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FLOW FIELD ANALYSIS OF SOME MIXING AND CONVEYING SCREW ELEMENT REGIONS, WITHIN A CLOSELY INTERMESHING, CO-ROTATING TWIN-SCREW EXTRUDER

VOLUME 2

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Appendix A: Example of a Mesh Data File (.mdf).

01.02.000 ** MESH GENERATOR *MECANIQUE APPLIQUEE* / MESH DATA FILE /
**
*** No User's Comment ***

* LEVEL 1 : Description of the Macro-Vertices

| 0.0000000 | 0.0000000 | 0.0000000 |
| 0.0057362 | 0.0000000 | 0.0000000 |
| 0.0082350 | 0.0048900 | 0.0000000 |
| 0.0000000 | 0.0048900 | 0.0000000 |
| -0.0082350 | 0.0048900 | 0.0000000 |
| -0.0057362 | 0.0000000 | 0.0000000 |

* LEVEL 2 : Geometrical Description of the Macro-Segments

| 1 | 2 | 1 | 0 |
| 2 | 3 | 1 | 0 |
| 3 | 4 | 1 | 0 |
| 4 | 5 | 1 | 0 |
| 5 | 6 | 1 | 0 |
| 1 | 6 | 1 | 0 |

* LEVEL 2 : Description of the Macro-Elements

| 2 | 4 |
| 4 | 5 | 6 | 1 |

* LEVEL 3 : Generation specifications

| 1 | 1 | 0 |
| 1 | 1 | 0 |

* LEVEL 3 : Distribution specifications

| 1 | 2 | 20 | F | 3 | 1 |
| 3.0000000 |
| 2 | 3 | 20 | F | 3 | 1 |
| 1.0000000 |
| 3 | 4 | 20 | F | 3 | 1 |
| 2.0000000 |
| 1 | 4 | 20 | F | 3 | 1 |
| 1.0000000 |
| 4 | 5 | 20 | F | 3 | 1 |
| 3.0000000 |
| 5 | 6 | 20 | F | 3 | 1 |
| 1.0000000 |
| 1 | 6 | 20 | F | 3 | 1 |
| 3.0000000 |

* LEVEL 4 : Output format for the boundaries

| 1 |
| 1 |

* LEVEL 4 : Renumbering data

| 0 |

* LEVEL 4 : Subdomains

| 2 |
| 1 |

* LEVEL 4 : Boundary sets data

| 2 |
| 3 | 0 | 5 | 0 | 2 | 1 |
| 5 | 0 | 3 | 0 | 2 | 1 |

* LEVEL 4 : Primes

| 0 |

* LEVEL 4 : Definition of Additional Fields

| 0 |
Appendix B:  Example of a Mesh File (.msh) - Reduced.

BEGIN ROOT MESH
2 800 861 0 1660 2 2
2 0 1 -4

1660 0 800 -5
1657 0 800 -5
 1 3 8 6 9 16 12 14 17 26
20 22 24 27 38 30 32 34 36 39

1621 1623 1625 1627 1629 1631 1633 1635 1637 1639
1641 1643 1645 1647 1649 1651 1653 1655 1657 1659
 3 3 3 3 3 3 3 3 3 3
 3 3 3 3 3 3 3 3 3 3

2 2 2 2 2 2 2 2 2 2
2 2 2 2 2 2 2 2 2 2
1 2
2 3

859 861
861 860
ENDOF ROOT MESH
BEGIN PMESH
0 2
ENOF PMESH
BEGIN REORDER
191 172 154 137 121 106 92 79 67 56
46 37 29 22 16 11 7 4 2 1
211 192 173 155 138 122 107 93 80 68
57 47 38 30 23 17 12 8 5 3

800 799 797 794 790 785 779 772 764 755
745 734 722 709 695 680 664 647 629 610
ENOF REORDER
BEGIN FIELD
COORDINATES 1 1 1 2 1722
-0.8209614E-02-0.82350000E-02-0.8219617E-02-0.8194280E-02-0.8173849E-02

405
-0.8148653E-02 -0.8133614E-02 -0.8118421E-02 -0.8098823E-02 -0.8073858E-02

0.2664890E-03 0.0000000E+00 0.3010196E-04 0.1196668E-03 0.0000000E+00
0.3010196E-04 0.0000000E+00

END OF FIELD
POLYDATA
- 3.4.6 -

BEGIN PA3MN 1
#Main menu
. 1 0
#
BEGIN BAKEN 1
# Save and exit
. 1 0
ENDOF BAKEN
#
BEGIN RDMSH 1
# Read a mesh file
. 0 0
ENDOF RDMSH
#
BEGIN RDOPT 1
# Read and optimize a mesh file
. 1 0
ENDOF RDOPT
#
BEGIN CVMSH 1
# Convert a mesh file
. 1 0
ENDOF CVMSH
#
BEGIN SYNTA 1
# Filename syntax
. 1 1
I 1| 1
ENDOF SYNTA
#
BEGIN OUTPU 1
# Outputs
. 1 2
I 1| 32
I 1| 2
D 3| 0.1000000E+01 0.1000000E+01 0.1000000E-01
ENDOF OUTPU
#
BEGIN RDDAT 1
# Read an old data file
. 0 0
ENDOF RDDAT
#
BEGIN CRRUN 1
# Create a new task
. 1 0
I 1| 1
ENDOF CRRUN
#
BEGIN MDRUN 1
# Redefine global parameters of a task
. 0 0
ENDOF MDRUN
BEGIN NRUN1
# F.E.M. Task 1
. 1 1
C 79|F.E.M. Task 1
| I 1| 1
I 1| 0
I 1| 0
C 79|New computation
| I 1| 6
D 1| 0.10000000E-08
D 1| 0.10000000E+05
I 1| 4
L 1| F
D 3| 0.00000000E+00 0.00000000E+00 0.00000000E+00
#
BEGIN NUPAR
# Numerical parameters
. 1 5
I 1| 50
D 2| 0.10000000E-07 0.10000000E+05
I 1| 0
I 1| 0
I 1| 0
I 0|
D 6| 0.00000000E+00 0.10000000E+01 0.10000000E-01 0.10000000E-03
| 0.25000000E+00 0.10000000E-02
I 1| 20
I 1| 0
C 80|
|
C 80|
|
D 3| 0.00000000E+00 0.10000000E+01 0.10000000E-03
D 1| 0.00000000E+00
L 1| T
L 1| T
L 1| F
ENDOF NUPAR
#
BEGIN CRPRO
# Create a sub-task
. 1 0
ENDOF CRPRO
#
BEGIN MDPRO
# Redefine global parameters of a sub-task
. 0 0
ENDOF MDPRO
#
BEGIN ASSVE
# Velocity fields management
. 0 0
C 79|2.
|
I 2| 764 0
ENDOF ASSVE
#
BEGIN ASSTP
# Temperature fields management
. 0 0
ENDOF ASSTP

BEGIN ASSPR
  # Pressure fields management
  . 0 0
C 7912.
| I 2 | 764 0
ENDOF ASSPR

BEGIN ASSST
  # Stresses fields management
  . 0 0
ENDOF ASSST

BEGIN ASSDA
  # Darcy fields management
  . 0 0
ENDOF ASSDA

BEGIN ASSMS
  # Species fields management
  . 0 0
ENDOF ASSMS

BEGIN ASSPT
  # Potential fields management
  . 0 0
ENDOF ASSPT

BEGIN ASSHF
  # Thickness fields management
  . 0 0
ENDOF ASSHF

BEGIN ASSIN
  # Interfaces management (UV)
  . 0 0
ENDOF ASSIN

BEGIN PRCDN
  # Assign the pressure
  . 1 0
C 7912.
| D 3 | 0.0000000E+00 0.0000000E+00 0.0000000E+00 != PRESSURE ASSIGNED AT THE POINT !=
I 11 1
D 11 0.1000000E+06
C 7911
| ENDENOF PRCDN

BEGIN PSICN
  # Assign the stream function
  . 0 0
ENDOF PSICN

BEGIN CMINT
  # Mesh-mesh interpolation
  . 0 0
ENDOF CMINT

BEGIN ESPES
  # Define species
  . 0 0
ENDOF ESPES

BEGIN REACT
  # Define reactions
  . 0 0
ENDOF REACT
BEGIN PRBLM

Task 1 Sub-task 1

I 1| 1
I 1| 0
I 1| -1
I 1| 0
I 1| -1
I 1| -1
I 1| -1
I 1| -1
I 1| -1

BEGIN SUPOR

Domain of the sub-task

I 1| 0
C 79| 2
I 1| 0
ENDOF SUPOR

BEGIN MATDA

Material data

I 1| 0

BEGIN VISGA

Shear-rate dependence of viscosity

I 1| 3

BEGIN CSTGA

Constant viscosity

D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.0000000E+00
D 1| 0.0000000E+00
D 1| 0.0000000E+00
C 79| f(g) = fac

ENDOF CSTGA

BEGIN BIRCA

Bird-Carreau law

D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.0000000E+00
C 79| f(g) = facinf + (fac-facinf) * (1 + tan*tnat*g*g)**((expo-1)/2)

ENDOF BIRCA
BEGIN RELAX 1
  Relaxation mode
  . 1 0
  C 79|Relaxation mode 1
  |  
  I 1| 1
  D 1| 0.1000000E+01
  D 1| 0.1000000E+01
ENDOF RELAX
ENDOF VINTG

BEGIN MASPE 1
  Density
  . 1 0
  D 1| 0.8000000E+03
ENDOF MASPE

BEGIN INERT 1
  Inertia terms
  . 1 0
  L 1| F
ENDOF INERT

BEGIN VOLEX 1
  Coefficient of thermal expansion
  . 1 0
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  C 79| The density will be given by: \( \rho_0 \times (1 - \beta ( t - t_b ) \beta ) \)
  |  
  C 79| where \( \rho_0 \) is the reference density introduced in
  | the 'density' menu
  |  
  C 79| \( \beta \) is the coefficient of thermal expansi
  | on
  |  
  C 79| \( t_b \) is a reference temperature
ENDOF VOLEX

BEGIN CONDU 1
  Thermal conductivity
  . 1 0
  D 1| 0.1000000E+01
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  C 79| cond_ = a + b*t + c*t*t + d*t*t*t
  |  
ENDOF CONDU

BEGIN HECAP 1
  Heat capacity per unit mass
  . 1 0
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  D 1| 0.0000000E+00
  C 79| \( C_p = a + b*t + c*t*t + d*t**3 \)
  |  
ENDOF HECAP

BEGIN CONVE 1
  Heat convection
  . 1 0
  L 1| F
ENDOF CONVE
BEGIN VHEAT
  # Viscous heating
  . 1 0
L 1 P
ENDOF VHEAT

BEGIN GRAVI
  # Gravity
  . 1 0
D 1 0.00000000E+00
D 1 -0.98100000E+01
D 1 0.00000000E+00
ENDOF GRAVI

BEGIN TINIT
  # Average estimate
  . 1 
C 79 Average temperature
    
D 1 0.30000000E+03
ENDOF TINIT

BEGIN PRODQ
  # Source per unit volume
  . 1 1
C 79 Heat source per unit volume
    
D 1 0.00000000E+00
ENDOF PRODQ

BEGIN ADVCO
  # Carrier fluid concentration
  . 1 0
D 1 0.10132500E+06
D 1 0.83143000E+01
C 79 Ideal gas law : c(T) = P0 / Rg * T
    
ENDOF ADVCO

BEGIN ADVDF
  # Diffusivity
  . 1 2
D 1 0.10000000E+01
D 1 0.00000000E+00
C 79 Power law : D(T) = fact * (T)**expo
    
I 1 0
D 1 0.10000000E+01
D 1 0.00000000E+00
D 1 0.00000000E+00
D 1 0.00000000E+00
ENDOF ADVDF

BEGIN ADVAT
  # Thermal diffusion factor
  . 1 0
D 1 0.00000000E+00
D 1 0.00000000E+00
D 1 0.00000000E+00
C 79 Polynomial law : a(T) = a0 + a1 * T + a2 * T^2
    
ENDOF ADVAT

BEGIN SIGTY
  # Electrical conductivity
  . 1 0
I 1 1

BEGIN CSTSG
  Constant conductivity
  . 1 0
D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.0000000E+00
C 79| \( \text{sig}(T) = a \)
ENDOF CSTSG

BEGIN LINSG 1
  Linear conductivity
  . 1 0
D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.0000000E+00
C 79| \( \text{sig}(T) = a + b \times T \)
ENDOF LINSG

BEGIN EXPSG 1
  Exponential conductivity
  . 1 0
D 1| 0.1000000E+01
D 1| 0.0000000E+00
D 1| 0.0000000E+00
C 79| \( \text{sig}(T) = a \times \exp(b - c/T) \)
ENDOF EXPSG
ENDOF SIGTY
ENDOF MATDA

BEGIN BDCVE 1
  Flow boundary conditions
  . 1 0
L 1| T
D 1| 0.1000000E+01

BEGIN BDSVE 1
  Flow Boundary Set
  . 1 2
C 79| Inflow along boundary 1
    I 1| 3
    I 1| 7
    C 79| (2*3).
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
D 5| 0.0000000E+00
D 5| -0.5200000E-06 0.0000000E+00 0.0000000E+00 0.0000000E+00
D 5| 0.0000000E+00
D 5| -0.5200000E-06 0.0000000E+00 0.0000000E+00 0.0000000E+00
D 5| 0.0000000E+00
D 5| -0.5200000E-06 0.0000000E+00 0.0000000E+00 0.0000000E+00
D 5| 0.0000000E+00
I 1| 0.
ENDOF BDSVE
BEGIN BDSVE  2
Flow Boundary Set
   1  2
C 79|vx, vy, vz imposed along boundary  2 |
   I  1|  4
   I  1|  11
C 79|(2*4).
   D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  5|  -1 -1 -1 -1 -1
   I  3|  1 -1 -1
D  5|  0.1750500E-01  0.0000000E+00  0.1000000E-01  0.6283185E+01  0.0000000E+00 
   |  0.0000000E+00
   I  3|  1 -1 -1
D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  3|  1 -1 -1
D  5|  0.1750500E-01  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  1|  0
ENDOF BDSVE

BEGIN BDSVE  3
Flow Boundary Set
   1  2
C 79|vx, vy, vz imposed along boundary  3 |
   I  1|  5
   I  1|  11
C 79|(2*5).
   D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  5|  -1 -1 -1 -1 -1
   I  3|  1 -1 -1
D  5|  0.1750500E-01  0.0000000E+00  0.1000000E-01  0.6283185E+01  0.0000000E+00 
   |  0.0000000E+00
   I  3|  1 -1 -1
D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  3|  1 -1 -1
D  5|  0.1750500E-01  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  1|  0
ENDOF BDSVE

BEGIN BDSVE  4
Flow Boundary Set
   1  2
C 79|vn & vs imposed along boundary  4 |
   I  1|  6
   I  1|  1
C 79|(2*6).
   D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  5|  -1 -1 -1 -1 -1
   I  3|  0 -1 -1
D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  3|  0 -1 -1
D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  3|  0 -1 -1
D  5|  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00  0.0000000E+00 
   |  0.0000000E+00
   I  1|  0
BEGIN BDSVE
Flow Boundary Set
C 79|Outflow along boundary 5
| I 1| 7
I 1| 8
C 79|(2*7).
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.000000E+00
I 5| 3 -1 -1 -1 0
I 3| 0 -1 -1
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.200000E+01
I 3| 0 -1 -1
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.200000E+01
I 3| -1 -1 -1
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.000000E+00
I 1| 0
ENDOF BDSVE

BEGIN BDCPR
Pressure boundary conditions
. 0 0
ENDOF BDCPR

BEGIN BDCPT
Thermal boundary conditions
. 0 1
I 1| 1
C 79|
| I 1| -1
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.000000E+00
D 5| 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
| 0.000000E+00
ENDOF BDCPT

BEGIN BDCMS
Concentration boundary conditions
. 0 0
ENDOF BDCMS

BEGIN BDCPT
Potential boundary conditions
. 0 0
ENDOF BDCPT

BEGIN BDCCHF
Thickness boundary conditions
. 0 0
ENDOF BDCCHF

BEGIN SMAIL
Global remeshing
. 0 0
ENDOF SMAIL
BEGIN RIGTR
  # Rigid translation
  . 1 0
  I 1| 0
  C 79|.
  |
  I 1| -1
  D 1| 0.00000000E+00
  D 1| 0.00000000E+00
  D 1| 0.00000000E+00
  C 79| Translation speed : d/dt (X, Y, Z) = (Ux, Uy, Uz)
  |
ENDOF RIGTR

BEGIN INTerp
  # Interpolation
  . 1 0
  I 1| 1
  I 1| 0
  L 1| F
  I 2| 3 0
  L 1| F
ENDOF INTerp

BEGIN BUBBL
  # Bubbling
  . 1 0
  I 1| 0
ENDOF BUBBL
ENDOF PRBLM

BEGIN PRBLM
  # Task 1 Sub-task 1
  . 1 3
  C 79| Local shear-rate
  |
  I 1| 5
  I 1| 1
  I 1| 764
  I 1| 0
  I 1| -1
  I 1| -1
  I 1| -1
  I 1| -1
  I 1| -1
  I 1| -1

BEGIN SUPOR
  # Domain of the sub-task
  . 1 0
  I 1| 2
  C 79|2.
  |
  I 1| 0
ENDOF SUPOR

BEGIN MATda
  # Material data
  . 0 0
ENDOF MATda

BEGIN BDCPR
  # Pressure boundary conditions
  . 0 0
ENDOF BDCPR
BEGIN BDCMS 1
  Concentration boundary conditions
  . 0 0
ENDOF BDCMS

BEGIN BDCPT 1
  Potential boundary conditions
  . 0 0
ENDOF BDCPT

BEGIN BDCHF 1
  Thickness boundary conditions
  . 0 0
ENDOF BDCHF

BEGIN RIGTR 1
  Rigid translation
  . 1 0
I 1| 0
C 79|.
| I 1| -1
D 1| 0.00000000E+00
D 1| 0.00000000E+00
C 79|Translation speed : d/dt (X, Y, Z) = (Ux, Uy, Uz)
|
ENDOF RIGTR
ENDOF PRBLM

BEGIN PRBLM 3
  Task 1 Sub-task 1
  . 1 3
C 79|Inelastic stress tensor
| I 1| 5
I 1| 4
I 1| 764
I 1| 0
I 1| -1
I 1| -1
I 1| -1
I 1| -1
I 1| -1
I 1| -1

BEGIN SUPOR 1
  Domain of the sub-task
  . 1 0
I 1| 2
C 79|2.
| I 1| 0
ENDOF SUPOR

BEGIN MATDA 1
  Material data
  . 0 0
ENDOF MATDA

BEGIN BDCPR 1
  Pressure boundary conditions
  . 0 0
ENDOF BDCPR

BEGIN BDCMS 1
  Concentration boundary conditions
  . 0 0
ENDOF BDCMS
BEGIN BDCPT
  Potential boundary conditions
  . 0 0
ENDOF BDCPT

BEGIN BDCHF
  Thickness boundary conditions
  . 0 0
ENDOF BDCHF

BEGIN RIGTR
  Rigid translation
  . 1 0
I 1| 0
C 79|.
| I 1| -1
D 1| 0.00000000E+00
D 1| 0.00000000E+00
D 1| 0.00000000E+00
C 79|Translation speed : d/dt (X, Y, Z) = (Ux, Uy, Uz)
| ENDOF RIGTR
ENDOF PRBIM

BEGIN PRBIM
  Task 1 Sub-task 1
  . 1 3
C 79|Mixing efficiency
| I 1|  5
I 1|  1
I 1| 764
I 1|  0
I 1| -1
I 1| -1
I 1| -1
I 1| -1
I 1| -1
I 1| -1
ENDOF SUPOR

BEGIN SUPOR
  Domain of the sub-task
  . 1 0
I 1|  2
C 79|2.
| I 1|  0
ENDOF SUPOR

BEGIN MATDA
  Material data
  . 0 0
ENDOF MATDA

BEGIN BDCPR
  Pressure boundary conditions
  . 0 0
ENDOF BDCPR

BEGIN BDCMS
  Concentration boundary conditions
  . 0 0
ENDOF BDCMS
BEGIN BDCPT
#
Potential boundary conditions
. 0 0
ENDOF BDCPT
#
BEGIN BDCHF
#
Thickness boundary conditions
. 0 0
ENDOF BDCHF
#
BEGIN RIGTR
#
Rigid translation
. 1 0
I 1| 0
C 79|.
| I 1| -1
D 1| 0.00000000E+00
D 1| 0.00000000E+00
D 1| 0.00000000E+00
C 79|Translation speed : d/dt (X, Y, Z) = (Ux, Uy, Uz)
|
ENDOF RIGTR
ENOF PRLM
ENOF NRUN1
ENOF PSTMN
#

BEGIN OPEN
# Files opening
  0 0
C 55|MSH_1 f i  md3d0x1.msh
C 55|RES_1 f o  60m2nsa.res
C 55|CPV_1 f o  60m2nxa.cfv
#
BEGIN TOPO
# Topological operations
  0 0
C 6|MSH_1
C 35| 1 root mesh
C 55|1.
C 35| 1 S1.
C 55|2.
C 35| 1 (S1*B1).
C 55| (2*3).
C 35| 1 (S1*B2).
C 55| (2*4).
C 35| 1 (S1*B3).
C 55| (2*5).
C 35| 1 (S1*B4).
C 55| (2*6).
C 35| 1 (S1*B5).
C 55| (2*7).
#
BEGIN FIELDS
# Fields definition
  0 0
#
BEGIN FIELD1
# One field definition
  1 0
I 5| 1 1 1 1 3 0
C 21|XY COORDINATES
#
BEGIN READ
# One field initialization by read
  0 0
C 6|MSH_1
ENDOF READ
ENDOF FIELD1
#
BEGIN FIELD1
# One field definition
  1 0
I 5| 2 2 3 1 3 0
C 21|UV VELOCITIES
ENDOF FIELD1
#
BEGIN FIELD1
# One field definition
  1 0
I 5| 2 1 0 1 -1
C 21|P PRESSURE
ENDOF FIELD1
#
BEGIN FIELD1
# One field definition
  1 0
I 5| 3 5 0 1 0
C 21|Q Flow rate
#
420
BEGIN EVALX
    One field initialization by interpolation
    . 0 0
    L 1|  F  
    I 2|  3  1
    I 1|  4
    D 1|-0.5200000E-06
    ENDOF EVALX
ENDOF FIELD1

BEGIN FIELD1 5
    One field definition
    . 1 0
    I 5|  3  3  1  3  0
    C 21|v ns Veloc. N/S
    ENDOF FIELD1

BEGIN FIELD1 6
    One field definition
    . 1 0
    I 5|  3  5  0  1  0
    C 21|Gr_p Grad P
    ENDOF FIELD1

BEGIN FIELD1 7
    One field definition
    . 1 0
    I 5|  3  1  0  1  0
    C 21|p Pressure
    ENDOF FIELD1

BEGIN FIELD1 8
    One field definition
    . 1 0
    I 5|  7  3  1  3  0
    C 21|v ns Veloc. N/S
    ENDOF FIELD1

BEGIN FIELD1 9
    One field definition
    . 1 0
    I 5|  7  1  0  1  0
    C 21|p Pressure
    ENDOF FIELD1

BEGIN FIELD1 10
    One field definition
    . 1 0
    I 5|  2  3  0  1  0
    C 21|GMP LOCAL SHEAR-RATE
    ENDOF FIELD1

BEGIN FIELD1 11
    One field definition
    . 1 0
    I 5|  2  1  2  6  0
    C 21|T TENSOR T
    ENDOF FIELD1

BEGIN FIELD1 12
    One field definition
    . 1 0
    I 5|  2  3  0  1  0
    C 21|MIX LOCAL MIXING
    ENDOF FIELD1

421
BEGIN FIELD1 13
  One field definition
  1 0
  I 5| 2 5 0 1 0
C 2!|CMP LOCAL SHEAR-RATE
ENDOF FIELD1

BEGIN FIELD1 14
  One field definition
  1 0
  I 5| 2 5 2 6 0
C 2!|TENSOR T
ENDOF FIELD1

BEGIN FIELD1 15
  One field definition
  1 0
  I 5| 2 5 0 1 0
C 2!|MIX LOCAL MIXING
ENDOF FIELD1

BEGIN FIELD1 16
  One field definition
  1 0
  I 5| 7 5 0 1 0
C 2!|Q0 Q-output
ENDOF FIELD1

BEGIN PROBLS 1
  Problems definition
  0 0

BEGIN BEVXYZ 1
  Condition on a field at given coord.
  1 0
C 16| P = 0
I 3| 3 2 1
D 3| 0.0000000E+00 0.0000000E+00 0.0000000E+00
I 1| 1
D 1| 0.1000000E+06
ENDOF BEVXYZ

BEGIN PROB1 1
  One problem specifications
  1 1
C 16|Navier-Stokes 3D
I 4| 1 1 2 1
I 1| 1
I 2| 2 3
I 2| 0 0
L 1| F F F T F F F F
I 3| 3 1 5
D 28| 0.8000000E+03 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.4400000E+04 0.0000000E+00 0.5000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
ENDOF PROB1
BEGIN PROBLEM 2
One problem specifications
  . 1 0
C 16 | Inflow
I  3 | 54 1 3
I  2 | 1 4
I  2 | 2 6
I  2 | 0 2
L  1 | F
I  2 | 5 0
D  0
END OF PROBLEM

BEGIN BEVAXS 1
Field init.(parameter) on a boundary
  . 1 0
C 16 | Vx = 0
I  3 | 5 3 2
I  1 | 1
I  4 | 1 0 0 0
D  0
D  0
D  0
D  0
D  0
D  0
END OF BEVAXS

BEGIN BEVAXS 2
Field init.(parameter) on a boundary
  . 1 0
C 16 | Vx Vy Vz imposed
I  3 | 2 4 0
I  1 | 1
I  4 | 1 7 0 0
D  5 | 0.000000E+00 0.000000E+00 -0.6283185E+01 0.000000E+00
    | 0.000000E+00
D  0
D  0
D  0
D  0
D  0
D  0
D  0
END OF BEVAXS
BEGIN BEVAXS 3
Field init. (parameter) on a boundary
  1 0
C 16| Vx Vy Vz imposed
I 3| 2 5 0
I 1| 1
I 4| 1 7 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.6283185E+01 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
I 4| 2 7 0 0
D 5| -0.1099872E+00 0.6283185E+01 0.0000000E+00 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
I 4| 3 7 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
ENDOF BEVAXS

BEGIN BEVAXS 4
Field init. (parameter) on a boundary
  1 0
C 16| Vn Vs imposed
I 3| 2 6 0
I 1| 1
I 4| 1 0 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
I 4| 2 0 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
I 4| 3 0 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.0000000E+00
D 0|
D 0|
ENDOF BEVAXS

BEGIN BEVAXS 5
Field init. (parameter) on a boundary
  1 0
C 16| Outflow Vs = 0
I 3| 8 7 2
I 1| 1
I 4| 1 0 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.2000000E+01
D 0|
D 0|
I 4| 2 0 0 0
D 5| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
    | 0.2000000E+01
D 0|
D 0|
ENDOF BEVAXS
BEGIN PROB1
One problem specifications
. 1 0
C 16|Tensor T
I 3| 19 1 2
I 2| 1 2
I 1| 11
I 1| 0
L 4| F T F F
I 5| 4 3 1 5 0
D 14| 0.44000000E+04 0.00000000E+00 0.50000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00
ENDOF PROB1

BEGIN PROB1
One problem specifications
. 1 0
C 16|Calcul. of mixing
I 3| 19 1 2
I 2| 1 2
I 1| 12
I 1| 0
L 4| F T F F
I 5| 19 3 1 5 0
D 14| 0.44000000E+04 0.00000000E+00 0.50000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00
ENDOF PROB1

BEGIN PROB1
One problem specifications
. 1 0
C 16|Calcul. of IId
I 3| 19 1 2
I 2| 1 2
I 1| 13
I 1| 0
L 4| F T F F
I 5| 1 3 1 5 0
D 14| 0.44000000E+04 0.00000000E+00 0.50000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00
ENDOF PROB1

BEGIN PROB1
One problem specifications
. 1 0
C 16|Tensor T
I 3| 19 1 2
I 2| 1 2
I 1| 14
I 1| 0
L 4| F T F F
I 5| 4 3 1 5 0
D 14| 0.44000000E+04 0.00000000E+00 0.50000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.10000000E+01 0.00000000E+00
| 0.00000000E+00 0.00000000E+00 0.00000000E+00
ENDOF PROB1
BEGIN PROBL 9
One problem specifications
.  1 0
C 16|Calcul. of mixing
I 3| 19 1 2
I 2| 1 2
I 1| 15
I 1| 0
L 4| F T F F
I 5| 19 3 1 5 0
D 14| 0.4400000E+04 0.0000000E+00 0.5000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.1000000E+01 0.0000000E+00
| 0.0000000E+00 0.0000000E+00
ENDOF PROBL

BEGIN PROBL 10
One problem specifications
.  1 1
C 16|Post-Processor 2D
I 4| 18 1 7 2
I 2| 1 2
I 1| 16
I 1| 0
L 6| F T F F F F
I 6| 8 1 1 5 0 0
D 20| 0.4400000E+04 0.0000000E+00 0.5000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.1000000E+01 0.0000000E+00
| 0.0000000E+00 0.0000000E+00 0.1000000E+01 0.1000000E+01
| 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
ENDOF PROBL

BEGIN EVOLU 1
Multi-step problem definition
.  1 0
C 6|RES_1

BEGIN SOLVER 1
Solver
.  1 0
C 16|F.E.M. Task 1
I 3| 50 1 0
L 4| T T T T
D 2| 0.1000000E-07 0.1000000E+05
I 3| 1 2 3
ENDOF SOLVER

BEGIN SOLVER 2
Solver
.  1 0
C 16|Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 4
ENDOF SOLVER

BEGIN SOLVER 3
Solver
.  1 0
C 16|Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 5
ENDOF SOLVER
BEGIN SOLVER 4
Solver
  . 1 0
C 16| Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 6
ENDOF SOLVER

BEGIN SOLVER 5
Solver
  . 1 0
C 16| Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 7
ENDOF SOLVER

BEGIN SOLVER 6
Solver
  . 1 0
C 16| Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 8
ENDOF SOLVER

BEGIN SOLVER 7
Solver
  . 1 0
C 16| Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 9
ENDOF SOLVER

BEGIN SOLVER 8
Solver
  . 1 0
C 16| Postprocessors
I 3| 6 3 0
L 4| T T F T
D 2| 0.1000000E-07 0.1000000E+05
I 1| 10
ENDOF SOLVER

BEGIN OUTPUT 1
Output
  . 0 0

BEGIN CFVPF 1
  Interface CFView-PF
  . 0 0
C 6| CFV_1
I 10| 2 2 3 10 11 12 13 14 15 16
I 3| 3 0
I 3| 4 0
I 3| 5 0
I 3| 6 0
I 3| 7 0
ENDOF CFVPF
ENDOF OUTPUT
ENDOF EVOLU
ENDOF PROBLS
ENDOF FIELDS
ENDOF TOPO
BEGIN VERBOS 1
# Control of verbosity
  0  0
C 12|BANNER  2
C 12|GPS    0
C 12|ADR    0
C 12|TOPO   2
C 12|FIELDS 2
C 12|PROBLEMS 2
C 12|B.CONDIT. 2
C 12|CONSTRAINT 0
C 12|SOLVER  2
ENDOF VERBOS
ENDOF OPEN
Appendix D: Example of a Listings File (.lst).

Startup file is /disk2/user/ceacsg1/brucedp/.p3rc

PPPPPP OOOOO LL YY YY FFFFFF LL OOOOO WW WW
PP PP OOOO LL YY YY FF LL OOOO WW WW
PP PP OOOO LL YY YY FF LL OOOO WW WW
PPPPPP OOOO LL YY YY FFFFFF LL OOOO WW WW
PP OOOO LL YYYY FF LL OOOO WW WW
PP OOOO LL YYYY FF LL OOOO WW WW
PP OOOO LL YYYY FF LL OOOO WW WW
PP OOOO LL YYYY FF LL OOOO WW WW

*******************************************************************************
* *
* * POLYPFLOW s.a. *
* *
*******************************************************************************

*******************************************************************************
* *
* Version 3.4.6 *
* 1 *
* *
*******************************************************************************

*******************************************************************************
* *
* TOPO *
* *
*******************************************************************************

root mesh

Space Dim. : 3
Num. of bricks: 2298
Num. of faces : 8125
Num. of segm. : 9508
Num. of nodes : 3680

S1.

Space Dim. : 3
Num. of bricks: 2298
Num. of faces : 8125
Num. of segm. : 9508
Num. of nodes : 3680
<table>
<thead>
<tr>
<th></th>
<th>Space Dim.</th>
<th>Num. of faces</th>
<th>Num. of segm.</th>
<th>Num. of nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(S1^*B1)$</td>
<td>2</td>
<td>766</td>
<td>1687</td>
<td>920</td>
</tr>
<tr>
<td>$(S1^*B2)$</td>
<td>2</td>
<td>405</td>
<td>945</td>
<td>540</td>
</tr>
<tr>
<td>$(S1^*B3)$</td>
<td>2</td>
<td>135</td>
<td>315</td>
<td>180</td>
</tr>
<tr>
<td>$(S1^*B4)$</td>
<td>2</td>
<td>390</td>
<td>910</td>
<td>520</td>
</tr>
<tr>
<td>$(S1^*B5)$</td>
<td>2</td>
<td>766</td>
<td>1687</td>
<td>920</td>
</tr>
</tbody>
</table>

**FIELDS**

**COORDINATES**
- Abreviated as: $XY$
- Support: root mesh
- Interp. Type: $P_1;C_0$
- Tensor Type: 1
- Num. of Comp.: 3
- Num. of Var.: 11040

**VELOCITIES**
- Abreviated as: $UV$
- Support: $S_1$
- Interp. Type: $P_2;C_0$
- Tensor Type: 1
- Num. of Comp.: 3
- Num. of Var.: 70833

**PRESSURE**
- Abreviated as: $P$
- Support: $S_1$
- Interp. Type: $P_1;C_0$
- Tensor Type: 0
- Num. of Comp.: 1
- Num. of Var.: 3680
Flow rate
Abreviated as: \( Q \)
Support: \((S1 \cdot B1)\)
Interp. Type: Cste over domain
Tensor Type: 0
Num. of Comp.: 1
Num. of Var.: 1

Veloc. N/S
Abreviated as: \( v_{ns} \)
Support: \((S1 \cdot B1)\)
Interp. Type: \( P2;C0 \)
Tensor Type: 1
Num. of Comp.: 3
Num. of Var.: 10119

Grad P
Abreviated as: \( \text{GrP} \)
Support: \((S1 \cdot B1)\)
Interp. Type: Cste over domain
Tensor Type: 0
Num. of Comp.: 1
Num. of Var.: 1

Pressure
Abreviated as: \( P \)
Support: \((S1 \cdot B1)\)
Interp. Type: \( P1;C0 \)
Tensor Type: 0
Num. of Comp.: 1
Num. of Var.: 920

Veloc. N/S
Abreviated as: \( v_{ns} \)
Support: \((S1 \cdot B5)\)
Interp. Type: \( P2;C0 \)
Tensor Type: 1
Num. of Comp.: 3
Num. of Var.: 10119

Pressure
Abreviated as: \( P \)
Support: \((S1 \cdot B5)\)
Interp. Type: \( P1;C0 \)
Tensor Type: 0
Num. of Comp.: 1
Num. of Var.: 920

LOCAL SHEAR
Abreviated as: \( GMP \)
Support: \( S1 \)
Interp. Type: \( P2;C0 \)
Tensor Type: 0
Num. of Comp.: 1
Num. of Var.: 23611

TENSOR T
Abreviated as: \( T \)
Support: \( S1 \)
Interp. Type: \( P1;C0 \)
Tensor Type: 2
Num. of Comp.: 6
Num. of Var.: 22080
LOCAL MIXIN

Abreviated as : MIX
Support : S1.
Interp. Type : P2:C0
Tensor Type : 0
Num. of Comp. : 1
Num. of Var. : 23611

LOCAL SHEAR

Abreviated as : GMP
Support : S1.
Interp. Type : Cste over domain
Tensor Type : 0
Num. of Comp. : 1
Num. of Var. : 1

TENSOR T

Abreviated as : T
Support : S1.
Interp. Type : Cste over domain
Tensor Type : 2
Num. of Comp. : 6
Num. of Var. : 6

LOCAL MIXIN

Abreviated as : MIX
Support : S1.
Interp. Type : Cste over domain
Tensor Type : 0
Num. of Comp. : 1
Num. of Var. : 1

Q-output

Abreviated as : Q0
Support : (S1*B5).
Interp. Type : Cste over domain
Tensor Type : 0
Num. of Comp. : 1
Num. of Var. : 1

******************************************************************************
*                                                                       *
* PROBLEMS                                                               *
*                                                                       *
******************************************************************************

Navier-Stokes 3D

Support : S1.
Coordinates : COORDINATES
Input Fields :
Output Fields : VELOCITIES

Navier-Stokes 3D
isothermal flow problem
generalized newtonian fluid

no streamline upwinding in momentum equation
picard iteration for viscosity law
viscosity function: visc = F(g)

shear-rate dependence of the viscosity: F(g)
viscosity law: power law:
F(g) = fac * g**(expo-1)
fac = 4.40000E+03, expo = 5.00000E-01

specific mass: \( \rho = 8.00000E+02 \)

gravity field taken into account:
gx = 0.00000E+00
gy = -9.81000E+00
gz = 0.00000E+00

inertia terms neglected in momentum equation

Inflow
Support: (S1*B1).
Coordinates: COORDINATES
Input Fields: Flow rate
Output Fields: VELOCITIES, Grad P

NORMAL FORCE AND FLOW RATE
=================================

imposed on a 2D cross-section (the domain is 3D)

Outflow
Support: (S1*B5).
Coordinates: COORDINATES
Input Fields: -
Output Fields: Veloc. N/S, PRESSURE

Calcul. of IId
Support: S1.
Coordinates: COORDINATES
Input Fields: VELOCITIES
Output Fields: LOCAL SHEAR

algebraic post-processor 3D
the mean least square technique is applied for computing
the local shear rate 'gamma-dot'

Tensor T
Support: S1.
Coordinates: COORDINATES
Input Fields: VELOCITIES
Output Fields: TENSOR T

algebraic post-processor 3D
the mean least square technique is applied for computing
the stress tensor T

viscosity function: visc = F(g)

shear-rate dependence of the viscosity: F(g)
viscosity law: power law:
F(g) = fac * g**(expo-1)
fac = 4.40000E+03, expo = 5.00000E-01
<table>
<thead>
<tr>
<th>Calcul. of mixin</th>
<th>Support :</th>
<th>S1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coordinates :</td>
<td>COORDINATES</td>
</tr>
<tr>
<td></td>
<td>Input Fields :</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td></td>
<td>Output Fields :</td>
<td>LOCAL MIXIN</td>
</tr>
</tbody>
</table>

algebraic post-processor 3D
the mean least square technique is applied for computing
the function $d/(d+w)$

<table>
<thead>
<tr>
<th>Calcul. of IIId</th>
<th>Support :</th>
<th>S1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coordinates :</td>
<td>COORDINATES</td>
</tr>
<tr>
<td></td>
<td>Input Fields :</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td></td>
<td>Output Fields :</td>
<td>LOCAL SHEAR</td>
</tr>
</tbody>
</table>

algebraic post-processor 3D
the mean least square technique is applied for computing
the local shear rate 'gamma-dot'

<table>
<thead>
<tr>
<th>Tensor T</th>
<th>Support :</th>
<th>S1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coordinates :</td>
<td>COORDINATES</td>
</tr>
<tr>
<td></td>
<td>Input Fields :</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td></td>
<td>Output Fields :</td>
<td>TENSOR T</td>
</tr>
</tbody>
</table>

algebraic post-processor 3D
the mean least square technique is applied for computing
the stress tensor $T$

viscosity function : $\eta = F(\gamma)$

shear-rate dependence of the viscosity : $F(\gamma)$

viscosity law : power law :

\[ F(\gamma) = \text{fac} \times \gamma^{\expo-1} \]

\[ \text{fac} = 4.400000E+03, \expo = 5.000000E-01 \]

<table>
<thead>
<tr>
<th>Calcul. of mixin</th>
<th>Support :</th>
<th>S1.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coordinates :</td>
<td>COORDINATES</td>
</tr>
<tr>
<td></td>
<td>Input Fields :</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td></td>
<td>Output Fields :</td>
<td>LOCAL MIXIN</td>
</tr>
</tbody>
</table>

algebraic post-processor 3D
the mean least square technique is applied for computing
the function $d/(d+w)$

<table>
<thead>
<tr>
<th>Post-Processor 2</th>
<th>Support :</th>
<th>(S1*B5).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coordinates :</td>
<td>COORDINATES</td>
</tr>
<tr>
<td></td>
<td>Input Fields :</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td></td>
<td>Output Fields :</td>
<td>Q-output</td>
</tr>
</tbody>
</table>

algebraic post-processor 2D and 2D 1/2
the flow rate through the current boundary part is obtained
from the integration of the velocity field

plane geometry
Liaison vns vxy
Field: Veloc. N/S
Support: (S1*B5).
Lagr. Mult. of: VELOCITIES
Act. on Probs: Outflow

Vs = 0
Field: Veloc. N/S
Support: (S1*B1).
Lagr. Mult. of: VELOCITIES
Act. on Probs:
    Navier-Stokes 3D
    Inflow
    Outflow
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Post-Processor 2
For comp. 1: Zero Value
For comp. 2: Zero Value

Vx Vy Vz imposed
Field: VELOCITIES
Support: (S1*B2).
Act. on Probs:
    Navier-Stokes 3D
    Inflow
    Outflow
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Post-Processor 2
For comp. 1: Funct. 7 used
For comp. 2: Funct. 7 used
For comp. 3: Funct. 7 used

Vx Vy Vz imposed
Field: VELOCITIES
Support: (S1*B3).
Act. on Probs:
    Navier-Stokes 3D
    Inflow
    Outflow
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Calcul. of IIId
    Tensor T
    Calcul. of mixin
    Post-Processor 2
For comp. 1: Funct. 7 used
For comp. 2: Funct. 7 used
For comp. 3: Funct. 7 used
Vn Vs imposed

<table>
<thead>
<tr>
<th>Field</th>
<th>VELOCITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>(S1*B4)</td>
</tr>
<tr>
<td>Act. on Probs</td>
<td></td>
</tr>
</tbody>
</table>

Navier-Stokes 3D

Inflow

Outflow

Calcul. of IID

Tensor T

Calcul. of mixin

Calcul. of IID

Tensor T

Calcul. of mixin

Post-Processor 2

For comp. 1 : Zero Value
For comp. 2 : Zero Value
For comp. 3 : Zero Value

Outflow Vs = 0

<table>
<thead>
<tr>
<th>Field</th>
<th>Veloc. N/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>(S1*B5)</td>
</tr>
<tr>
<td>Lagr. Mult. of</td>
<td>VELOCITIES</td>
</tr>
<tr>
<td>Act. on Probs</td>
<td></td>
</tr>
</tbody>
</table>

Navier-Stokes 3D

Inflow

Outflow

Calcul. of IID

Tensor T

Calcul. of mixin

Calcul. of IID

Tensor T

Calcul. of mixin

Post-Processor 2

For comp. 1 : Zero Value
For comp. 2 : Zero Value

*************
*
* SOLVER *
*
*************

F.E.M. Task 1

Type of Evolu.: Implicit
Infl. on Evol.: Influent
Explicit part : One pass
Problem list :

Navier-Stokes 3D

Inflow

Outflow

Nitmax : 50
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 1294
Number of active var. : 43578
Number of static var. : 6902
BLAS3 in use, Blocs = 20
### Iteration 1

Frontal method information:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal pivot</td>
<td>0.1937432E-16</td>
</tr>
<tr>
<td>Maximal pivot</td>
<td>0.5730315E+03</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
<td>-0.7111102E+04 / 1</td>
</tr>
<tr>
<td>Maximal rhs</td>
<td>-0.2287599E+02</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
<td>0.1000000E+01</td>
</tr>
<tr>
<td>Relative var. of field PRESSURE</td>
<td>0.1000000E+01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1000000E+01</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
<td>0.1000000E+01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1000000E+01</td>
</tr>
</tbody>
</table>

### Iteration 2

Frontal method information:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal pivot</td>
<td>0.1402268E-15</td>
</tr>
<tr>
<td>Maximal pivot</td>
<td>0.1971791E+03</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
<td>-0.2337855E+05 / 1</td>
</tr>
<tr>
<td>Maximal rhs</td>
<td>-0.8585958E+00</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
<td>0.8730840E-01</td>
</tr>
<tr>
<td>Relative var. of field PRESSURE</td>
<td>0.3018232E+02</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1261249E+00</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
<td>0.3234326E+01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1324824E+00</td>
</tr>
</tbody>
</table>

### Iteration 3

Frontal method information:

<table>
<thead>
<tr>
<th>Parameter</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Minimal pivot</td>
<td>0.1231819E-15</td>
</tr>
<tr>
<td>Maximal pivot</td>
<td>0.3114774E+03</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
<td>-0.2042417E+05 / 1</td>
</tr>
<tr>
<td>Maximal rhs</td>
<td>-0.8476212E-02</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
<td>0.3146219E-01</td>
</tr>
<tr>
<td>Relative var. of field PRESSURE</td>
<td>0.1210261E+00</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.3343865E-01</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
<td>0.1461724E+00</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.3845588E-01</td>
</tr>
</tbody>
</table>

### Iteration 4

Frontal method information:

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Minimal pivot</td>
<td>0.1175142E-15</td>
</tr>
<tr>
<td>Maximal pivot</td>
<td>0.4152498E+03</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
<td>-0.1913705E+05 / 1</td>
</tr>
<tr>
<td>Maximal rhs</td>
<td>-0.2997244E-02</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
<td>0.1485865E-01</td>
</tr>
<tr>
<td>Relative var. of field PRESSURE</td>
<td>0.4651829E-01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1191951E-01</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
<td>0.6462103E-01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.1493558E-01</td>
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### Iteration 5

Frontal method information:

<table>
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</thead>
<tbody>
<tr>
<td>Minimal pivot</td>
<td>0.1156776E-15</td>
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<tr>
<td>Maximal pivot</td>
<td>0.4901114E+03</td>
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<tr>
<td>log10 / sign (det.)</td>
<td>-0.1857672E+05 / 1</td>
</tr>
<tr>
<td>Maximal rhs</td>
<td>-0.1228125E-02</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
<td>0.6678801E-02</td>
</tr>
<tr>
<td>Relative var. of field PRESSURE</td>
<td>0.1574646E-01</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.4667895E-02</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
<td>0.2777761E-01</td>
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<tr>
<td>Relative var. of field Veloc. N/S</td>
<td>0.6033448E-02</td>
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438
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<td>Minimal pivot</td>
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<td>Maximal pivot</td>
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<tr>
<td>log10 / sign (det.)</td>
</tr>
<tr>
<td>Maximal rhs</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
</tr>
<tr>
<td>Relative var. of field (PRESSURE)</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
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<td>Relative var. of field Veloc. N/S</td>
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<td>Minimal pivot</td>
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<td>Maximal pivot</td>
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<tr>
<td>log10 / sign (det.)</td>
</tr>
<tr>
<td>Maximal rhs</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
</tr>
<tr>
<td>Relative var. of field (PRESSURE)</td>
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<tr>
<td>Relative var. of field Veloc. N/S</td>
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<tr>
<td>Relative var. of field Grad P</td>
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<td>Relative var. of field Veloc. N/S</td>
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<td>Frontal method information:</td>
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<td>Minimal pivot</td>
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<tr>
<td>Maximal pivot</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
</tr>
<tr>
<td>Maximal rhs</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
</tr>
<tr>
<td>Relative var. of field (PRESSURE)</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
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<table>
<thead>
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<td>Maximal pivot</td>
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<tr>
<td>log10 / sign (det.)</td>
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<tr>
<td>Maximal rhs</td>
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<td>Relative var. of field VELOCITIES</td>
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<tr>
<td>Relative var. of field (PRESSURE)</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
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<td>Relative var. of field Veloc. N/S</td>
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<table>
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<td>Minimal pivot</td>
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<tr>
<td>Maximal pivot</td>
</tr>
<tr>
<td>log10 / sign (det.)</td>
</tr>
<tr>
<td>Maximal rhs</td>
</tr>
<tr>
<td>Relative var. of field VELOCITIES</td>
</tr>
<tr>
<td>Relative var. of field (PRESSURE)</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
</tr>
<tr>
<td>Relative var. of field Grad P</td>
</tr>
<tr>
<td>Relative var. of field Veloc. N/S</td>
</tr>
</tbody>
</table>
Iteration 11

Frontal method information :
Minimal pivot : 0.1147618E-15
Maximal pivot : 0.5636695E+03
log10 / sign (det.) : -0.1814495E+05 / 1
Maximal rhs : 0.1016634E-04
Relative var. of field VELOCITIES : 0.6085764E-04
Relative var. of field (PRESSURE) : 0.2477883E-04
Relative var. of field Veloc. N/S : 0.3255921E-04
Relative var. of field Grad P : 0.1861722E-03
Relative var. of field Veloc. N/S : 0.3582353E-04

Iteration 12

Frontal method information :
Minimal pivot : 0.1147618E-15
Maximal pivot : 0.5640373E+03
log10 / sign (det.) : -0.1814320E+05 / 1
Maximal rhs : 0.4801094E-05
Relative var. of field VELOCITIES : 0.2761507E-04
Relative var. of field (PRESSURE) : 0.1127937E-04
Relative var. of field Veloc. N/S : 0.1476166E-04
Relative var. of field Grad P : 0.8150137E-04
Relative var. of field Veloc. N/S : 0.1546963E-04

Iteration 13

Frontal method information :
Minimal pivot : 0.1147620E-15
Maximal pivot : 0.5642031E+03
log10 / sign (det.) : -0.1814243E+05 / 1
Maximal rhs : 0.2282139E-05
Relative var. of field VELOCITIES : 0.1253181E-04
Relative var. of field (PRESSURE) : 0.5166288E-05
Relative var. of field Veloc. N/S : 0.6690892E-05
Relative var. of field Grad P : 0.3569691E-04
Relative var. of field Veloc. N/S : 0.6759466E-05

Iteration 14

Frontal method information :
Minimal pivot : 0.1147621E-15
Maximal pivot : 0.5642779E+03
log10 / sign (det.) : -0.1814209E+05 / 1
Maximal rhs : 0.1090097E-05
Relative var. of field VELOCITIES : 0.5720336E-05
Relative var. of field (PRESSURE) : 0.2378481E-05
Relative var. of field Veloc. N/S : 0.3032959E-05
Relative var. of field Grad P : 0.1563610E-04
Relative var. of field Veloc. N/S : 0.2979849E-05

Iteration 15

Frontal method information :
Minimal pivot : 0.1147622E-15
Maximal pivot : 0.5643116E+03
log10 / sign (det.) : -0.1814195E+05 / 1
Maximal rhs : 0.5226075E-06
Relative var. of field VELOCITIES : 0.2651451E-05
Relative var. of field (PRESSURE) : 0.1099797E-05
Relative var. of field Veloc. N/S : 0.1375267E-05
Relative var. of field Grad P : 0.6847319E-05
Relative var. of field Veloc. N/S : 0.1356313E-05
Iteration 16

Frontal method information:
Minimal pivot : 0.1147623E-15
Maximal pivot : 0.5643267E+03
log10 / sign (det.) : -0.1814188E+05 / 1
Maximal rhs : 0.2512350E-06
Relative var. of field VELOCITIES : 0.1228857E-05
Relative var. of field (PRESSURE) : 0.5104619E-06
Relative var. of field Veloc. N/S : 0.6239012E-06
Relative var. of field Grad P : 0.2996944E-05
Relative var. of field Veloc. N/S : 0.6174339E-06

Iteration 17

Frontal method information:
Minimal pivot : 0.1147623E-15
Maximal pivot : 0.5643336E+03
log10 / sign (det.) : -0.1814185E+05 / 1
Maximal rhs : 0.1210263E-06
Relative var. of field VELOCITIES : 0.5695608E-06
Relative var. of field (PRESSURE) : 0.2377133E-06
Relative var. of field Veloc. N/S : 0.2832053E-06
Relative var. of field Grad P : 0.1310671E-05
Relative var. of field Veloc. N/S : 0.2811630E-06

Iteration 18

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643366E+03
log10 / sign (det.) : -0.1814184E+05 / 1
Maximal rhs : 0.5860899E-07
Relative var. of field VELOCITIES : 0.2640284E-06
Relative var. of field (PRESSURE) : 0.1110259E-06
Relative var. of field Veloc. N/S : 0.1286393E-06
Relative var. of field Grad P : 0.5725975E-06
Relative var. of field Veloc. N/S : 0.1280893E-06

Iteration 19

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643380E+03
log10 / sign (det.) : -0.1814183E+05 / 1
Maximal rhs : 0.2843196E-07
Relative var. of field VELOCITIES : 0.1224744E-06
Relative var. of field (PRESSURE) : 0.5199331E-07
Relative var. of field Veloc. N/S : 0.5847279E-07
Relative var. of field Grad P : 0.2498372E-06
Relative var. of field Veloc. N/S : 0.5838371E-07

Iteration 20

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643386E+03
log10 / sign (det.) : -0.1814183E+05 / 1
Maximal rhs : 0.1380081E-07
Relative var. of field VELOCITIES : 0.5695619E-07
Relative var. of field (PRESSURE) : 0.2440706E-07
Relative var. of field Veloc. N/S : 0.2659816E-07
Relative var. of field Grad P : 0.1088414E-06
Relative var. of field Veloc. N/S : 0.2662659E-07
Iteration 21

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643390E+03
log10 / sign (det.) : -0.1814183E+05 / 1
Maximal rhs : 0.6702082E-08
Relative var. of field VELOCITIES : 0.2677814E-07
Relative var. of field (PRESSURE : 0.1148256E-07
Relative var. of field Veloc. N/S : 0.1210800E-07
Relative var. of field Grad P : 0.4733188E-07
Relative var. of field Veloc. N/S : 0.1215071E-07

Iteration 22

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643390E+03
log10 / sign (det.) : -0.1814183E+05 / 1
Maximal rhs : 0.3256048E-08
Relative var. of field VELOCITIES : 0.1272219E-07
Relative var. of field (PRESSURE : 0.5413042E-08
Relative var. of field Veloc. N/S : 0.5515915E-08
Relative var. of field Grad P : 0.2054055E-07
Relative var. of field Veloc. N/S : 0.5548271E-08

Iteration 23

Frontal method information:
Minimal pivot : 0.1147624E-15
Maximal pivot : 0.5643391E+03
log10 / sign (det.) : -0.1814183E+05 / 1
Maximal rhs : 0.1582442E-08
Relative var. of field VELOCITIES : 0.6051773E-08
Relative var. of field (PRESSURE : 0.2556569E-08
Relative var. of field Veloc. N/S : 0.2514685E-08
Relative var. of field Grad P : 0.8892462E-08
Relative var. of field Veloc. N/S : 0.2535068E-08
Convergence assumed : Rel. var. LT 0.1000000E-07

Postprocessors
Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Calcul. of IId
Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T
Frontal method preprocessor
Maximum frontal width : 482
Number of active var. : 18191
Number of static var. : 5420
BLAS3 in use, Blocs = 20

Iteration 1

Frontal method information :
Minimal pivot : 0.1983149E-13
Maximal pivot : 0.5316473E-09
log10 / sign (det.) : -0.2495639E+06 / 1
Maximal rhs : 0.1287985E-06
Relative var. of field LOCAL SHEAR 0.1000000E+01

Iteration 2

Frontal method information :
Minimal pivot : 0.1983149E-13
Maximal pivot : 0.5316473E-09
log10 / sign (det.) : -0.2495639E+06 / 1
Maximal rhs : 0.9264423E-22
Relative var. of field LOCAL SHEAR 0.2844649E-14
Convergence assumed : Rel. var. LT 0.1000000E-07

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*       SOLVER                *
*                             *
*******************************

Postprocessors
Type of Evolu. : Explicit
Infl. on Evol. : Transparent
Explicit part : One pass
Problem list : Tensor T

Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 798
Number of active var. : 21984
Number of static var. : 96
BLAS3 in use, Blocs = 20

Iteration 1

Frontal method information :
Minimal pivot : 0.6197360E-12
Maximal pivot : 0.7367612E-09
log10 / sign (det.) : -0.2195902E+06 / 1
Maximal rhs : -0.7358483E-04
Relative var. of field TENSOR T 0.1000000E+01

443
Iteration 2

Frontal method information:
Minimal pivot : 0.6197360E-12
Maximal pivot : 0.7367612E-09
log10 / sign (det.) : -0.2195902E+06 / 1
Maximal rhs : 0.3875176E-19
Relative var. of field TENSOR T : 0.2858581E-14
Convergence assumed : Rel. var. LT 0.1000000E-07

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*                     *
*  SOLVER             *
*                     *
********************

Postprocessors

Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Calcul. of mixin

Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 482
Number of active var. : 18191
Number of static var. : 5420
BLAS3 in use, Blocs = 20

Iteration 1

Frontal method information:
Minimal pivot : 0.1983149E-13
Maximal pivot : 0.5316473E-09
log10 / sign (det.) : -0.2495639E+06 / 1
Maximal rhs : 0.5525010E-09
Relative var. of field LOCAL MIXIN : 0.1000000E+01

Iteration 2

Frontal method information:
Minimal pivot : 0.1983149E-13
Maximal pivot : 0.5316473E-09
log10 / sign (det.) : -0.2495639E+06 / 1
Maximal rhs : 0.4135903E-24
Relative var. of field LOCAL MIXIN : 0.3606005E-14
Convergence assumed : Rel. var. LT 0.1000000E-07
Postprocessors
Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Calcul. of IId

Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 1
Number of active var. : 1
Number of static var. : 0
BLAS3 in use, Blocs = 20

Iteration 1
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.5535300E+01 / 1
Maximal rhs : 0.1454083E-03
Relative var. of field LOCAL SHEAR 0.1000000E+01

Iteration 2
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.5535300E+01 / 1
Maximal rhs : 0.2884280E-18
Relative var. of field LOCAL SHEAR 0.1994479E-14
Convergence assumed : Rel. var. LT 0.1000000E-07
Postprocessors
Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Tensor T
Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 6
Number of active var. : 6
Number of static var. : 0
BLAS3 in use, Blocs = 20

Iteration 1
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.3321180E+02 / 1
Maximal rhs : 0.1002990E+02
Relative var. of field TENSOR T 0.1000000E+01

Iteration 2
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.3321180E+02 / 1
Maximal rhs : 0.1101704E-16
Relative var. of field TENSOR T 0.1090506E-13
Convergence assumed : Rel. var. LT 0.1000000E-07
Postprocessors
Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Calcul. of mixin

Nitmax : 6
Static : T
Conver. Crit. : 0.1000000E-07
Diverg. Crit. : 0.1000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 1
Number of active var. : 1
Number of static var. : 0
BLAS3 in use, Blocs = 20

Iteration 1
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.5535300E+01 / 1
Maximal rhs : 0.1511218E-05
Relative var. of field LOCAL MIXIN 0.1000000E+01

Iteration 2
Frontal method information :
Minimal pivot : 0.2915414E-05
Maximal pivot : 0.2915414E-05
log10 / sign (det.) : -0.5535300E+01 / 1
Maximal rhs : 0.2057043E-20
Relative var. of field LOCAL MIXIN 0.1285093E-14
Convergence assumed : Rel. var. LT 0.1000000E-07
Postprocessors
Type of Evolu.: Explicit
Infl. on Evol.: Transparent
Explicit part : One pass
Problem list : Post-Processor 2

Nitmax : 6
Static : T
Conver. Crit. : 0.10000000E-07
Diverg. Crit. : 0.10000000E+05
Print Iter. : T

Frontal method preprocessor
Maximum frontal width : 1
Number of active var. : 1
Number of static var. : 0
BLAS3 in use, Blocks = 20

Iteration 1

Frontal method information :
Minimal pivot : 0.10000000E+01
Maximal pivot : 0.10000000E+01
log10 / sign (det.) : -0.7216450E-14 / 1
Maximal rhs : 0.5208735E-06
Relative var. of field Q-output : 0.00000000E+00
Convergence assumed : Rel. var. LT 0.10000000E-07
Appendix E: Example of a Result File (.res) - Reduced.

BEGIN FIELD
COORDINATES 1 1 1 3 11040
-0.1265632E-02 -0.2480693E-02 -0.3666588E-02 -0.4549999E-02 -0.1585082E-02
-0.2759561E-02 -0.3914596E-02 -0.4867974E-02 -0.1904532E-02 -0.2825528E-02

ENDOF FIELD
BEGIN FIELD
VELOCITIES 2 3 1 3 70833
0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00

ENDOF FIELD
BEGIN FIELD
PRESSURE 2 1 0 1 3680
0.6797855E+05 0.4745180E+05 0.3537908E+05 0.1669526E+04 0.7653203E+04
-0.8559998E+04 0.4052335E+04 -0.2936573E+05 0.9313728E+04 0.3450544E+04

ENDOF FIELD
BEGIN FIELD
Flow rate 9 5 0 1 1

ENDOF FIELD
BEGIN FIELD
Veloc. N/S 9 3 1 3 10119
0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00
0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00 0.0000000E+00

ENDOF FIELD
BEGIN FIELD
Grad P 9 5 0 1 1

ENDOF FIELD
<table>
<thead>
<tr>
<th>Pressure</th>
<th>9</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>920</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
</tbody>
</table>

---
<table>
<thead>
<tr>
<th>Veloc. N/S</th>
<th>13</th>
<th>3</th>
<th>1</th>
<th>3</th>
<th>10119</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
</tbody>
</table>

---
| -0.2617711E-04 | -0.1804767E-03 | -0.1985772E-04 | -0.1704456E-03 | -0.1831495E-04 |
| -0.1753062E-03 | -0.1941079E-04 | -0.1789624E-04 | -0.2068439E-04 | -0.5839749E-03 |
| -0.4919908E-03 | -0.4733939E-03 | -0.4809070E-03 | -0.4861376E-03 | |

---
<table>
<thead>
<tr>
<th>Pressure</th>
<th>13</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>920</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
<tr>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td>0.0000000E+00</td>
<td></td>
</tr>
</tbody>
</table>

---
<table>
<thead>
<tr>
<th>LOCAL SHEAR</th>
<th>2</th>
<th>3</th>
<th>0</th>
<th>1</th>
<th>23611</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8511253E+02</td>
<td>0.1342007E+03</td>
<td>0.1680791E+03</td>
<td>0.1878259E+03</td>
<td>0.1973596E+03</td>
<td></td>
</tr>
<tr>
<td>0.1705500E+03</td>
<td>0.1644297E+03</td>
<td>0.1647140E+03</td>
<td>0.1486400E+03</td>
<td>0.1474432E+03</td>
<td></td>
</tr>
</tbody>
</table>

---
| 0.1135311E+01 | 0.1127745E+01 | 0.1115936E+01 | 0.1111622E+01 | 0.1477163E+01 |
| 0.6844444E+00 | 0.5918458E+00 | 0.5813712E+00 | 0.5837047E+00 | 0.5817278E+00 |
| 0.5787311E+00 | |

---
<table>
<thead>
<tr>
<th>Tensor T</th>
<th>2</th>
<th>1</th>
<th>2</th>
<th>6</th>
<th>22080</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.7530872E+04</td>
<td>-0.4513127E+03</td>
<td>0.1346680E+03</td>
<td>0.1946903E+05</td>
<td>-0.2449779E+04</td>
<td></td>
</tr>
<tr>
<td>0.3367656E+03</td>
<td>0.6274563E+04</td>
<td>0.1731849E+05</td>
<td>0.2416165E+04</td>
<td>0.4784347E+03</td>
<td></td>
</tr>
</tbody>
</table>

---
| -0.1071896E+04 | -0.8615300E+03 | -0.6772992E+03 | -0.4444540E+03 | -0.2127038E+04 |
| -0.1500648E+04 | -0.1226392E+04 | -0.1014447E+04 | -0.8000226E+03 | -0.5245219E+03 |

---
<table>
<thead>
<tr>
<th>Local Mixin</th>
<th>2</th>
<th>3</th>
<th>0</th>
<th>1</th>
<th>23611</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1634932E+00</td>
<td>0.2881566E+00</td>
<td>0.3810606E+00</td>
<td>0.4477062E+00</td>
<td>0.6054454E+00</td>
<td></td>
</tr>
<tr>
<td>0.5810425E+00</td>
<td>0.5163167E+00</td>
<td>0.3734266E+00</td>
<td>0.5688195E+00</td>
<td>0.6276320E+00</td>
<td></td>
</tr>
</tbody>
</table>

---
<table>
<thead>
<tr>
<th>Tensor Type</th>
<th>Rank</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Shear</td>
<td>2</td>
<td>5 3 1 1</td>
</tr>
<tr>
<td>Tensor T</td>
<td>2</td>
<td>5 2 6 6</td>
</tr>
<tr>
<td>Local Mixin</td>
<td>2</td>
<td>5 0 1 1</td>
</tr>
</tbody>
</table>

END OF FIELD
BEGIN FIELD
Q-output
<table>
<thead>
<tr>
<th>Rank</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>5 0 1 1</td>
</tr>
</tbody>
</table>

END OF FIELD
The 24mm pitched, single-flighted conveying screw elements channel flow simulations were represented using the following parameters.

**Name of Mesh File:**
24mmp.msh

**Name of Data File:**
24mtime.dat

**New Task:**
1. **Task 1:**
   - **Method of Solving Problem:**
     - F.E.M. task
     - Time dependent

   **Geometry:**
   - 2D planar geometry

   **Create a Sub-Task:**
   A. **Sub-Task 1:**
     - **Problem to be Solved:**
       - Generalized Newtonian isothermal flow problem

     **Domain of the Sub-Task:**
     - On sub-domain S1

   B. **Sub-Task 2:**
     - **Problem to be Solved:**
       - Generalized Newtonian isothermal flow problem

     **Domain of the Sub-Task:**
     - On sub-domain S2
Titles Given to Sub-Tasks 1 and 2:
1 Liquid right
2 Liquid left

C Sub-Task 3:
Problem to be Solved:
Post-Processor

Title Given to Sub-Task 3:
3 Tracking

Domain of the Sub-Task:
On sub-domains S1+S2

Sub-Task 1: Liquid right

Material Data (Ideal Rheology for Polypropylene):

1 Shear-Rate Dependence of Viscosity:
Power Law (f(g) is a function of shear rate):

\[ f(g) = \text{fac} \cdot g^{\text{expo}-1} \]

Shear Rate Viscosity (poise): \( \text{fac} = 4400 \)
Power Index: \( \text{expo} = 0.5 \)

5 Density:
Density (kg m\(^{-3}\)): \( r_0 = 800 \)

6 Inertia Terms:
Inertia will be neglected in the momentum equations:

11 Gravity:
Gravity component (m sec\(^{-2}\)): \( g_x = 0, g_y = 0 \) and \( g_z = 0 \)

Flow Boundary Conditions:
Boundary Number to Which Conditions Apply:
BS1: Moving outer wall
Normal & Tangential Velocities Imposed ($v_n$ & $v_t$):

Normal velocity component (m sec$^{-1}$): $v_n = 0$
Tangential velocity component (m sec$^{-1}$): $v_t = 0.13$

Boundary Number to Which Conditions Apply:
BS2: Screw profile (stationary)

Normal & Tangential Velocities Imposed ($v_n$ & $v_t$):

Normal velocity component (m sec$^{-1}$): $v_n = 0$
Tangential velocity component (m sec$^{-1}$): $v_t = 0$

Interface Conditions
Interface is imposed: Along subdomains S1 and S2

0 Interface
Moving interface
Surface tension force:

\[ t_n = \gamma R \]

Surface tension coefficient (kg sec$^{-2}$): $\gamma = 0$ (No surface tension effect)

Global Remeshing:

Remeshing technique

2 Method of Spines
Remeshing inlet: Intersection with boundary 1
Remeshing outlet: Intersection with boundary 2

Element distortion check
No action is taken as long as the following distortion limits are not exceeded:

Minimum interior angle: 5
Maximum interior angle: 170
Maximum aspect ratio: 10
Maximum bend: 0.8
Maximum skew: 10
Domain for rigid translation

The current translation is defined on an empty mesh

Rigid translation

Translational speed (m sec⁻¹): \( U_x = 0, U_y = 0 \) and \( U_z = 0 \)

Sub-Task 2: Liquid left

Identical properties to Sub-task 1 used

Interpolation:

Linear coordinates

Quadratic velocities, linear pressure

Picard iterations on viscosity(g)

No upwinding in momentum equations

Numerical Parameters:

No previous solution

Coupled iterations of moving surfaces

Calculation of initial solution

Surface kinematic condition

Numerical Parameters for Iterations:

Maximum number of iterations = 50

Convergence test = \( 1 \times 10^{-7} \)

Divergence test = \( 1 \times 10^{3} \)

Transient Iterative Parameters:

Initial time value = 0

Upper time limit = 10

Initial value of time step = \( 1 \times 10^{-3} \)

Minimum admissible value of the time-step = \( 1 \times 10^{-4} \)

Maximum admissible value of the time-step = \( 2.5 \times 10^{-1} \)

Tolerance for time marching = \( 1 \times 10^{-3} \)

Maximum number of successful steps = 100

Method for the integration

Crank-Nicholson and Implicit Euler methods determined and results compared.
Assign the Pressure:
Field is shared by sub-tasks: $S_1 + S_2$
Pressure field is currently imposed at the node closest to the coordinates: $x = 0$ and $y = 0$.
Current value of the pressure condition is: $P = 0 \text{ (Pa)}$

Assign the Stream Function:
Field is shared by sub-tasks: $S_1 + S_2$
The stream function currently vanishes at the node closest to the coordinates: $x = 0$ and $y = 0$.

Mesh to Mesh Interpolation
None

Outputs
Output at each: $dt = 0.01$
Current output(s): Polyplot
Listing: max
Check ADDR: off
Appendix G:
Flow Problem Parameters as Seen Within Each Polymesh Menu, for the Time-Dependent Simulation of the 2D Y-Z Screw Channel Flow, Representative of the Single-Flighted Conveying Screw Elements.

************************************
*                                 *
*    POLYDATA                    *
*                                 *
************************************

Version : 3. 4. 6. 1

# - Save and exit
1 - Read a mesh file (enter 1 or CR)
2 - Read and optimize a mesh file (enter 2)
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
# - Outputs
# - Read an old data file
# - Create a new task
# - Redefine global parameters of a task

Enter your choice

Enter the name of the mesh file (default = msh)

24mmp.msh

Is it a formatted file
Enter y(es) or n(o) (CR=yes)

Loading the mesh data ...

************************************
*                                 *
*    POLYDATA                    *
*                                 *
************************************

Version : 3. 4. 6. 1

# - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file (enter 3)
3 - Convert a mesh file (enter 4)
4 - Filename syntax
# - Outputs
6 - Read an old data file (enter 6)
7 - Create a new task (enter 7 or CR)
# - Redefine global parameters of a task

Enter your choice

6

Enter the name of the old data file (default = dat)

24mtime.dat

Loading the data ...

Checking the data ...
Enter your choice

-1 - Upper level menu     (enter -1 or CR)
  0 - Output Triggering    (enter 0)
  1 - Disable Polyplot output (enter 1)
  2 - Enable Patran output (enter 2)
  3 - Enable Supertab output (enter 3)
  4 - Enable DataVisual output (enter 4)
  # - Enable Explorer output
  6 - Enable CFView-PF output (enter 6)
  7 - Enable Polyflow output (enter 7)
  8 - Listing : none (enter 8)
  9 - Listing : min (enter 9)
 10 - Listing : max (enter 10)
 11 - Enable ADDR check (enter 11)

Enter your choice

-2 - Delete the current task     (enter -2)
-1 - Accept the current setup    (enter -1 or CR)
> 1 - F.E.M. task                 (enter 1)
# - MIXING task
  3 - Steady-state problem(s)     (enter 3)
> 4 - Time-dependent problem(s)   (enter 4)
  5 - Evolution problem(s)        (enter 5)
  6 - Rigid rotation              (enter 6)
> 7 - 2D planar geometry          (enter 7)
# - 2D axisymmetric geometry     (enter 9)
  9 - 2D 1/2 planar geometry      (enter 9)
# - 2D 1/2 axisymmetric geometry

Enter your choice
1 - Upper level menu                    (enter -1 or CR)
1 - Numerical parameters              (enter  1)
2 - Create a sub-task                 (enter  2)
3 - Redefine global parameters of a sub-task (enter  3)
4 - Assign the pressure                (enter  4)
5 - Assign the stream function        (enter  5)
6 - Mesh-mesh interpolation           (enter  6)
# - Define species                    (enter  9)
# - Define reactions                  (enter 10)
9 - Liquid right                      (enter 11)
10 - Liquid Left                      (enter 10)
11 - Tracking                         (enter 11)

Enter your choice

4

******************************************************************************
*                                                          *
*    Numerical parameters                                   *
*                                                          *
******************************************************************************

- Maximum number of iterations = 50
- Convergence test = 1.0000000E-07
- Divergence test = 1.0000000E+03

-1 - Upper level menu                        (enter -1 or CR)
1 - Modify of the max number of iterations  (enter  1)
2 - Modify of the convergence test          (enter  2)
3 - Modify of the divergence test           (enter  3)

Enter your choice
**Transient iterative parameters**

- Initial time value = 0.00000000E+00
- Upper time limit = 1.00000000E+01
- Initial value of the time step = 1.00000000E-02
- Min admissible value of the time-step = 1.00000000E-03
- Max admissible value of the time-step = 2.50000000E-04
- Tolerance for time marching = 1.00000000E-03
- Max number of successful steps = 100
- Use of the Crank-Nicholson method for the integration

-1 - Upper level menu  (enter -1 or CR)
1 - Modify the initial time value  (enter 1)
2 - Modify the upper time limit  (enter 2)
3 - Modify the initial value of the time-step (enter 3)
4 - Modify the min value of the time-step (enter 4)
5 - Modify the max value of the time-step (enter 5)
6 - Modify the tolerance (enter 6)
7 - Modify the max number of successful steps (enter 7)
8 - Use of the 0-order method
9 - Use of the implicit Euler method (enter 9)
10 - Use of the Galerkin method (enter 10)
11 - Use of the Crank-Nicholson method (enter 11)
12 - Disable prediction of velocity field (enter 12)

Enter your choice

***
*  Assign the pressure  *
*
***

The calculation of the pressure field associated with the following velocity field requires a point at which the value of the pressure is imposed.

1 : Field shared by sub-tasks- Liquid right
   - Liquid Left

-1 - Upper level menu  (enter -1 or CR)
1 - Pressure condition for field 1 (enter 1)

Enter your choice

1

***
*  Pressure condition  *
*
***

The pressure field is currently imposed at the node closest to coordinates:

\[ X = 0.00000000E+00 \quad Y = 0.00000000E+00 \]

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

Current value of pressure condition is 0.00000000E+00
Enter its new value (CR=no modification)
The calculation of the stream function PSI associated with the following velocity or Darcy pressure field requires a point at which PSI equals to zero.

1 : Field shared by sub-tasks - Liquid right
- Liquid Left

-1 - Upper level menu (enter -1 or CR)
1 - Condition on the stream function for field 1 (enter 1)

Enter your choice

1

***************************************************************
* *
* Condition on the stream function *
* *
***************************************************************

The stream function currently vanishes at the node closest to coordinates:

X = 0.0000000E+00  Y = 0.0000000E+00

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

***************************************************************
* *
* Mesh-mesh interpolation *
* *
***************************************************************

Mesh-mesh interpolations interpolate all potential velocity, pressure, temperature, and stress fields from a previous result to the current task.

Such an interpolation has not yet been defined.

-1 - Accept current setup (enter -1 or CR)
1 - Create interpolations (enter 1)
# - Modify file names

Enter your choice

***************************************************************
* *
* Redefine global parameters of a sub-task *
* *
***************************************************************

Sub-task : Liquid right

-1 - Upper level menu (enter -1 or CR)
1 - Delete the current sub-task (enter 1)
2 - Modify the title of the current sub-task (enter 2)
3 - Modify the type of the current sub-task (enter 3)

Enter your choice

3
**Redefine global parameters of a sub-task**

1 - Generalized Newtonian isothermal flow problem (enter 1 or CR)
2 - Generalized Newtonian non-isothermal flow problem (enter 2)
3 - Heat conduction problem (enter 3)
4 - Differential viscoelastic isothermal flow problem
5 - Differential viscoelastic non-isothermal flow problem
6 - Postprocessor
7 - Integral viscoelastic isothermal flow problem
8 - Integral viscoelastic non-isothermal flow problem
9 - Darcy isothermal flow problem (enter 9)
10 - Darcy non-isothermal flow problem (enter 10)
11 - Slightly compressible flow problem (enter 11)
12 - Mass transfer problem (enter 12)
13 - Potential problem (enter 13)
14 - Film model: Gen. Newtonian isothermal (enter 14)
15 - Film model: Gen. Newtonian non-isothermal (enter 15)
16 - Film model: Viscoelastic isothermal
17 - Thickness for film
18 - Transport of species
19 - Closure

Enter your choice

1

**Liquid right**

-1 - Upper level menu (enter -1 or CR)
1 - Domain of the sub-task (enter 1)
2 - Material data (enter 2)
3 - Flow boundary conditions (enter 3)
4 - Global remeshing (enter 4)
5 - Rigid translation (enter 5)
6 - Interpolation (enter 6)
# - Bubbling

Enter your choice

-2 - Make the current domain empty (enter -2)
-1 - Upper level menu (enter -1 or CR)
0 - Extension to the whole mesh (enter 0)
1 - Removal of subdomain 1 (enter 1)
2 - Addition of subdomain 2 (enter 2)

Enter your choice
-1 - Upper level menu         (enter -1 or CR)
1 - Shear-rate dependence of viscosity (enter 1)
  # - Temperature dependence of viscosity
  # - Differential viscoelastic models
  # - Integral Viscoelastic models
  5 - Density                  (enter 5)
  6 - Inertia terms            (enter 6)
  # - Coefficient of thermal expansion
  # - Thermal conductivity
  # - Heat capacity per unit mass
  # - Viscous heating
11 - Gravity                  (enter 11)
  # - Average temperature
  # - Heat source per unit volume

Enter your choice

1

********************************************************************************
*                        *
*   Shear-rate dependence of viscosity   *
*                        *
********************************************************************************

-1 - Upper level menu         (enter -1 or CR)
1 - Constant viscosity        (enter 1)
  2 - Bird-Carreau law         (enter 2)
  > 3 - Power law              (enter 3)
  4 - Bingham law              (enter 4)
  5 - Herschel-Bulkley law     (enter 5)
  6 - Cross law                (enter 6)

Enter your choice

3

***************
*            *
*    Power law     *
*            *
***************

\[ f(g) = \text{fac} \times g^{(\text{expo}-1)} \]

\[
\text{fac} = 4.40000000E+03 \quad \text{expo} = 5.00000000E-01
\]

-1 - Upper level menu         (enter -1 or CR)
1 - Modification of fac       (enter 1)
  2 - Modification of expo    (enter 2)

Enter your choice
density = 8.000000E+02

-1 - Upper level menu (enter -1 or CR)
1 - Modification of density (enter 1)

Enter your choice

******************************************************
*                                                   *
*         Inertia terms                               *
*                                                   *
******************************************************

Inertia will be neglected in the momentum equations

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

******************************************************
*                                                   *
*         Gravity                                    *
*                                                   *
******************************************************

gx = 0.0000000E+00
gz = 0.0000000E+00
gy = 0.0000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Modification of gx (enter 1)
2 - Modification of gy (enter 2)
# - Modification of gz

Enter your choice

************************************************************
*                                                   *
*     Flow boundary conditions                        *
*                                                   *
************************************************************

-1 - Upper level menu (enter -1 or CR)
# - Normal flow rate imposed
1 - Interface along subdomain 2 (enter 1)
2 - vn & vs imposed along boundary 1 (enter 2)
3 - vn & vs imposed along boundary 2 (enter 3)

Select the boundary condition you want to modify

1
Current choice : Interface
No force postprocessor

-2 - Enable force postprocessor
-1 - Upper level menu
CR)
> 0 - Interface
1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
2 - Normal and tangential forces imposed (fn & fs) (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
5 - Slip conditions
6 - Plane of symmetry (fs=0 & vn=0) (enter 6)
7 - Inflow
8 - Outflow
# - Free surface
10 - Global force imposed (enter 10)
11 - Cartesian velocities imposed (vx,vy) (enter 11)

Enter your choice

0

********************
* *
* Interface *
* *
********************

The current setup is :
- Moving interface
- No Surface tension effect

-1 - Accept the current setup
1 - Define a fixed interface (enter 1)
2 - Modify the moving interface parameters (enter 2)

Enter your choice
2

********************
* *
* Kinematic condition *
* *
********************

-1 - Upper level menu (enter -1 or CR)
1 - Surface tension (enter 1)
2 - Boundary conditions (enter 2)
# - Normal force
4 - Direction of motion (enter 4)
5 - Contact (Blow mold.) (enter 5)
6 - Upwinding in the kinematic equation (enter 6)
7 - Outlet (Inv. prediction) (enter 7)
# - Drag

Enter your choice
1
Surface tension:

\[ tn = -\gamma \frac{1}{R} \]

where: \( \gamma \) = surface tension coefficient
\( R \) = local radius of curvature

Current value of \( \gamma \) is 0.00000000E+00
Enter its new value (CR=no modification)

* * *
* Flow boundary condition along boundary 1 *
* *
* * *

Current choice: \( v_n \) & \( v_s \) imposed
No force postprocessor

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)

# - Interface
1 - Normal and tangential velocities imposed (\( v_n \) & \( v_s \)) (enter 1)
2 - Normal and tangential forces imposed (\( f_n \) & \( f_s \)) (enter 2)
3 - Normal velocity and tangential force imposed (\( v_n \) & \( f_s \)) (enter 3)
4 - Normal force and tangential velocity imposed (\( f_n \) & \( v_s \)) (enter 4)
5 - Slip conditions (enter 5)
6 - Plane of symmetry (\( f_s = 0 \) & \( v_n = 0 \)) (enter 6)
7 - Inflow (enter 7)
8 - Outflow (enter 8)
9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
11 - Cartesian velocities imposed (\( v_x, v_y \)) (enter 11)

Enter your choice

1

* * *
* \( v_n \) & \( v_s \) imposed along boundary 1 *
* *
* * *

- \( v_n \) : constant = 0.00000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Constant (enter 1)
2 - Linear function of coordinates (enter 2)

Enter your choice
vn & vs imposed along boundary 1

- vs : constant = 1.3000000E-01

-1 - Upper level menu (enter -1 or CR)
1 - Constant (enter 1)
2 - Linear function of coordinates (enter 2)

Enter your choice

Flow boundary condition along boundary 2

Current choice : vn & vs imposed
No force postprocessor

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)
# - Interface
> 1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
  2 - Normal and tangential forces imposed (fn & fs) (enter 2)
  3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
  4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
  5 - Slip conditions (enter 5)
  6 - Plane of symmetry ( fs=0 & vn=0 ) (enter 6)
  7 - Inflow (enter 7)
  8 - Outflow (enter 8)
  9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
11 - Cartesian velocities imposed (vx,vy) (enter 11)

Enter your choice
1

vn & vs imposed along boundary 2

- vn : constant = 0.0000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Constant (enter 1)
2 - Linear function of coordinates (enter 2)

Enter your choice
**vn & vs imposed along boundary**

- **vs : constant = 0.0000000E+00**

1 - Constant
2 - Linear function of coordinates
3 - Enable the inverse prediction
4 - Deletion of a local remeshing
6 - Upper level menu
8 - Creation of a local remeshing
10 - 1-st local remeshing

Enter your choice

1

The current remeshing is defined on: S1.

2 - Make the current domain empty
1 - Upper level menu
1 - Extension to the whole mesh
1 - Removal of subdomain 1
2 - Addition of subdomain 2

Enter your choice

# - Adaptative section for prediction
# - Constant section for prediction
1 - Thomp. Transform
2 - Method of Spines
3 - Euclidian Method
4 - Thin Shell Method
5 - Optimesh

Enter your choice

2
The inlet of the system of spines is defined by the intersection with boundary 1

Do you agree with this? Enter y(es) or n(o) (CR=yes)

The outlet of the system of spines is defined by the intersection with boundary 2

Do you agree with this? Enter y(es) or n(o) (CR=yes)

Current setup:
- no action if distortion limits exceeded
- min interior angle = 5.0000000E+00
- max interior angle = 1.7000000E+02
- max aspect ratio = 1.0000000E+01
- max bend = 8.0000000E-01
- max skew = 1.0000000E+01

-1 - Accept the current setup
 1 - No action if distortion limits exceeded
 2 - Warning if distortion limits exceeded
 3 - Stop if distortion limits exceeded
 4 - Modification of the minimum interior angle
 5 - Modification of the maximum interior angle
 6 - Modification of the maximum aspect ratio
 7 - Modification of the maximum bend
 8 - Modification of the maximum skew

Enter your choice

The current translation is defined on: empty mesh.

# - Make the current domain empty
-1 - Upper level menu
# - Extension to the whole mesh
1 - Addition of subdomain 1

Enter your choice
**Rigid translation**

Translation speed : \( \frac{d}{dt} (X, Y, Z) = (Ux, Uy, Uz) \)

\[
\begin{align*}
Ux & = 0.0000000000E+00 \\
Uz & = 0.0000000000E+00 \\
\end{align*}
\]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of Ux (enter 1)
2 - Modification of Uy (enter 2)
# - Modification of Uz

Enter your choice

**Interpolation**

Current setup : Linear coordinates
- Quadratic velocities, linear pressure
- Picard iterations on viscosity(g)
- No upwinding in momentum equations

-1 - Upper level menu (enter -1 or CR)
1 - Quadratic coordinates (enter 1)
# - Quadratic element for stresses
# - 4x4 SU element for stresses
# - 4x4 SUPG element for stresses
# - EVSS for stresses
# - EVSS SU for stresses
# - EVSS SUPG for stresses
8 - Quadratic velocities, linear pressure (enter 8)
# - Mini-element for velocities, constant pressure
10 - Linear velocities, constant pressure (enter 10)
11 - Quadratic velocities, linear discontinuous pressure (enter 11)
12 - Newton iterations on viscosity(g) (enter 12)
# - Linear element for temperature
# - Quadratic element for temperature
# - 2x2 element for temperature
# - 4x4 element for temperature
# - Upwinding in momentum equations
# - Sub-interpolation

Enter your choice
*******
*    *
* Tracking    *
*    *
*******

-1 - Upper level menu (enter -1)
1 - Local shear-rate (enter 1)
2 - Viscosity (enter 2)
3 - Rate of deformation tensor (enter 3)
4 - Inelastic stress tensor (enter 4)
5 - Viscous heating (enter 5)
# - Total extra-stress tensor (enter #)
7 - Residence time (enter 7)
8 - Tracking of material points (enter 8 or CR)
9 - Tracking of a material property (enter 9)
10 - Forces on slices (enter 10)

Enter your choice

The calculation will be done on (S1+S2).

Hit CR to continue
3D single-flighted conveying screw elements simulations were represented using the following parameters.

**Name of Mesh File:**
double2.msh

**Name of Data File:**
double2.dat

**New Task:**

1. **Task 1:**
   **Method of Solving Problem:**
   F.E.M. task
   Steady-state

**Create a Sub-Task:**

A. **Sub-Task 1:**
   **Problem to be Solved:**
   Generalized Newtonian isothermal flow problem

   **Title Given to Sub-Task 1:**
   1. 3D Rotation

B. **Sub-Task 2 - 5:**
   **Problem to be Solved:**
   Post-Processor

   **Titles Given to Sub-Task 2 - 8:**
   2. Local shear-rate (& average value)
   3. Inelastic stress tensor (& average value)
   4. Mixing efficiency (& average value)
   5. Outflow (through outlet BS8)
Domain of the Sub-Tasks:
Over whole mesh

Material Data (Ideal Rheology for Polypropylene):

1. Shear-Rate Dependence of Viscosity:

Power Law (\(f(g)\) is a function of shear rate):

\[ f(g) = \text{fac} \times g^{\text{expo}-1} \]

Shear Rate Viscosity (poise): \(\text{fac} = 4400\)
Power Index: \(\text{expo} = 0.5\)

5 Density:
Density (kg m\(^{-3}\)): \(\rho_0 = 800\)

6 Inertia Terms:
Inertia will be neglected in the momentum equations:

11 Gravity:
Gravity component (m sec\(^{-2}\)) \(g_x = 0, g_y = -9.81\) and \(g_z = 0\)

The \(g_y = -9.81\) value is not taken into account within momentum equations, as only volumetric gravity force is considered within Polyflow.

Flow Boundary Conditions:

Boundary Number to Which Conditions Apply:

BS1: Inlet

6 Inflow
Volumetric flow rate (m\(^3\) sec\(^{-1}\)) = \(5.20 \times 10^{-7}\)

Boundary Number to Which Conditions Apply:

BS2: Right Hand Element (rotating at 1 revolution per second).

11 Cartesian Velocities Imposed (\(v_x, v_y, v_z\)):
Coordinates of 1st rotation centre (m):
\(x = -0.017505, y = 0\) and \(z = 0\)
Coordinates of 2nd rotation centre (m):
\(x = -0.012505, y = 0\) and \(z = -0.01647\)
Angular velocity (rad sec\(^{-1}\)):
\(\nu = 2\pi\)
Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \).

**Boundary Number to Which Conditions Apply:**

BS3: Crossover Region (rotating at 1 revolution per second).

11 Cartesian Velocities Imposed \((v_x, v_y)\):

- Coordinates of 1st rotation centre (m): \( x = 0, y = 0.019865 \) and \( z = 0 \)
- Coordinates of 2nd rotation centre (m): \( x = 0.005, y = 0.019865 \) and \( z = -0.01647 \)
- Angular velocity (rad sec\(^{-1}\)) : \( \nu = -2\pi \)

(Negative value indicates clockwise direction).

Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**

BS4: Crossover Region (rotating at 1 revolution per second).

11 Cartesian Velocities Imposed \((v_x, v_y)\):

- Coordinates of 1st rotation centre (m): \( x = 0, y = 0.019865 \) and \( z = 0 \)
- Coordinates of 2nd rotation centre (m): \( x = 0.005, y = 0.019865 \) and \( z = -0.01647 \)
- Angular velocity (rad sec\(^{-1}\)) : \( \nu = -2\pi \)

(Negative value indicates clockwise direction).

Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**

BS5: Left Hand Element (rotating at 1 revolution per second).

11 Cartesian Velocities Imposed \((v_x, v_y)\):

- Coordinates of 1st rotation centre (m): \( x = 0.017505, y = 0 \) and \( z = 0 \)
- Coordinates of 2nd rotation centre (m): \( x = 0.022505, y = 0 \) and \( z = -0.01647 \)
- Angular velocity (rad sec\(^{-1}\)) : \( \nu = 2\pi \)

(Positive value indicates counter-clockwise direction).

Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**

BS6: Left Hand Element - Additional Face (rotating at 1 revolution per second).

11 Cartesian Velocities Imposed \((v_x, v_y)\):

- Coordinates of 1st rotation centre (m): \( x = 0.017505, y = 0 \) and \( z = 0 \)
- Coordinates of 2nd rotation centre (m): \( x = 0.022505, y = 0 \) and \( z = -0.01647 \)
- Angular velocity (rad sec\(^{-1}\)) : \( \nu = 2\pi \)
(Positive value indicates counter-clockwise direction).
Components of translation velocity (m sec⁻¹): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**

BS7: Outer Figure-of-Eight Barrel (non-slip boundary).

1. **Normal & Tangential Velocities Imposed \((v_n \& v_t)\):**

   Normal velocity component (m sec⁻¹): \( v_n = 0 \)
   Tangential velocity component (m sec⁻¹): \( v_t = 0 \)

**Boundary Number to Which Conditions Apply:**

BS8: Outlet.

7. **Outflow**

   Zero normal force imposed

**Interpolation:**

Linear coordinates
Quadratic velocities, linear pressure
Picard iterations on viscosity\((g)\)
No upwinding in momentum equations

**Numerical Parameters:**

No previous solution
Maximum number of iterations \(= 50\)
Convergence test \(= 1 \times 10^{-8}\)
Divergence test \(= 1 \times 10^3\)
Coupled iterations for moving boundaries
Surface kinematic condition

**Mesh to Mesh Interpolation**

None

**Outputs**

Current output(s): CFView-PF
Listing: max
Check ADDR: off
Appendix I:

Flow Problem Parameters as Seen Within Each Polydata Menu, for the Steady State Simulation of the 3D half profile, Representative of the Single-Flighted Conveying Screw Elements.

```
# - Save and exit
1 - Read a mesh file (enter 1 or CR)
2 - Read and optimize a mesh file (enter 2)
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
# - Outputs
# - Read an old data file (enter 6)
# - Create a new task (enter 7 or CR)
# - Redefine global parameters of a task
```

Enter your choice

Enter the name of the mesh file (default = msh)

double2.msh

Is it a formatted file
Enter y(es) or n(o) (CR=yes)

Loading the mesh data ...

```
# - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file (enter 3)
3 - Convert a mesh file (enter 4)
4 - Filename syntax
# - Outputs
6 - Read an old data file (enter 6)
7 - Create a new task (enter 7 or CR)
# - Redefine global parameters of a task
```

Enter your choice

6

Enter the name of the old data file (default = dat)

double2.dat

Loading the data ...

Checking the data ...
Version: 3.4.6.1

0 - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file
3 - Convert a mesh file
4 - Filename syntax
5 - Outputs
7 - Create a new task
8 - Redefine global parameters of a task
9 - F.E.M. Task 1

Enter your choice
5

* * * * * * *
* Outputs *
* * * * * * *

Current output(s): CFView-PF
Listing: max
Check ADDR: off

-1 - Upper level menu
# - Output Triggering
1 - Enable 3DCross output
2 - Enable Patran output
3 - Enable Supertab output
4 - Enable DataVisual output
# - Enable Explorer output
6 - Disable CFView-PF output
7 - Enable Polyflow output
8 - Listing: none
9 - Listing: min
10 - Listing: max
11 - Enable ADDR check

Enter your choice
Redefine global parameters of a task

Current setup: - P.E.M. task
- Steady-state

-2 - Delete the current task (enter -2)
-1 - Accept the current setup (enter -1 or CR)
> 1 - F.E.M. task (enter 1)
# - MIXING task
> 3 - Steady-state problem(s) (enter 3)
4 - Time-dependent problem(s) (enter 4)
5 - Evolution problem(s) (enter 5)
6 - Rigid rotation (enter 6)

Enter your choice

-1 - Upper level menu (enter -1 or CR)
1 - Numerical parameters (enter 1)
2 - Create a sub-task (enter 2)
3 - Redefine global parameters of a sub-task (enter 3)
# - Assign the pressure
# - Assign the stream function
6 - Mesh-mesh interpolation (enter 6)
# - Define species
# - Define reactions
9 - 3D Rotation (enter 9)
10 - Local shear-rate (enter 10)
11 - Inelastic stress tensor (enter 11)
12 - Mixing efficiency (enter 12)

Enter your choice

1

-1 - Upper level menu (enter -1 or CR)
- Start with an old result file (enter 2)
2 - Modify the max number of iterations (enter 3)
3 - Modify the convergence test (enter 4)
4 - Modify the divergence test (enter 5)
5 - Decoupled iterations for moving bound.
# - Modify the max number of 'fixed' iterations
# - Modify the convergence test ('fixed' iterations)
8 - Line kinematic condition (enter 8)

Enter your choice
Mesh-mesh interpolations interpolate all potential velocity, pressure, temperature, and stress fields from a previous result to the current task.

Such an interpolation has not yet been defined.

-1 - Accept current setup (enter -1 or CR)
  1 - Create interpolations (enter 1)
  # - Modify file names

Enter your choice

Sub-task : 3D Rotation

-1 - Upper level menu (enter -1 or CR)
  1 - Delete the current sub-task (enter 1)
  2 - Modify the title of the current sub-task (enter 2)
  3 - Modify the type of the current sub-task (enter 3)

Enter your choice

3

Predictive model

> 1 - Generalized Newtonian isothermal flow problem (enter 1 or CR)
  2 - Generalized Newtonian non-isothermal flow problem (enter 2)
  3 - Heat conduction problem (enter 3)
  4 - Differential viscoelastic isothermal flow problem (enter 4)
  5 - Differential viscoelastic non-isothermal flow problem (enter 5)
  # - Postprocessor
  7 - Integral viscoelastic isothermal flow problem (enter 7)
  8 - Integral viscoelastic non-isothermal flow problem (enter 8)
  9 - Darcy isothermal flow problem (enter 9)
  10 - Darcy non-isothermal flow problem (enter 10)
  11 - Slightly compressible flow problem (enter 11)
  # - Mass transfer problem (enter 13)
  13 - Potential problem

Enter your choice
Enter your choice

1

The current sub-task is defined on: whole mesh

Enter your choice

1
Shear-rate dependence of viscosity

-1 - Upper level menu (enter -1 or CR)
1 - Constant viscosity (enter 1)
2 - Bird-Carreau law (enter 2)
> 3 - Power law (enter 3)
4 - Bingham law (enter 4)
5 - Herschel-Bulkley law (enter 5)
6 - Cross law (enter 6)

Enter your choice

3

Power law

\[ f(g) = \text{fac} \times g^{\text{expo}-1} \]

\[ \text{fac} = 4.4000000E+03 \quad \text{expo} = 5.0000000E-01 \]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of \text{fac} (enter 1)
2 - Modification of \text{expo} (enter 2)

Enter your choice

Density

\[ \text{density} = 8.0000000E+02 \]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of density (enter 1)

Enter your choice

Inertia terms

Inertia will be neglected in the momentum equations

Do you agree with this?
Enter y(es) or n(o) (CR=yes)
gx = 0.00000000B+00  
gz = 0.00000000B+00

-1 - Upper level menu  (enter -1 or CR)
  1 - Modification of gx  (enter 1)
  2 - Modification of gy  (enter 2)
  3 - Modification of gz  (enter 3)

Enter your choice

*************************************************************
*                                                            *
*     Flow boundary conditions                                  *
*                                                            *
*************************************************************

-1 - Upper level menu  (enter -1 or CR)
  # - Normal flow rate imposed
  1 - Inflow along boundary 1  (enter 1)
  2 - vx,vy,vz imposed along boundary 2  (enter 2)
  3 - vx,vy,vz imposed along boundary 3  (enter 3)
  4 - vx,vy,vz imposed along boundary 4  (enter 4)
  5 - vx,vy,vz imposed along boundary 5  (enter 5)
  6 - vx,vy,vz imposed along boundary 6  (enter 6)
  7 - vn & vs imposed along boundary 7  (enter 7)
  8 - Outflow along boundary 8  (enter 8)

Select the boundary condition you want to modify
1

*************************************************************
*                                                            *
*     Flow boundary condition along boundary 1                 *
*                                                            *
*************************************************************

Current choice: Inflow

No force postprocessor

-2 - Enable force postprocessor  (enter -2)
-1 - Upper level menu  (enter -1 or CR)

# - Interface
  1 - Normal and tangential velocities imposed (vn & vs)  (enter 1)
  2 - Normal and tangential forces imposed (fn & fs)  (enter 2)
  3 - Normal velocity and tangential force imposed (vn & fs)  (enter 3)
  4 - Normal force and tangential velocity imposed (fn & vs)  (enter 4)
  5 - Slip conditions  (enter 5)
  6 - Plane of symmetry  (fs=0 & vn=0)  (enter 6)
  7 - Inflow  (enter 7)
  8 - Outflow  (enter 8)
  9 - Free surface  (enter 9)
  10 - Global force imposed  (enter 10)
  11 - Cartesian velocities imposed (vx, vy, vz)  (enter 11)

Enter your choice
Current value of the volumetric flow rate is 5.2000000E-07
Enter its new value (CR=no modification)

Flow boundary condition along boundary 2

Current choice : vx, vy, vz imposed
No force postprocessor

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)

# - Interface
1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
2 - Normal and tangential forces imposed (fn & fs) (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
5 - Slip conditions (enter 5)
6 - Plane of symmetry (fs=0 & vn=0) (enter 6)
7 - Inflow (enter 7)
8 - Outflow (enter 8)
9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
>11 - Cartesian velocities imposed (vx, vy, vz) (enter 11)

Enter your choice

11

vx, vy, vz imposed along boundary 2

The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  x1 = -1.7505000E-02 y1 = 0.0000000E+00 z1 = 0.0000000E+00
- Coordinates of the 2nd point of the rotation axis
  x2 = -1.2505000E-02 y2 = 0.0000000E+00 z2 = -1.6470000E-02
- Angular velocity = 6.2831850E+00
- Components of the translation velocity
  tx = 0.0000000E+00 ty = 0.0000000E+00 tz = 0.0000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Modification of 1st point of the axis (enter 1)
2 - Modification of 2nd point of the axis (enter 2)
3 - Modification of angular velocity (enter 3)
4 - Modification of translation velocity (enter 4)

Enter your choice
The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  \( x_1 = 0.0000000E+00 \) \( y_1 = 1.9865000E-02 \) \( z_1 = 0.0000000E+00 \)

- Coordinates of the 2nd point of the rotation axis
  \( x_2 = 5.0000000E-03 \) \( y_2 = 1.9865000E-02 \) \( z_2 = -1.6470000E-02 \)

- Angular velocity = -6.2831850E+00

- Components of the translation velocity
  \( t_x = 0.0000000E+00 \) \( t_y = 0.0000000E+00 \) \( t_z = 0.0000000E+00 \)

-1 - Upper level menu (enter -1 or CR)
  1 - Modification of 1st point of the axis (enter 1)
  2 - Modification of 2nd point of the axis (enter 2)
  3 - Modification of angular velocity (enter 3)
  4 - Modification of translation velocity (enter 4)

Enter your choice

-1 - Upper level menu (enter -1 or CR)
  1 - Modification of 1st point of the axis (enter 1)
  2 - Modification of 2nd point of the axis (enter 2)
  3 - Modification of angular velocity (enter 3)
  4 - Modification of translation velocity (enter 4)

Enter your choice
The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  \[ x_1 = 1.7505000E-02 \quad y_1 = 0.0000000E+00 \quad z_1 = 0.0000000E+00 \]
- Coordinates of the 2nd point of the rotation axis
  \[ x_2 = 2.2505000E-02 \quad y_2 = 0.0000000E+00 \quad z_2 = -1.6470000E-02 \]
- Angular velocity = \[ 6.2831850E+00 \]
- Components of the translation velocity
  \[ t_x = 0.0000000E+00 \quad t_y = 0.0000000E+00 \quad t_z = 0.0000000E+00 \]

-1 - Upper level menu (enter -1 or CR)
  1 - Modification of 1st point of the axis (enter 1)
  2 - Modification of 2nd point of the axis (enter 2)
  3 - Modification of angular velocity (enter 3)
  4 - Modification of translation velocity (enter 4)

Enter your choice

The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  \[ x_1 = 1.7505000E-02 \quad y_1 = 0.0000000E+00 \quad z_1 = 0.0000000E+00 \]
- Coordinates of the 2nd point of the rotation axis
  \[ x_2 = 2.2505000E-02 \quad y_2 = 0.0000000E+00 \quad z_2 = -1.6470000E-02 \]
- Angular velocity = \[ 6.2831850E+00 \]
- Components of the translation velocity
  \[ t_x = 0.0000000E+00 \quad t_y = 0.0000000E+00 \quad t_z = 0.0000000E+00 \]

-1 - Upper level menu (enter -1 or CR)
  1 - Modification of 1st point of the axis (enter 1)
  2 - Modification of 2nd point of the axis (enter 2)
  3 - Modification of angular velocity (enter 3)
  4 - Modification of translation velocity (enter 4)

Enter your choice
Flow boundary condition along boundary

Current choice: vn & vs imposed
No force postprocessor

-2 - Enable force postprocessor  (enter -2)
-1 - Upper level menu  (enter -1 or CR)

# - Interface
> 1 - Normal and tangential velocities imposed (vn & vs)  (enter 1)
  2 - Normal and tangential forces imposed (fn & fs)  (enter 2)
  3 - Normal velocity and tangential force imposed (vn & fs)  (enter 3)
  4 - Normal force and tangential velocity imposed (fn & vs)  (enter 4)
  5 - Slip conditions  (enter 5)
  6 - Plane of symmetry (fs=0 & vn=0)  (enter 6)
  7 - Inflow  (enter 7)
  8 - Outflow  (enter 8)
  9 - Free surface  (enter 9)
10 - Global force imposed  (enter 10)
11 - Cartesian velocities imposed (vx,vy,vz)  (enter 11)

Enter your choice

-1 - Upper level menu  (enter -1 or CR)
1 - Constant  (enter 1)
2 - Linear function of coordinates  (enter 2)

Enter your choice

-1 - Upper level menu  (enter -1 or CR)
# - Constant  (enter -1 or CR)
# - Linear function of coordinates
Flow boundary condition along boundary 6

Current choice: Outflow

No force postprocessor

-2 - Enable force postprocessor
-1 - Upper level menu
CR)
# - Interface
1 - Normal and tangential velocities imposed (vn & vs)
2 - Normal and tangential forces imposed (fn & fs)
3 - Normal velocity and tangential force imposed (vn & fs)
4 - Normal force and tangential velocity imposed (fn & vs)
5 - Slip conditions
6 - Plane of symmetry (fs=0 & vn=0)
7 - Inflow
> 8 - Outflow
9 - Free surface
10 - Global force imposed
11 - Cartesian velocities imposed (vx,vy,vz)

Enter your choice
8

Zero normal force imposed

Do you agree with this?
Enter y(es) or n(o)  (CR=yes)
Current setup: Linear coordinates
Quadratic velocities, linear pressure
Picard iterations on viscosity(g)
No upwinding in momentum equations

-1 - Upper level menu
CR)
1 - Quadratic coordinates
# - Quadratic element for stresses
# - 4x4 SU element for stresses
# - 4x4 SUPG element for stresses
# - EVSS for stresses
# - EVSS SU for stresses
# - EVSS SUPG for stresses
8 - Quadratic velocities, linear pressure
9 - Mini-element for velocities, constant pressure
10 - Linear velocities, constant pressure
11 - Quadratic velocities, linear discontinuous pressure
12 - Newton iterations on viscosity(g)
# - Linear element for temperature
# - Quadratic element for temperature
# - 2x2 element for temperature
# - 4x4 element for temperature
# - Upwinding in momentum equations
# - Sub-interpolation

Enter your choice

****************************
* *
* Local shear-rate *
* *
****************************

-1 - Upper level menu
1 - Local shear-rate
2 - Viscosity
3 - Rate of deformation tensor
4 - Inelastic stress tensor
5 - Viscous heating
# - Total extra-stress tensor
7 - Residence time
# - Tracking of material points
9 - Tracking of a material property
10 - Forces on slices

Enter your choice

The calculation will be done on S1.

Hit CR to continue
-1 - Upper level menu
1 - Local shear-rate
2 - Viscosity
3 - Rate of deformation tensor
4 - Inelastic stress tensor
5 - Viscous heating
# - Total extra-stress tensor
7 - Residence time
# - Tracking of material points
9 - Tracking of a material property
10 - Forces on slices

Enter your choice

The calculation will be done on Sl.

Hit CR to continue

-1 - Upper level menu
1 - Local shear-rate
2 - Viscosity
3 - Rate of deformation tensor
4 - Inelastic stress tensor
5 - Viscous heating
# - Total extra-stress tensor
7 - Residence time
# - Tracking of material points
9 - Tracking of a material property
10 - Forces on slices

Enter your choice

The calculation will be done on Sl.

Hit CR to continue
2D trilobal element and mixing disc zone simulations were represented using the following parameters.

**Name of Mesh File:**

- `2d*te.msh`  `* = 0° - 30° in 5° rotations`  (Trilobe elements)
- `2d*md.msh`  `* = 0° - 30° in 5° rotations`  (Mixing discs)

**Name of Data File:**

- `2d*A60m2B.dat`

where,

- `A = te` or `md` used to represent either the trilobe element or mixing disc zones respectively.
- `B = If the problem contained non-slip boundaries then the suffix` `ns` was used. For problems possessing slip boundaries, then the suffixes `p1`, `p2`, ... were used instead to represent the different degrees of slippage.

**New Task:**

1. **Task 1:**

   **Method of Solving Problem:**
   - F.E.M. task
   - Steady-state

   **Geometry:**
   - 2D planar geometry

   **Create a Sub-Task:**

   A. **Sub-Task 1:**

      **Problem to be Solved:**
      Generalized Newtonian isothermal flow problem

      **Title Given to Sub-Task 1:**
      1. Rotation
B Sub-Task 2 - 4:

Problem to be Solved:
Post-Processor

Titles Given to Sub-Task 2 - 8:
2. Local shear-rate (& average value)
3. Inelastic stress tensor (& average value)
4. Mixing efficiency (& average value)

Domain of the Sub-Tasks:
Over whole mesh

Material Data (Ideal Rheology for Polypropylene):

1 Shear-Rate Dependence of Viscosity:
Power Law ($f(g)$ is a function of shear rate):

$$f(g) = \text{fac} \times g^{\text{expo}-1}$$

Shear Rate Viscosity (poise): $\text{fac} = 4400$
Power Index: $\text{expo} = 0.5$

5 Density:
Density (kg m$^{-3}$): $\rho_0 = 800$

6 Inertia Terms:
Inertia will be neglected in the momentum equations:

11 Gravity:
Gravity component (m sec$^{-2}$) $g_x = 0$ and $g_y = -9.81$

The $g_y = -9.81$ value is not taken into account within momentum equations, as only volumetric gravity force is considered within Polyflow.

Flow Boundary Conditions:

Boundary Number to Which Conditions Apply:
BS1: Left Hand Element (rotating counter-clockwise at 1 revolution per second).
11 Cartesian Velocities Imposed ($v_x, v_y$):
Coordinates of rotational centre (m): $x = -0.017505$ and $y = 0$
Angular velocity (rad sec$^{-1}$): $v = 2\pi$
(Positive value indicates counter-clockwise direction).
Components of translation velocity (m sec$^{-1}$): $t_x = 0$ and $t_y = 0$

Boundary Number to Which Conditions Apply:
BS2: Right Hand Element (rotating counter-clockwise at 1 revolution per second).

11 Cartesian Velocities Imposed ($v_x, v_y$):
Coordinates of rotational centre (m): $x = 0.017505$, $y = 0$
Angular velocity (rad sec$^{-1}$): $v = 2\pi$
(Positive value indicates counter-clockwise direction).
Components of translation velocity (m sec$^{-1}$): $t_x = 0$ and $t_y = 0$

Boundary Number to Which Conditions Apply:
BS3: Outer Figure-of-Eight Barrel (non-slip boundary)

1 Normal & Tangential Velocities Imposed ($v_n, v_t$):
Normal velocity component (m sec$^{-1}$): $v_n = 0$
Tangential velocity component (m sec$^{-1}$): $v_t = 0$

For the 2D slip problems, $v_t$ was assigned the following values to represent different values of slippage:

- $v_t = 0.25 (2\pi)$
- $v_t = 0.50 (2\pi)$
- $v_t = 0.75 (2\pi)$

Full slip was assumed to be the value $v_t = 2\pi$. For all calculations $r = 0.020075$ m, where $r$ is the distance between the center of each element and the outer barrel surface.

**Interpolation:**
Linear coordinates
Quadratic velocities, linear pressure
Picard iterations on viscosity(g)
No upwinding in momentum equations
Numerical Parameters:
No previous solution
Maximum number of iterations $= 50$
Convergence test $= 1 \times 10^4$
Divergence test $= 1 \times 10^3$
Coupled iterations for moving boundaries
Surface kinematic condition

Assign the Pressure:
The pressure field is currently imposed at the node closest to the coordinates: $x = 0$ and $y = 0$

Current value of the pressure condition is: $P = 0$ (Pa)

Assign the Stream Function:
The stream function currently vanishes at the node closest to the coordinates: $x = 0$ and $y = 0$

Mesh to Mesh Interpolation
None

Outputs
Current output(s): CFView-PF
Listing: max
Check ADDR: off
Appendix K:

Flow Problem Parameters as Seen Within Each Polydata Menu, for the Steady State Simulation of all 2D Mixing Zones.

****************************************************
*                                                *
*  POLYDATA  *                                     *
*                                                *
****************************************************

Version : 3. 4. 6. 1

# - Save and exit
1 - Read a mesh file (enter 1 or CR)
2 - Read and optimize a mesh file (enter 2)
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
# - Outputs
# - Read an old data file
# - Create a new task
# - Redefine global parameters of a task

Enter your choice

Enter the name of the mesh file (default = msh)

2d0se.msh

Is it a formatted file
Enter y(es) or n(o) (CR=yes)

Loading the mesh data...

****************************************************
*                                                *
*  POLYDATA  *                                     *
*                                                *
****************************************************

Version : 3. 4. 6. 1

# - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file (enter 3)
3 - Convert a mesh file (enter 4)
4 - Filename syntax
# - Outputs
6 - Read an old data file (enter 6)
7 - Create a new task (enter 7 or CR)
# - Redefine global parameters of a task

Enter your choice

6

Enter the name of the old data file (default = dat)

2d0se60m2nsa.dat

Loading the data...

Checking the data...
Version: 3.4.6.1

0 - Save and exit (enter 0)
# - Read a mesh file
# - Read and optimize a mesh file
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
5 - Outputs (enter 5)
# - Read an old data file
7 - Create a new task (enter 7)
8 - Redefine global parameters of a task (enter 8)
9 - P.E.M. Task 1 (enter 9)

Enter your choice
5

Current output(s): CFView-PF
Listing: max
Check ADDR: off

-1 - Upper level menu (enter -1 or CR)
# - Output Triggering
1 - Enable Polyplot output (enter 1)
2 - Enable Patran output (enter 2)
3 - Enable Supertab output (enter 3)
4 - Enable DataVisual output (enter 4)
# - Enable Explorer output
6 - Disable CFView-PF output (enter 6)
7 - Enable Polyflow output (enter 7)
8 - Listing: none (enter 8)
9 - Listing: min (enter 9)
10 - Listing: max (enter 10)
11 - Enable ADDR check (enter 11)

Enter your choice
Redefine global parameters of a task

Current setup:
- P.E.M. task
  - Steady-state
  - 2D planar geometry

- 2 - Delete the current task (enter -2)
- 1 - Accept the current setup (enter -1 or CR)
> 1 - P.E.M. task
    # - MIXING task
> 3 - Steady-state problem(s) (enter 3)
  4 - Time-dependent problem(s) (enter 4)
  5 - Evolution problem(s) (enter 5)
  6 - Rigid rotation (enter 6)
> 7 - 2D planar geometry (enter 7)
    # - 2D axisymmetric geometry
  9 - 2D 1/2 planar geometry (enter 9)
    # - 2D 1/2 axisymmetric geometry

Enter your choice

- 1 - Upper level menu (enter -1 or CR)
1 - Numerical parameters (enter 1)
2 - Create a sub-task (enter 2)
3 - Redefine global parameters of a sub-task (enter 3)
4 - Assign the pressure (enter 4)
5 - Assign the stream function (enter 5)
6 - Mesh-mesh interpolation (enter 6)
# - Define species
# - Define reactions
9 - Rotation (enter 9)
10 - Local shear-rate (enter 10)
11 - Inelastic stress tensor (enter 11)
12 - Mixing efficiency (enter 12)

Enter your choice

1
- No previous solution
- Maximum number of iterations = 50
- Convergence test = 1.0000000E-08
- Divergence test = 1.0000000E+03
- Coupled iterations for moving bound.
- Surface kinematic condition

1 - Upper level menu
2 - Start with an old result file
3 - Modify the max number of iterations
4 - Modify the convergence test
5 - Modify the divergence test
5 - Decoupled iterations for moving bound.
# - Modify the max number of 'fixed' iterations
# - Modify the convergence test ('fixed' iterations)
# - Line kinematic condition

Enter your choice

The calculation of the pressure field associated with the following velocity field requires a point at which the value of the pressure is imposed.

1 : Field of sub-task Rotation

-1 - Upper level menu (enter -1 or CR)
1 - Pressure condition for field 1 (enter 1)

Enter your choice

1

The pressure field is currently imposed at the node closest to coordinates:

X = 0.0000000E+00  Y = 0.0000000E+00

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

Current value of pressure condition is 0.0000000E+00
Enter its new value (CR=no modification)
The calculation of the stream function PSI associated with the following velocity or Darcy pressure field requires a point at which PSI equals to zero.

1 : Field of sub-task Rotation

-1 - Upper level menu (enter -1 or CR)
1 - Condition on the stream function for field 1 (enter 1)

Enter your choice

1

The stream function currently vanishes at the node closest to coordinates:

X = 0.0000000E+00  Y = 0.0000000E+00

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

Mesh-mesh interpolations interpolate all potential velocity, pressure, temperature, and stress fields from a previous result to the current task.

Such an interpolation has not yet been defined.

-1 - Accept current setup (enter -1 or CR)
1 - Create interpolations (enter 1)
# - Modify file names

Enter your choice

-1 - Upper level menu (enter -1 or CR)
1 - Delete the current sub-task (enter 1)
2 - Modify the title of the current sub-task (enter 2)
3 - Modify the type of the current sub-task (enter 3)

Enter your choice

3
Redefine global parameters of a sub-task

1 - Generalized Newtonian isothermal flow problem (enter 1 or CR)
2 - Generalized Newtonian non-isothermal flow problem (enter 2)
3 - Heat conduction problem (enter 3)
4 - Differential viscoelastic isothermal flow problem (enter 4)
5 - Differential viscoelastic non-isothermal flow problem (enter 5)
# - Postprocessor
7 - Integral viscoelastic isothermal flow problem (enter 7)
8 - Integral viscoelastic non-isothermal flow problem (enter 8)
9 - Darcy isothermal flow problem (enter 9)
10 - Darcy non-isothermal flow problem (enter 10)
11 - Slightly compressible flow problem (enter 11)
# - Mass transfer problem
13 - Potential problem (enter 13)
14 - Film model: Gen. Newtonian isothermal (enter 14)
15 - Film model: Gen. Newtonian non-isothermal (enter 15)
16 - Film model: Viscoelastic isothermal (enter 16)
# - Thickness for film
# - Transport of species
# - Closure

Enter your choice

******************************
*                           *
* Rotation                  *
*                           *
******************************

-1 - Upper level menu (enter -1 or CR)
1 - Domain of the sub-task (enter 1)
2 - Material data (enter 2)
3 - Flow boundary conditions (enter 3)
# - Global remeshing
# - Rigid translation
6 - Interpolation (enter 6)
# - Bubbling

Enter your choice

The current sub-task is defined on: whole mesh

-2 - Make the current domain empty (enter -2)
-1 - Upper level menu (enter -1 or CR)
# - Extension to the whole mesh
1 - Removal of subdomain 1 (enter 1)

Enter your choice
-1 - Upper level menu
1 - Shear-rate dependence of viscosity (enter -1 or CR)
#   Temperature dependence of viscosity
#   Differential viscoelastic models
#   Integral Viscoelastic models
5 - Density (enter 5)
6 - Inertia terms (enter 6)
#   Coefficient of thermal expansion
#   Thermal conductivity
#   Heat capacity per unit mass
#   Viscous heating
11 - Gravity (enter 11)
#   Average temperature
#   Heat source per unit volume

Enter your choice

1

**************************************************************
*                                                           *
*  Shear-rate dependence of viscosity  *                     *
*                                                           *
**************************************************************

-1 - Upper level menu (enter -1 or CR)
1 - Constant viscosity (enter 1)
2 - Bird-Carreau law (enter 2)
> 3 - Power law (enter 3)
4 - Bingham law (enter 4)
5 - Herschel-Bulkley law (enter 5)
6 - Cross law (enter 6)

Enter your choice

3

***************
*  Power law  *
*  ************

\[ f(g) = \text{fac} \times g^{(\text{expo} - 1)} \]

\[
\text{fac} = 4.000000E+03 \quad \text{expo} = 5.000000E-01
\]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of fac (enter 1)
2 - Modification of expo (enter 2)

Enter your choice
density = 8.00000000E+02

-1 - Upper level menu (enter -1 or CR)
1 - Modification of density (enter 1)

Enter your choice

Inertia will be neglected in the momentum equations

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

gx = 0.00000000E+00
gz = 0.00000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Modification of gx (enter 1)
2 - Modification of gy (enter 2)
# - Modification of gz

Enter your choice

-1 - Upper level menu (enter -1 or CR)
# - Normal flow rate imposed
1 - vx, vy imposed along boundary 1 (enter 1)
2 - vx, vy imposed along boundary 2 (enter 2)
3 - vn & vs imposed along boundary 3 (enter 3)

Select the boundary condition you want to modify

1
Flow boundary condition along boundary 1

Current choice: vx, vy imposed

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)

# - Interface
1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
2 - Normal and tangential forces imposed (fn & fs) (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
5 - Slip conditions (enter 5)
6 - Plane of symmetry (fs = 0 & vn = 0) (enter 6)
7 - Inflow (enter 7)
8 - Outflow (enter 8)
9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
>11 - Cartesian velocities imposed (vx, vy) (enter 11)

Enter your choice

11

The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the rotation center
  x = -1.7505000E-02  y = 0.0000000E+00
- Angular velocity = 6.2831850E+00
- Components of the translation velocity
  tx = 0.0000000E+00  ty = 0.0000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Modification of the rotation center (enter 1)
2 - Modification of angular velocity (enter 2)
3 - Modification of translation velocity (enter 3)

Enter your choice
The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the rotation center
  \( x = 1.7505000E-02 \ y = 0.0000000E+00 \)
- Angular velocity = 6.2831850E+00
- Components of the translation velocity
  \( tx = 0.0000000E+00 \ t y = 0.0000000E+00 \)

1 - Upper level menu  (enter -1 or CR)
2 - Modification of the rotation center  (enter 1)
3 - Modification of angular velocity  (enter 2)
4 - Modification of translation velocity  (enter 3)

Enter your choice

-2 - Enable force postprocessor  (enter -2)
-1 - Upper level menu  (enter -1 or CR)
# - Interface
1 - Normal and tangential velocities imposed (vn & vs)  (enter 1)
2 - Normal and tangential forces imposed (fn & fs)  (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs)  (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs)  (enter 4)
5 - Slip conditions  (enter 5)
6 - Plane of symmetry  (fs=0 & vn=0)  (enter 6)
7 - Inflow  (enter 7)
8 - Outflow  (enter 8)
9 - Free surface  (enter 9)
10 - Global force imposed  (enter 10)
11 - Cartesian velocities imposed (vx,vy)  (enter 11)

Enter your Cartesian choice

1

-1 - Upper level menu  (enter -1 or CR)
1 - Constant  (enter 1)
2 - Linear function of coordinates  (enter 2)

Enter your choice
-1 - Upper level menu  (enter -1 or CR)
1 - Constant  (enter 1)
2 - Linear function of coordinates  (enter 2)

Enter your choice

***************
*                  *
*  Interpolation  *
*                  *
***************

Current setup : Linear coordinates
Quadratic velocities, linear pressure
Picard iterations on viscosity(g)
No upwinding in momentum equations

-1 - Upper level menu  (enter -1 or CR)
1 - Quadratic coordinates  (enter 1)
  # - Quadratic element for stresses
  # - 4x4 SU element for stresses
  # - 4x4 SUPG element for stresses
  # - EVSS for stresses
  # - EVSS SUPG for stresses
8 - Quadratic velocities, linear pressure  (enter 8)
  # - Mini-element for velocities, constant pressure
10 - Linear velocities, constant pressure  (enter 10)
11 - Quadratic velocities, linear discontinuous pressure  (enter 11)
12 - Newton iterations on viscosity(g)  (enter 12)
  # - Linear element for temperature
  # - Quadratic element for temperature
  # - 2x2 element for temperature
  # - 4x4 element for temperature
  # - Upwinding in momentum equations
  # - Sub-interpolation

Enter your choice

---
-1 - Upper level menu (enter -1)
1 - Local shear-rate (enter 1 or CR)
2 - Viscosity (enter 2)
3 - Rate of deformation tensor (enter 3)
4 - Inelastic stress tensor (enter 4)
5 - Viscous heating (enter 5)
# - Total extra-stress tensor
7 - Residence time (enter 7)
# - Tracking of material points
9 - Tracking of a material property (enter 9)
10 - Forces on slices (enter 10)

Enter your choice

The calculation will be done on S1.

Hit CR to continue

-1 - Upper level menu (enter -1)
1 - Local shear-rate (enter 1)
2 - Viscosity (enter 2)
3 - Rate of deformation tensor (enter 3)
4 - Inelastic stress tensor (enter 4 or CR)
5 - Viscous heating (enter 5)
# - Total extra-stress tensor
7 - Residence time (enter 7)
# - Tracking of material points
9 - Tracking of a material property (enter 9)
10 - Forces on slices (enter 10)

Enter your choice

The calculation will be done on S1.

Hit CR to continue
-1 - Upper level menu
1 - Local shear-rate
2 - Viscosity
3 - Rate of deformation tensor
4 - Inelastic stress tensor
5 - Viscous heating
# - Total extra-stress tensor
7 - Residence time
# - Tracking of material points
9 - Tracking of a material property
10 - Forces on slices

Enter your choice

The calculation will be done on Sl.

Hit CR to continue
3D trilobal element and mixing disc zone simulations were represented using the following parameters.

**Name of Mesh File:**
- 3d*te.msh \( * = 0^\circ - 30^\circ \text{ in } 15^\circ \text{ rotations} \) (Trilobe elements)
- 3d*md.msh \( * = 0^\circ - 30^\circ \text{ in } 15^\circ \text{ rotations} \) (Staggered Mixing discs)

**Name of Data File:**
- 2d*A60m2ns.dat

where,

\( A = \text{te or md} \) used to represent either the trilobe element or mixing disc zones respectively.

**New Task:**

1. **Task 1:**
   - **Method of Solving Problem:**
     - F.E.M. task
     - Steady-state

**Create a Sub-Task:**

A **Sub-Task 1:**
- **Problem to be Solved:**
  - Generalized Newtonian isothermal flow problem

**Title Given to Sub-Task 1:**
1. 3D Rotation

B **Sub-Task 2 - 5:**
- **Problem to be Solved:**
  - Post-Processor

**Titles Given to Sub-Task 2 - 8:**
2. Local shear-rate (& average value)
3. Inelastic stress tensor (& average value)
4. Mixing efficiency (& average value)
5 Outflow (through outlet BS5)

**Domain of the Sub-Tasks:**
Over whole mesh

**Material Data (Ideal Rheology for Polypropylene):**

1 Shear-Rate Dependence of Viscosity:
Power Law ($f(g)$ is a function of shear rate):

\[ f(g) = \text{fac} \cdot g^{\text{expo}-1} \]

Shear Rate Viscosity (poise): \( \text{fac} = 4400 \)
Power Index: \( \text{expo} = 0.5 \)

5 Density:
Density (kg m\(^{-3}\)):
\( r_0 = 800 \)

6 Inertia Terms:
Inertia will be neglected in the momentum equations:

11 Gravity:
Gravity component (m sec\(^{-2}\)) \( g_x = 0, g_y = -9.81 \) and \( g_z = 0 \)

The \( g_y = -9.81 \) value is not taken into account within momentum equations, as only volumetric gravity force is considered within Polyflow.

**Flow Boundary Conditions:**

**Boundary Number to Which Conditions Apply:**

BS1: Inlet

6 Inflow
Volumetric flow rate (m\(^3\) sec\(^{-1}\)) \( = 5.20 \times 10^{-7} \)

**Boundary Number to Which Conditions Apply:**
BS2: Left Hand Element (rotating counter-clockwise at 1 revolution per second).

11 Cartesian Velocities Imposed \((v_x, v_y)\):
Coordinates of 1st rotation centre (m):
\( x = -0.017505, y = 0 \) and \( z = 0 \)
Coordinates of 2nd rotation centre (m): \( x = -0.017505, y = 0 \) and \( z = Z \)  
(where \( Z \) represents the coordinates of the end of the respective TSE element)  
Angular velocity (rad sec\(^{-1}\)): \( \nu = -2\pi \)  
(Negative value indicates counter-clockwise direction).  
Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**  
BS3: Right Hand Element (rotating counter-clockwise at 1 revolution per second).  

1** Cartesian Velocities Imposed \((v_x, v_y)\):**  
Coordinates of 1st rotation centre (m): \( x = 0.017505, y = 0 \) and \( z = 0 \)  
Coordinates of 2nd rotation centre (m): \( x = 0.017505, y = 0 \) and \( z = Z \)  
(where \( Z \) represents the coordinates of the end of the respective TSE element)  
Angular velocity (rad sec\(^{-1}\)): \( \nu = -2\pi \)  
(Negative value indicates counter-clockwise direction).  
Components of translation velocity (m sec\(^{-1}\)): \( t_x = 0, t_y = 0 \) and \( t_z = 0 \)

**Boundary Number to Which Conditions Apply:**  
BS4: Outer Figure-of-Eight Barrel (non-slip boundary).  

1** Normal & Tangential Velocities Imposed \((v_n, v_t)\):**  
Normal velocity component (m sec\(^{-1}\)): \( v_n = 0 \)  
Tangential velocity component (m sec\(^{-1}\)): \( v_t = 0 \)

**Boundary Number to Which Conditions Apply:**  
BS5: Outlet.  

7 Outflow  
Zero normal derivative on velocity imposed

**Interpolation:**  
Linear coordinates  
Quadratic velocities, linear pressure  
Picard iterations on viscosity(g)  
No upwinding in momentum equations

**Numerical Parameters:**  
No previous solution  
Maximum number of iterations \( = 50 \) for SGI calculations.
Convergence test

- for SGI calculations: $1 \times 10^8$
- for CRAY J90 calculations: $1 \times 10^7$

Divergence test

- $1 \times 10^4$

Coupled iterations for moving boundaries

Surface kinematic condition

**Assign the Pressure:**

Pressure field is currently imposed at the node closest to the coordinates: $x = 0, y = 0$ and $z = 0$

Current value of the pressure condition is: $P = 1 \times 10^5$ (Pa)

**Mesh to Mesh Interpolation**

None

**Outputs**

- Current output(s): CFView-PF
- Listing: max
- Check ADDR: off
Appendix M:

Flow Problem Parameters as Seen Within Each Polydata Menu, for the Steady State Simulation of all 3D Mixing Zones.

**************
*             *
*    POLYDATA  *
*             *
**************

Version: 3.4.6.1

# - Save and exit
1 - Read a mesh file (enter 1 or CR)
2 - Read and optimize a mesh file (enter 2)
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
# - Outputs
# - Read an old data file
# - Create a new task
# - Redefine global parameters of a task

Enter your choice

Enter the name of the mesh file (default = msh)
t3d15x2.msh

Is it a formatted file
Enter y(es) or n(o) (CR=ye) (CR=yes)

Loading the mesh data ...

**************
*             *
*    POLYDATA  *
*             *
**************

Version: 3.4.6.1

# - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file
3 - Convert a mesh file (enter 3)
4 - Filename syntax (enter 4)
# - Outputs
6 - Read an old data file (enter 6)
7 - Create a new task (enter 7 or CR)
# - Redefine global parameters of a task

Enter your choice

6

Enter the name of the old data file (default = dat)
60m2nsa.dat

Loading the data ...

Checking the data ...
0 - Save and exit
# - Read a mesh file
# - Read and optimize a mesh file
3 - Convert a mesh file
4 - Filename syntax
5 - Outputs
# - Read an old data file
7 - Create a new task
8 - Redefine global parameters of a task
9 - P.E.M. Task 1

Enter your choice
5

=================================

* Outputs *
=================================

Current output(s) : CPView-PF
Listing : max
Check ADDR : off

-1 - Upper level menu
# - Output Triggering
1 - Enable 3DCross output
2 - Enable Patran output
3 - Enable Supertab output
4 - Enable DataVisual output
# - Enable Explorer output
6 - Disable CPView-PF output
7 - Enable Polyflow output
8 - Listing : none
9 - Listing : min
10 - Listing : max
11 - Enable ADDR check

Enter your choice
Redefine global parameters of a task

Current setup: - F.E.M. task
- Steady-state

-2 - Delete the current task  (enter -2)
-1 - Accept the current setup (enter -1 or CR)
> 1 - F.E.M. task  (enter 1)
# - MIXING task
> 3 - Steady-state problem(s)  (enter 3)
  4 - Time-dependent problem(s) (enter 4)
  5 - Evolution problem(s) (enter 5)
  6 - Rigid rotation (enter 6)

Enter your choice

-1 - Upper level menu  (enter -1 or CR)
  1 - Numerical parameters  (enter 1)
  2 - Create a sub-task  (enter 2)
  3 - Redefine global parameters of a sub-task (enter 3)
  4 - Assign the pressure (enter 4)
# - Assign the stream function
  6 - Mesh-mesh interpolation (enter 6)
# - Define species
# - Define reactions
  9 - 3D Rotation (enter 9)
10 - Local shear-rate (enter 10)
11 - Inelastic stress tensor (enter 11)
12 - Mixing efficiency (enter 12)

Enter your choice

1
- No previous solution
- Maximum number of iterations = 50
- Convergence test = 1.0000000E-08
- Divergence test = 1.0000000E+04
- Coupled iterations for moving bound.
- Surface kinematic condition

-1 - Upper level menu
1 - Start with an old result file (enter -1 or CR)
2 - Modify the max number of iterations (enter 1)
3 - Modify the convergence test (enter 2)
4 - Modify the divergence test (enter 3)
5 - Decoupled iterations for moving bound. (enter 4)
# - Modify the max number of 'fixed' iterations (enter 5)
# - Modify the convergence test ('fixed' iterations) (enter 6)
8 - Line kinematic condition (enter 8)

Enter your choice

******************************************************************************
* *
* Assign the pressure *
* *
******************************************************************************

The calculation of the pressure field associated with the following velocity field requires a point at which the value of the pressure is imposed.

1 : Field of sub-task 3D Rotation

-1 - Upper level menu (enter -1 or CR)
1 - Pressure condition for field 1 (enter 1)

Enter your choice

1

******************************************************************************
* *
* Pressure condition *
* *
******************************************************************************

The pressure field is currently imposed at the node closest to coordinates:

X = 0.00000000E+00  Y = 0.00000000E+00  Z = 0.00000000E+00

Do you agree with this?
Enter y(es) or n(o) (CR=yes)

Current value of pressure condition is 1.0000000E+05
Enter its new value (CR=no modification)
Mesh-mesh interpolations interpolate all potential velocity, pressure, temperature, and stress fields from a previous result to the current task.

Such an interpolation has not yet been defined.

-1 - Accept current setup (enter -1 or CR)
1 - Create interpolations (enter 1)
# - Modify file names

Enter your choice

Sub-task : 3D Rotation

-1 - Upper level menu (enter -1 or CR)
1 - Delete the current sub-task (enter 1)
2 - Modify the title of the current sub-task (enter 2)
3 - Modify the type of the current sub-task (enter 3)

Enter your choice

> 1 - Generalized Newtonian isothermal flow problem (enter 1 or CR)
2 - Generalized Newtonian non-isothermal flow problem (enter 2)
3 - Heat conduction problem (enter 3)
4 - Differential viscoelastic isothermal flow problem (enter 4)
5 - Differential viscoelastic non-isothermal flow problem (enter 5)
# - Postprocessor
7 - Integral viscoelastic isothermal flow problem (enter 7)
8 - Integral viscoelastic non-isothermal flow problem (enter 8)
9 - Darcy isothermal flow problem (enter 9)
10 - Darcy non-isothermal flow problem (enter 10)
11 - Slightly compressible flow problem (enter 11)
# - Mass transfer problem
13 - Potential problem
# - Film model : Gen. Newtonian isothermal
# - Film model : Gen. Newtonian non-isothermal
# - Film model : Viscoelastic isothermal
# - Thickness for film
# - Transport of species
# - Closure

Enter your choice
- 1 - Upper level menu (enter -1 or CR)
1 - Domain of the sub-task (enter 1)
2 - Material data (enter 2)
3 - Flow boundary conditions (enter 3)
# - Global remeshing
# - Rigid translation
6 - Interpolation (enter 6)
# - Bubbling

Enter your choice

1

- 2 - Make the current domain empty (enter -2)
- 1 - Upper level menu (enter -1 or CR)
# - Extension to the whole mesh
1 - Removal of subdomain 1 (enter 1)

Enter your choice

- 1 - Upper level menu (enter -1 or CR)
1 - Shear-rate dependence of viscosity (enter 1)
# - Temperature dependence of viscosity
# - Differential viscoelastic models
# - Integral Viscoelastic models
5 - Density (enter 5)
6 - Inertia terms (enter 6)
# - Coefficient of thermal expansion
# - Thermal conductivity
# - Heat capacity per unit mass
# - Viscous heating
11 - Gravity (enter 11)
# - Average temperature
# - Heat source per unit volume

Enter your choice

1
Shear-rate dependence of viscosity

-1 - Upper level menu (enter -1 or CR)
1 - Constant viscosity (enter 1)
2 - Bird-Carreau law (enter 2)
> 3 - Power law (enter 3)
4 - Bingham law (enter 4)
5 - Herschel-Bulkley law (enter 5)
6 - Cross law (enter 6)

Enter your choice

Power law

\[ f(g) = \text{fac} \times g^{(\text{expo}-1)} \]

\[
\begin{align*}
\text{fac} & = 4.4000000E+03 \\
\text{expo} & = 5.0000000E-01
\end{align*}
\]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of fac (enter 1)
2 - Modification of expo (enter 2)

Enter your choice

Density

\[ \text{density} = 8.0000000E+02 \]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of density (enter 1)

Enter your choice

Inertia terms

Inertia will be neglected in the momentum equations

Do you agree with this?
Enter y(es) or n(o) (CR=yes)
\[\begin{align*}
  gx &= 0.00000000E+00 \\
  gz &= 0.00000000E+00
\end{align*}\]

-1 - Upper level menu (enter -1 or CR)
1 - Modification of gx (enter 1)
2 - Modification of gy (enter 2)
3 - Modification of gz (enter 3)

Enter your choice

-1 - Upper level menu
# - Normal flow rate imposed
1 - Inflow along boundary 1
2 - vx, vy, vz imposed along boundary
3 - vx, vy, vz imposed along boundary
4 - vn & vs imposed along boundary
5 - Outflow along boundary

Select the boundary condition you want to modify

1

# - Interface
1 - Normal and tangential velocities imposed (vn & vs)
2 - Normal and tangential forces imposed (fn & fs)
3 - Normal velocity and tangential force imposed (vn & fs)
4 - Normal force and tangential velocity imposed (fn & vs)
5 - Slip conditions
6 - Plane of symmetry (fs=0 & vn=0)
7 - Inflow
8 - Outflow
9 - Free surface
10 - Global force imposed
11 - Cartesian velocities imposed (vx, vy, vz)

Current choice: Inflow
No force postprocessor

-2 - Enable force postprocessor
-1 - Upper level menu
CR
Current value of the volumetric flow rate is 5.200000E-07
Enter its new value (CR=no modification)

-2 - Enable force postprocessor
-1 - Upper level menu
CR)
# - Interface
1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
2 - Normal and tangential forces imposed (fn & fs) (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
5 - Slip conditions (enter 5)
6 - Plane of symmetry (fs=0 & vn=0 ) (enter 6)
7 - Inflow (enter 7)
8 - Outflow (enter 8)
9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
>11 - Cartesian velocities imposed (vx,vy,vz) (enter 11)

Enter your choice
11

vx,vy,vz imposed along boundary 2

The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  x1 =-1.75050000E-02  y1 = 0.00000000E+00  z1 = 0.00000000E+00
- Coordinates of the 2nd point of the rotation axis
  x2 =-1.75050000E-02  y2 = 0.00000000E+00  z2 =-1.00000000E-02
- Angular velocity = -6.2831850E+00
- Components of the translation velocity
  tx = 0.00000000E+00  ty = 0.00000000E+00  tz = 0.00000000E+00

-1 - Upper level menu (enter -1 or CR)
1 - Modification of 1st point of the axis (enter 1)
2 - Modification of 2nd point of the axis (enter 2)
3 - Modification of angular velocity (enter 3)
4 - Modification of translation velocity (enter 4)

Enter your choice
The cartesian velocities are expressed as the combination of a rotation and of a translation.

- Coordinates of the 1st point of the rotation axis
  \( x_1 = 1.7505000E-02 \) \( y_1 = 0.00000008 + 0 \) \( z_1 = 0.0000000E+00 \)
- Coordinates of the 2nd point of the rotation axis
  \( x_2 = 1.7505000E-02 \) \( y_2 = 0.00000008 + 0 \) \( z_2 = -1.00000000E-02 \)
- Angular velocity \( = -6.28318500E+00 \)
- Components of the translation velocity
  \( t_x = 0.00000008 + 0 \) \( t_y = 0.00000008 + 0 \) \( t_z = 0.00000000E+00 \)

-1 - Upper level menu (enter -1 or CR)
1 - Modification of 1st point of the axis (enter 1)
2 - Modification of 2nd point of the axis (enter 2)
3 - Modification of angular velocity (enter 3)
4 - Modification of translation velocity (enter 4)

Enter your choice:

******************************************************************************
* * Flow boundary condition along boundary 4 * *
******************************************************************************

Current choice : vn & vs imposed
No force postprocessor

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)
1 - Interface
  > 1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
  2 - Normal and tangential forces imposed (fn & fs) (enter 2)
  3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
  4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
  5 - Slip conditions (enter 5)
  6 - Plane of symmetry (fs=0 & vn=0) (enter 6)
  7 - Inflow (enter 7)
  8 - Outflow (enter 8)
  9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
11 - Cartesian velocities imposed (vx,vy,vz) (enter 11)

Enter your choice:
1

******************************************************************************
* * vn & vs imposed along boundary 4 * *
******************************************************************************

- vn : constant = 0.00000005 + 0

-1 - Upper level menu (enter -1 or CR)
1 - Constant (enter 1)
2 - Linear function of coordinates (enter 2)

Enter your choice:
- vs : constant = 0.00000000E+00

-1 - Upper level menu (enter -1 or CR)
# - Constant
# - Linear function of coordinates

Enter your choice

******************************************************
*  
* Flow boundary condition along boundary  5  
*  
******************************************************

Current choice : Outflow
No force postprocessor

-2 - Enable force postprocessor (enter -2)
-1 - Upper level menu (enter -1 or CR)
CR)
# - Interface
1 - Normal and tangential velocities imposed (vn & vs) (enter 1)
2 - Normal and tangential forces imposed (fn & fs) (enter 2)
3 - Normal velocity and tangential force imposed (vn & fs) (enter 3)
4 - Normal force and tangential velocity imposed (fn & vs) (enter 4)
5 - Slip conditions (enter 5)
6 - Plane of symmetry ( fs=0 & vn=0 ) (enter 6)
7 - Inflow (enter 7)
> 8 - Outflow (enter 8)
9 - Free surface (enter 9)
10 - Global force imposed (enter 10)
11 - Cartesian velocities imposed (vx,vy,vz) (enter 11)

Enter your choice

8

******************************************************
*  
* Outflow along boundary  5  
*  
******************************************************

Zero normal derivative on velocity imposed

Do you agree with this?
Enter y(es) or n(o) (CR=yes)
Current setup: Linear coordinates
Quadratic velocities, linear pressure
Picard iterations on viscosity(g)
No upwinding in momentum equations

-1 - Upper level menu 
CR)
1 - Quadratic coordinates
# - Quadratic element for stresses
# - 4x4 SU element for stresses
# - 4x4 SUPG element for stresses
# - EVSS for stresses
# - EVSS SU for stresses
# - EVSS SUPG for stresses
8 - Quadratic velocities, linear pressure (enter 8)
9 - Mini-element for velocities, constant pressure (enter 9)
10 - Linear velocities, constant pressure (enter 10)
11 - Quadratic velocities, linear discontinuous pressure (enter 11)
12 - Newton iterations on viscosity(g) (enter 12)
# - Linear element for temperature
# - Quadratic element for temperature
# - 2x2 element for temperature
# - 4x4 element for temperature
# - Upwinding in momentum equations
# - Sub-interpolation

Enter your choice

-1 - Upper level menu 
1 - Local shear-rate
2 - Viscosity
3 - Rate of deformation tensor
4 - Inelastic stress tensor
5 - Viscous heating
# - Total extra-stress tensor
7 - Residence time
# - Tracking of material points
9 - Tracking of a material property
10 - Forces on slices

Enter your choice

The calculation will be done on S1.

Hit CR to continue
-1 - Upper level menu (enter -1)
1 - Local shear-rate (enter 1)
2 - Viscosity (enter 2)
3 - Rate of deformation tensor (enter 3)
4 - Inelastic stress tensor (enter 4 or CR)
5 - Viscous heating (enter 5)
# - Total extra-stress tensor (enter 7)
7 - Residence time (enter 7)
# - Tracking of material points (enter 9)
9 - Tracking of a material property (enter 9)
10 - Forces on slices (enter 10)

Enter your choice

The calculation will be done on S1.

Hit CR to continue

-1 - Upper level menu (enter -1)
1 - Local shear-rate (enter 1 or CR)
2 - Viscosity (enter 2)
3 - Rate of deformation tensor (enter 3)
4 - Inelastic stress tensor (enter 4)
5 - Viscous heating (enter 5)
# - Total extra-stress tensor (enter 7)
7 - Residence time (enter 7)
# - Tracking of material points (enter 9)
9 - Tracking of a material property (enter 9)
10 - Forces on slices (enter 10)

Enter your choice

The calculation will be done on S1.

Hit CR to continue
### APPENDIX N

**Screw Channel: Y-Z Cross Section**

<table>
<thead>
<tr>
<th>Vertex No.</th>
<th>Angle (degree)</th>
<th>Hypoth (m)</th>
<th>X value (m)</th>
<th>Y value (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>0.0000000</td>
<td>0.0000000</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
<td>0.0057362</td>
<td>0.0000000</td>
</tr>
<tr>
<td>3</td>
<td>27.6666667</td>
<td>0.0048900</td>
<td>0.0082350</td>
<td>0.0048900</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>0.0048900</td>
<td>0.0000000</td>
<td>0.0048900</td>
</tr>
<tr>
<td>5</td>
<td>27.6666667</td>
<td>0.0048900</td>
<td>-0.0082350</td>
<td>0.0048900</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-0.0057362</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>

**Appendix O:**

Macro-Vertex and -Element Numbering Schemes Assigned to the 2D Mesh Representing the Y-Z Cross Section Through the Screw Channel

![Diagram of screw channel](image)

**Appendix P:**

Sub-Domain Numbering Scheme Assigned for the Time-Dependent Flow Problem

![Diagram of sub-domain numbering](image)
### Screw Channel: Y-Z Cross Section

<table>
<thead>
<tr>
<th>Element No.</th>
<th>Segment Numbering</th>
<th>Shape</th>
<th>Radius of Arc</th>
<th>Center of Arc</th>
<th>Arc Orientation</th>
<th>No. of Distribution Segments</th>
<th>Conditions</th>
<th>Method</th>
<th>Total No. of Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 = 2</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Macr Vert 2</td>
<td>Gen. Chk. B.</td>
<td>400</td>
</tr>
<tr>
<td>2</td>
<td>2 = 3</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Both Extrms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3 = 4</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Macr Vert 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 = 1</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Both Extrms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4 = 5</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Macr Vert 5</td>
<td>Gen. Chk. B.</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td>5 = 6</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Both Extrms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6 = 1</td>
<td>Straight</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Macr Vert 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 = 4</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>20</td>
<td>Cheb Twrds Both Extrms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Appendix R: Boundary Numbering Scheme for the 2D Y-Z Screw Channel Mesh.**

<table>
<thead>
<tr>
<th>Outer Barrel Wall</th>
<th>Screw Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bound No.</td>
<td>1</td>
</tr>
<tr>
<td>Start</td>
<td>(Direction)</td>
</tr>
<tr>
<td>3 (=&gt; 4)</td>
<td>5</td>
</tr>
</tbody>
</table>

Total = 800
Appendix S:
Macro-Vertex Numbering
Scheme Assigned to Meshes
Pertaining to Set 1
Representations of the 2D Mixing Discs.
### Appendix Ti

**Mixing Disc - $\alpha = 0^\circ$**

> * - Right hand screw

<table>
<thead>
<tr>
<th>Vertex No.</th>
<th>Angle (degree)</th>
<th>Hypoth (m)</th>
<th>X value (m)</th>
<th>Y value (m)</th>
<th>Value Change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38.1450264</td>
<td>0.0176455</td>
<td>-0.0066062</td>
<td>0.0138773</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>37.2307299</td>
<td>0.0198625</td>
<td>-0.0054877</td>
<td>0.0158146</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>22.7692701</td>
<td>0.0198625</td>
<td>-0.0098178</td>
<td>0.0183146</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>21.8549736</td>
<td>0.0176455</td>
<td>-0.0109363</td>
<td>0.0163773</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>37.1780498</td>
<td>0.0200075</td>
<td>-0.0054146</td>
<td>0.0159412</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>22.8219502</td>
<td>0.0200075</td>
<td>-0.0097447</td>
<td>0.0184412</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>61.0357344</td>
<td>0.0198625</td>
<td>-0.0001269</td>
<td>0.0096187</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>61.0357344</td>
<td>0.0200075</td>
<td>0.0000000</td>
<td>0.0096889</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>98.1450264</td>
<td>0.0176455</td>
<td>-0.0000375</td>
<td>-0.0025000</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>97.2307299</td>
<td>0.0198625</td>
<td>0.0021995</td>
<td>-0.0025000</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>82.7692701</td>
<td>0.0198625</td>
<td>0.0021995</td>
<td>0.0025000</td>
<td>Yes</td>
</tr>
<tr>
<td>12</td>
<td>81.8549736</td>
<td>0.0176455</td>
<td>-0.0000375</td>
<td>0.0025000</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>97.1780498</td>
<td>0.0200075</td>
<td>0.0023457</td>
<td>-0.0025000</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>82.8219502</td>
<td>0.0200075</td>
<td>0.0023457</td>
<td>0.0025000</td>
<td>Yes</td>
</tr>
<tr>
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### Appendix T2

**Mixing Disc - $\alpha = 5^\circ$**

* - Right hand screw

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## Mixing Disc - $\alpha = 10^\circ$

* - Right hand screw

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### Appendix T4

**Mixing Disc - α = 15°**

* - Right hand screw

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**** - Represents Progress Between Values Shown For Each 5° Rotation

**Appendix W: Boundary Numbering Scheme Used for Each of the Set 1, 2D Mixing Disc Meshes.**

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Appendix X:
Macro-Vertex Numbering
Scheme Assigned to Meshes
Pertaining to Set 2
Representations of the 2D Mixing Discs.
### Appendix Y1

**Mixing Disc - \( \alpha = 25^\circ \)**

* - Right hand screw

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Appendix Z:
Macro-Element Numbering
Schemes Assigned to Each of the
Set 2, 2D Mixing Disc Meshes.
### Mixing discs - $\alpha = 25^\circ - 30^\circ$

**APPENDIX AA**

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<td>*</td>
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<td>Distribution</td>
<td>Conditions</td>
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**** - Represents Progress Between Values Shown For Each 5° Rotation

Appendix AB: Boundary Numbering Scheme Used for Each of the Set 2, 2D Mixing Disc Meshes.

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Appendix AC:

Macro-Vertex Numbering Scheme Assigned to Meshes Pertaining to Set 1

Representations of the 2D Trilobal Elements.
## APPENDIX A01

Trilobe Element - $\alpha = 0^\circ$

* = Right hand screw

<table>
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<tr>
<th>Vertex No.</th>
<th>Angle (degree)</th>
<th>Hypoth (m)</th>
<th>X value (m)</th>
<th>Y value (m)</th>
<th>Value</th>
<th>To Change</th>
</tr>
</thead>
<tbody>
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<td>0.0198625</td>
<td>-0.0274363</td>
<td>0.0172014</td>
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<th>Vertex No.</th>
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<th>Hypoth (m)</th>
<th>X value (m)</th>
<th>Y value (m)</th>
<th>Value Change?</th>
<th>To Change</th>
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APPENDIX A04

Trilobe Element - $\alpha = 15^\circ$  

* = Right hand screw

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## Appendix A05

Trilobe Element - $\alpha = 20^\circ$

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### APPENDIX AD6

**Trilobe Element - \( \alpha = 25^\circ \)**

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Appendix AE: Macro-Element Numbering Schemes Assigned to Each of the Set 1, 2D Trilobal Element Meshes.
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<th>Value</th>
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**** - Represents Progress Between Values Shown For Each 5° Rotation

Appendix AG: Boundary Numbering Scheme Used for Each of the Set 1, 2D Trilobal Element Meshes.

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Appendix AH:
Macro-Vertex Numbering
Scheme Assigned to the Mesh
Pertaining to the Set 2
Representation of the 2D
Trilobal Elements.
### APPENDIX A1

**Trilobe Element - $\alpha = 30^\circ$**

* = Right hand screw

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<th>Y Value (m)</th>
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**NOTES:**

1 Additional simulation performed as part of optimisation study.