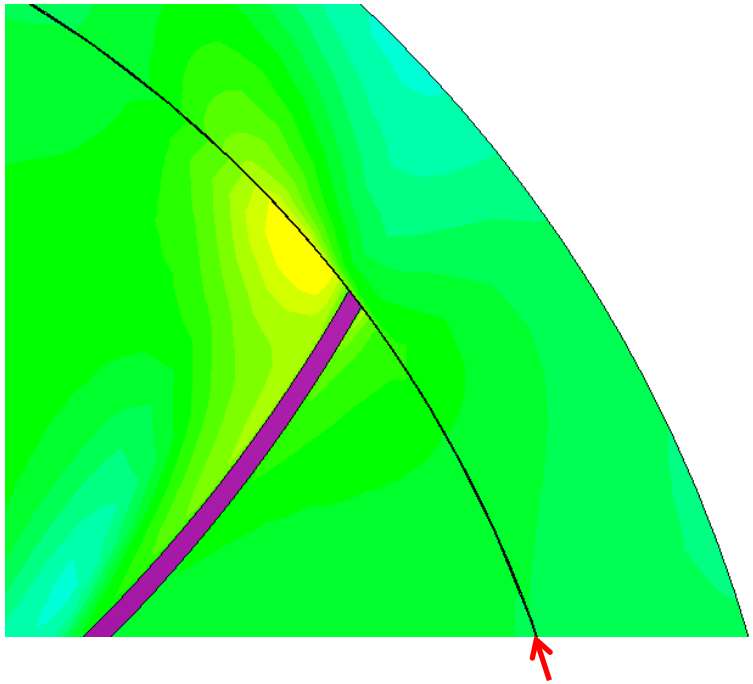
Setup, Example2 (Impeller)



Setup, Example2 (Impeller)

격자 형상





Gap : 0.1mm

Scale : milimeter[mm]

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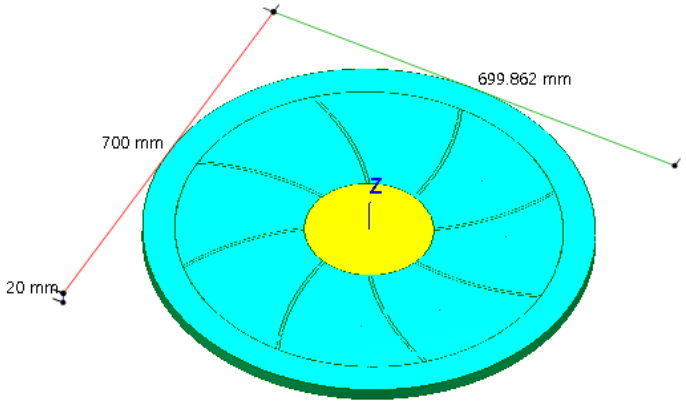
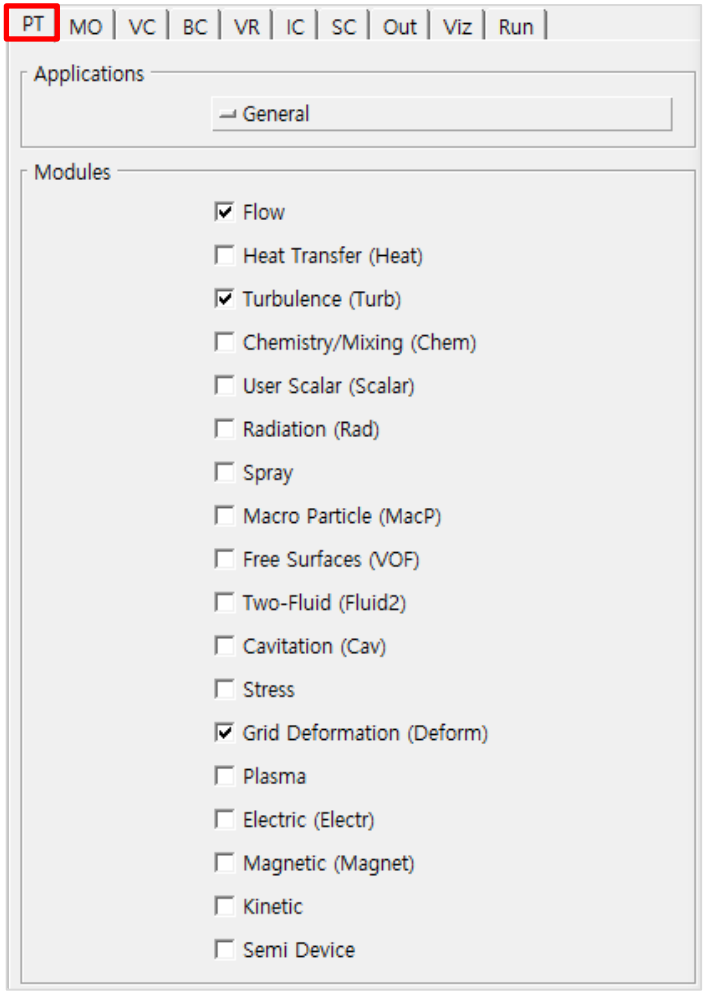
Setup, Example2 (Impeller)

1. DTF 파일 Open
2. PT : Flow, Grid Deformation 선택



Scale : milimeter[mm]



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Setup, Example2 (Impeller)

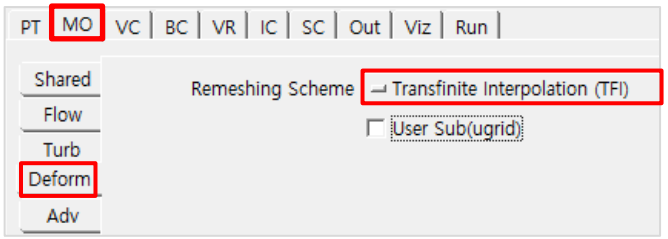
3. Model option

- Transient Time Step : Standard

  No. of steps : 1000

  Time Step : 0.1

- Grid deformation module은 반드시 Transient로 설정해야 함
- Deform : **Remeshing Scheme Transfinite Interpolation(TFI)**



4. Volume conditions

- solid를 제외한 전체 영역 선택 후 group로 지정
- Fluid subtype : Liquid(Water)선택

  Physics : density = 997 kg/m3

  Fluid : viscosity(kinematic) = 1.589E-05 m^2/s

- Solid : Aluminum alloy 선택(database)

  Physics : density = 2700 kg/m3

Setup, Example2 (Impeller)

5. Boundary conditions

→ BC Setting Mode : General

BC Type : inlet

Flow : Sub Type : Fix Vel. (Nomal)

Pressure= 0 Pa

Temperature=300K

Nomal Velocity = 1m/s

BC Type : outlet

Flow : Sub Type : Fixed Pressure

Pressure= 0 Pa

Temperature=300K

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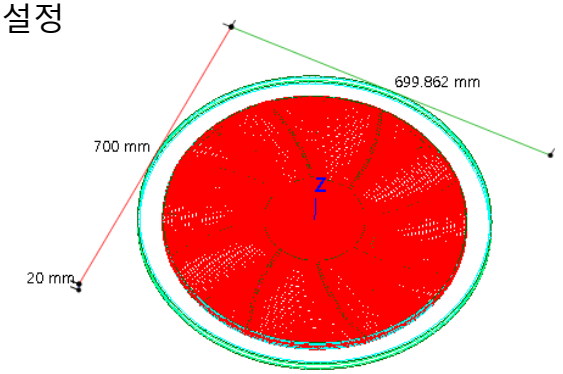
Setup, Example2 (Impeller)

5. Boundary conditions

회전 영역(붉은색)에 해당하는 모든 요소를 선택 후 아래와 같이 설정

Name	BC Type	BC SubType
outlet	Outlet	Fixed Pressure
inlet	Inlet	Fix Vel. (Normal)
arb_out	Wall	No Slip
NoName	Wall	No Slip
NoName	Wall	No Slip
Gen_3	Wall	No Slip
Gen_2	Interface	No Slip
Gen_1	Wall	No Slip



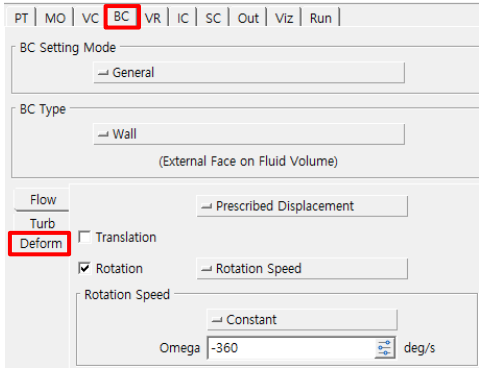
→ BC Setting Mode : General

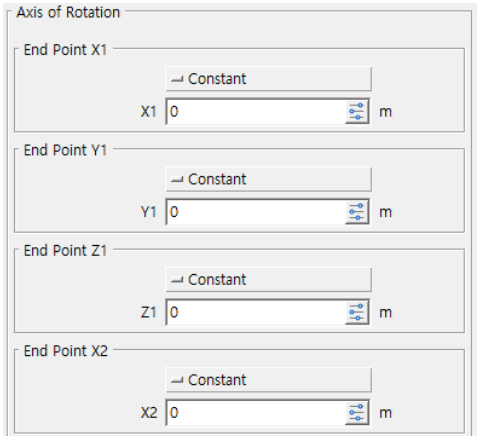
Deform : Prescribed Displacement

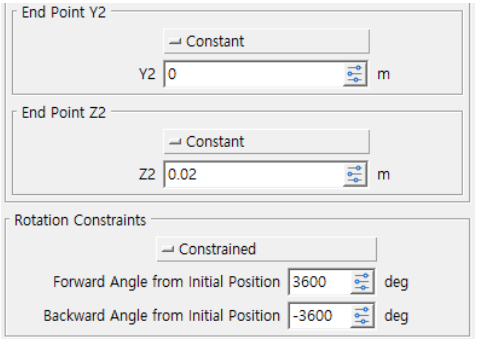
Rotation Speed = -360 deg/s

Axis of Rotation = P1(0, 0, 0), P2(0, 0, 0.02)을 중심축으로 회전

Forward / Backward Angle Form initial condition = 각각 360000/-360000(회전 한계각도 지정)







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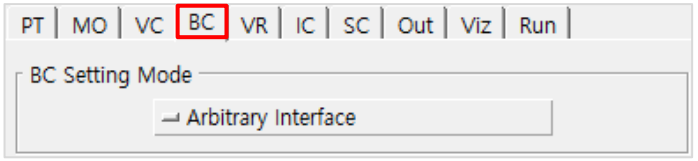
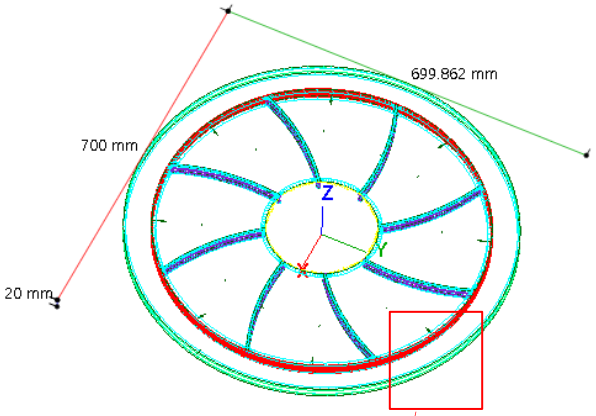
Setup, Example2 (Impeller)

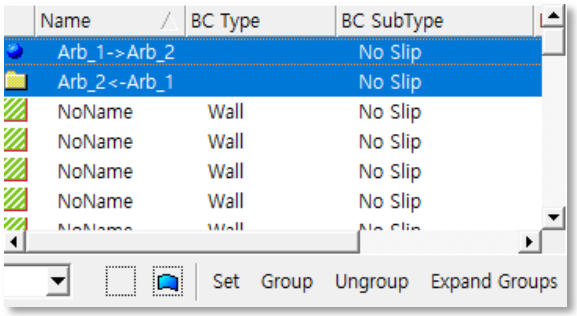


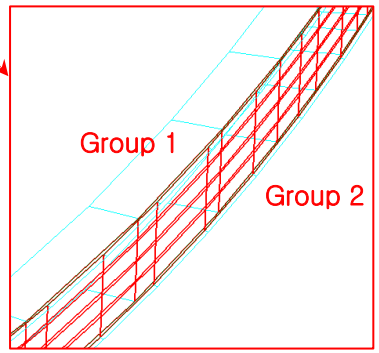
5. Boundary conditions

→ BC Setting Mode : ArbitrInterf. 선택

Arbitrary interface를 적용 하기 위해서는 서로 대응되는 모든 면을 각각 Group 설정



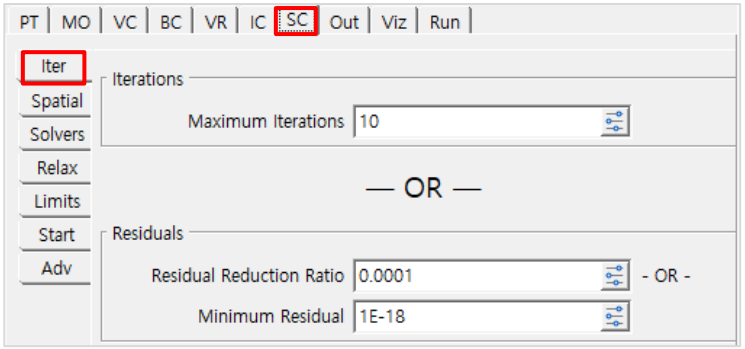




Setup, Example2 (Impeller)

6. SC (Solver control)

- Max iterations : 30



7. Run

- Submit to Solver