

MODUL APLIKASI KOMPUTASI PROSES

PENGGUNAAN COMPUTATIONAL FLUID DYNAMIC (CFD)
PADA SIKLON SEBAGAI PEMISAH PADATAN-GAS

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SIKLON

Siklon merupakan salah satu peralatan yang paling umum digunakan untuk mengendalikan emisi debu dari aliran gas pada proses industri. Meskipun perkembangan rekayasa saat ini telah memungkinkan untuk mengaplikasikan siklon, misalnya sebagai pengering dan reaktor, namun aplikasi utama siklon tetap pada bidang pengendalian pencemaran udara di mana efisiensi yang tinggi diperlukan untuk memenuhi peraturan yang diterapkan. Dibandingkan dengan alat pengendali polusi udara yang lain, siklon lebih disukai karena kesederhanaan dari desainnya, tidak mahal, biaya pemeliharaan rendah, dan kemampuan beradaptasi untuk berbagai kondisi operasi seperti pada suhu dan tekanan tinggi. Meskipun siklon sering digunakan sebagai tempat akhir pengumpulan di mana partikel yang berukuran besar ingin dipisahkan, siklon juga umum digunakan sebagai pra-pembersih sebagai kolektor yang lebih efisien seperti elektrostatis presipitator, *scrubber* atau kain saringan (Swamee dkk, 2009).

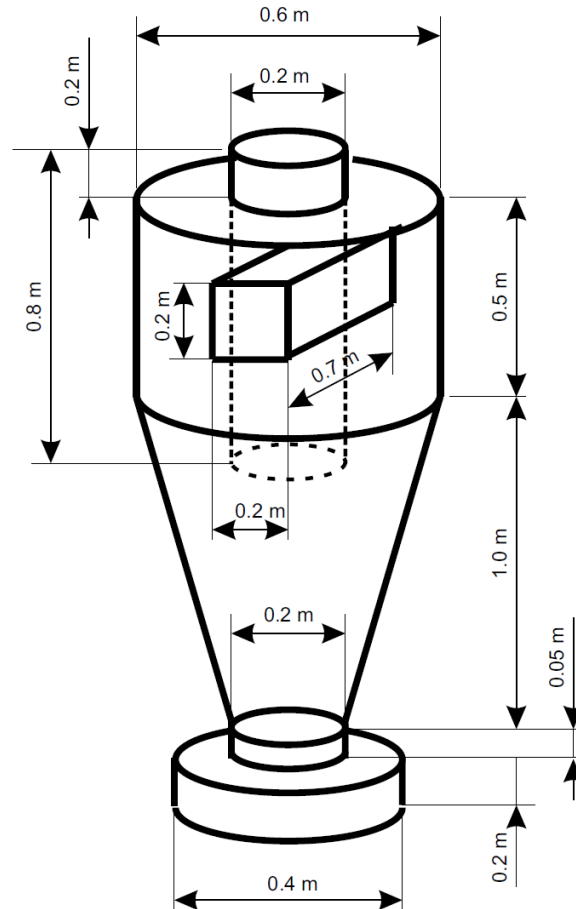
Pada modul ini kita akan membagi kita bagian pengerjaan:

1. Pembuatan geometri simple siklon dengan GAMBIT.
2. Meshing
3. Run Fluent simulation.

Berikut ditunjukkan data kondisi batas pada tabel 1 dan data dimensi siklon yang akan digunakan.

Tabel 1. Kondisi batas

air flow	0.27	m^3/s
air flow temperature	50	$^{\circ}C$
ash mass flux	0.001	kg/s
min. particle diameter	1	μm
max. particle diameter	300	μm
mean particle diameter	150	μm
spread parameter	2.8	
ash density	2100	kg/m^3



Gambar 1. Dimensi siklon

1. Pembuatan Geometry

- a. Geometry – Volume – Create Volume – Cylinder

Enter height =0,5, radius 1=0,3, radius 2 = 0,3

Press apply.

- b. Geometry – Volume – Create Volume – Frustum

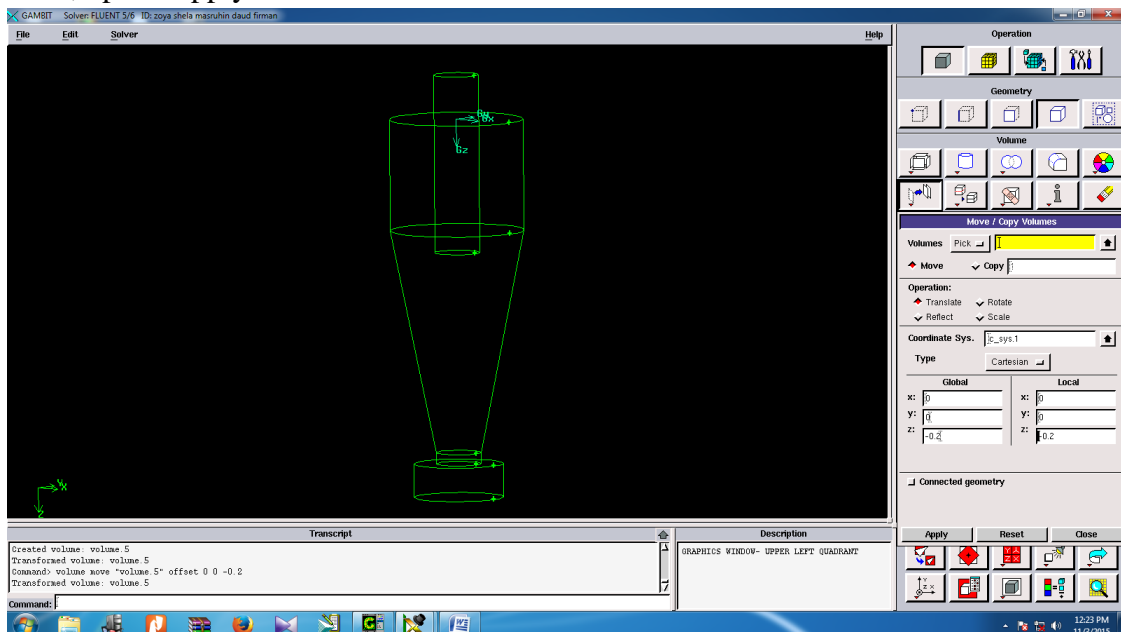
Enter height =1, radius 1=0,3, radius 2 = 0,3, radius 3 = 0,1

Press apply.

- c. Geometry – Volume – Move/Copy/Align

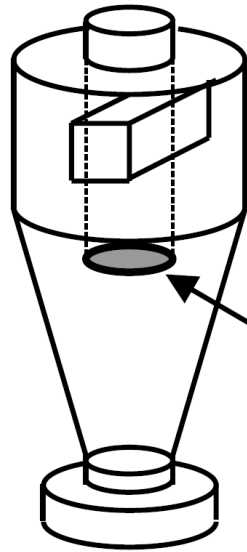
Select dengan mouse frustum: Pick volume 2, check move, translate enter $x=0,1$, $Y = 0$, $Z=0,5$ press apply

- d. Geometry — Volume — Create Volume— Cylinder
Enter height =0,05, radius 1=0,1, radius 2 = 0,1
Press apply.
- e. Geometry — Volume — Move/Copy/Align
Select dengan mouse cylinder: Pick volume 3, check move, translate enter x=0, Y = 0, Z=1,5 press apply
- f. Geometry — Volume — Create Volume —Cylinder
Enter height =0,15, radius 1=0,2, radius 2 = 0,2
Press apply.
- g. Geometry — Volume — Move/Copy/Align
Select dengan mouse cylinder: Pick volume 4, check move, translate enter x=0, Y = 0, Z=1,55 press apply
- h. Geometry — Volume — Create Volume —Cylinder
Enter height =0,8, radius 1=0,1, radius 2 = 0,1
Press apply.
- i. Geometry — Volume — Move/Copy/Align
Select dengan mouse cylinder: Pick volume 5, check move, translate enter x=0, Y = 0, Z=-0,2 press apply

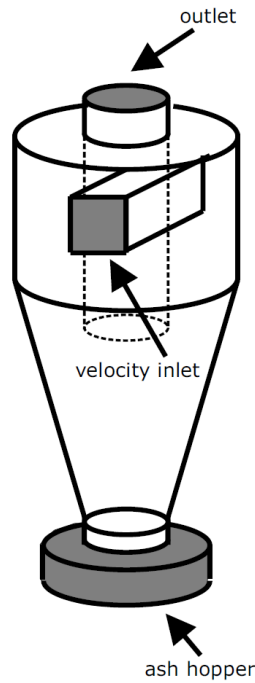


- j. Geometry — Volume — Create Volume —Brick
Enter Width=0,2, Dept =0,7, Height 2 = 0,2
Press apply.

- k. Geometry – Volume – Move/Copy/Align
- l. Select dengan mouse cylinder: Pick volume 6, check move, translate enter $x=0.2$, $Y = 0.35$, $Z=0.1$ press apply
- m. Geometry – Volume – Boeelan Operation – Unite
Select semua volume kecuali volume 5: Pick volume 1,2, 3, 4 dan 6. Press apply
- n. Geometry – Volume – Boeelan Operation – Subtract
Select volume hasil akhir operation : volume 1. Select dengan mouse sisa volume kecuali volume 5 check retain under substract volume. Press apply
- o. Geometry –Face – Connect/ Disconnect Faces – Connect



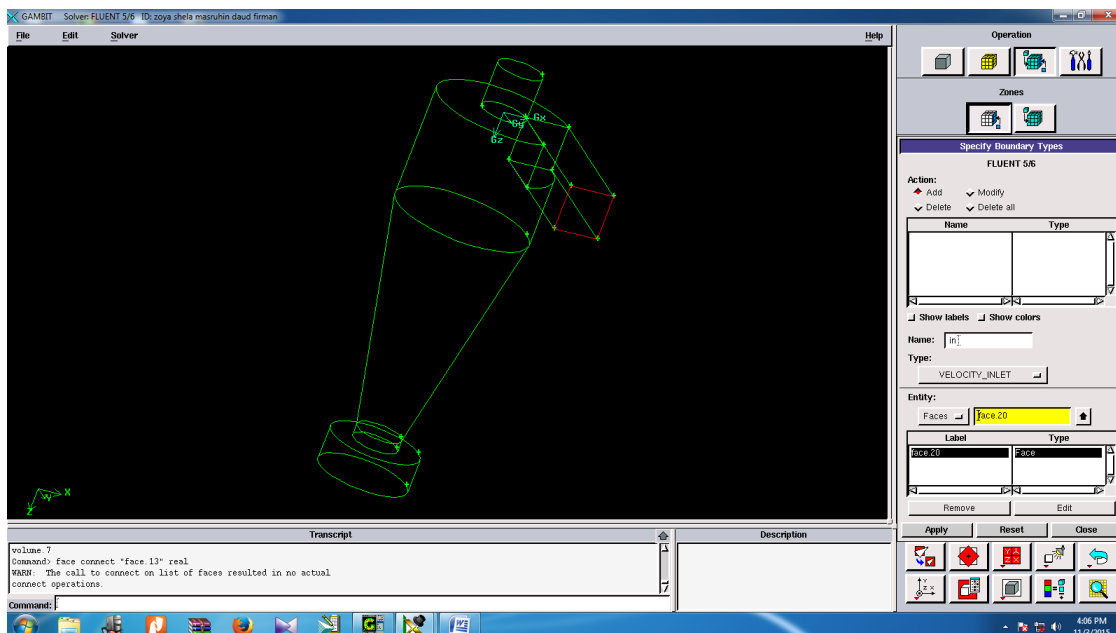
Gambar 2. Connect Face



Gambar 3. boundary condition

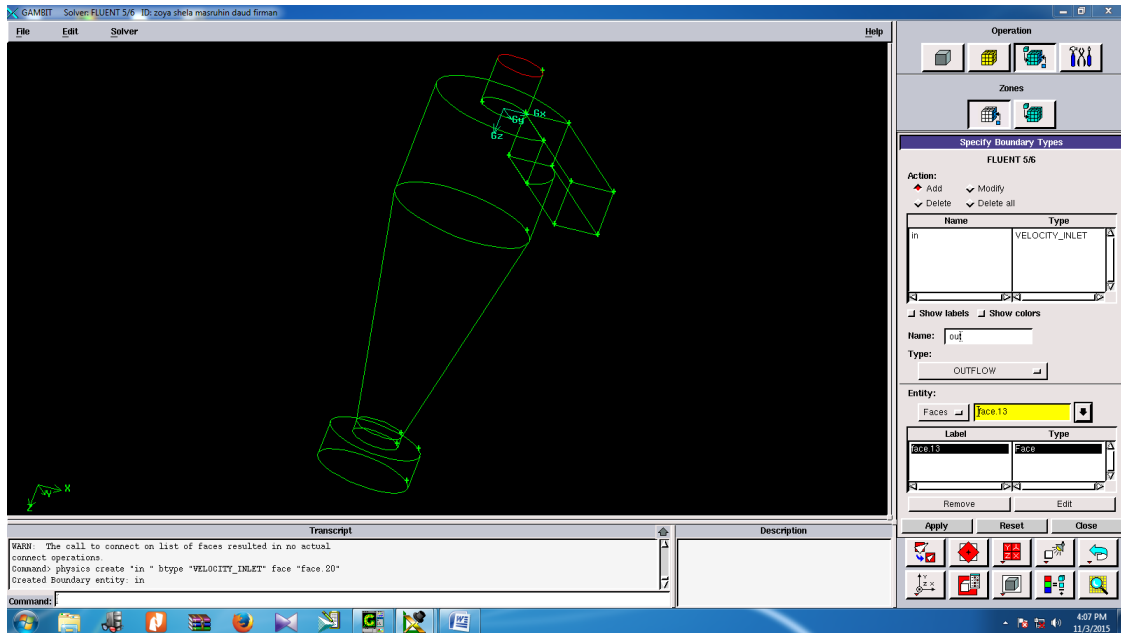
Penentuan Kondisi batas seperti gambar 3.

- a. Zones — Specify Boundary Types — In — Velocity Inlet
Pick entity :face, face inlet siklon seperti ditunjukkan gambar 3



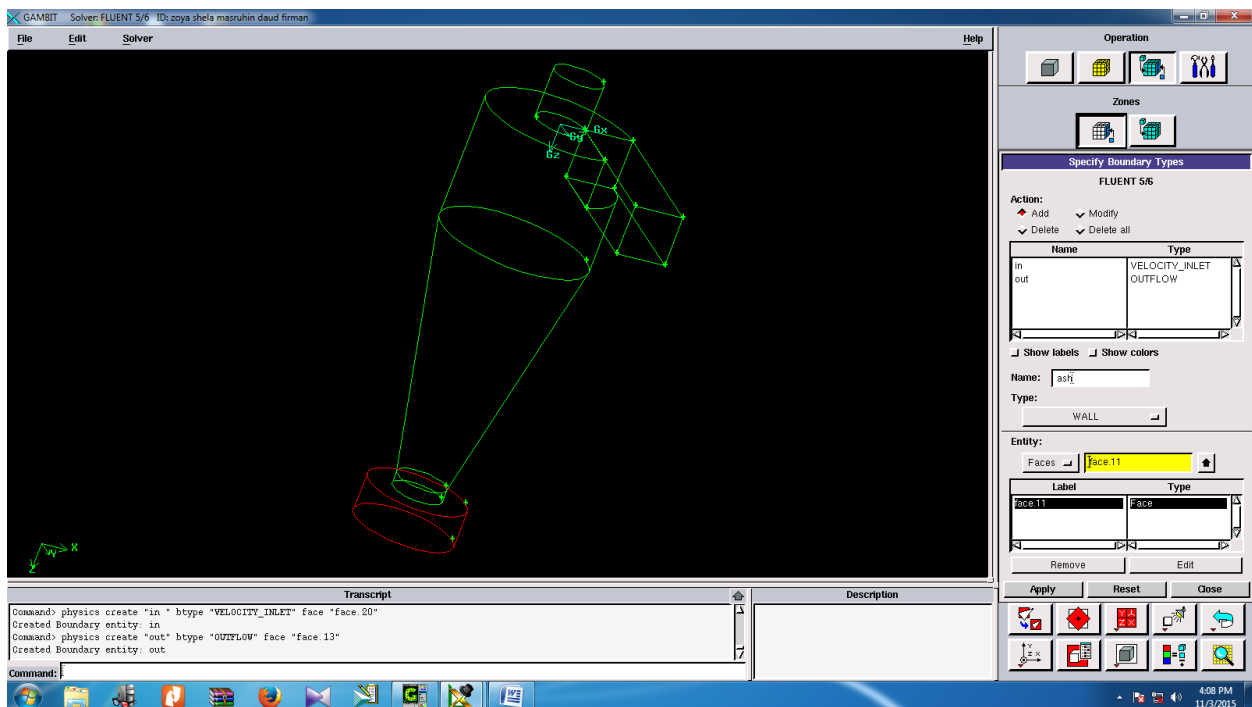
- b. Zones — Specify Boundary Types — Out — Out Flow

Pick entity :face, face outflow siklon seperti ditunjukkan gambar 3



c. Zones — Specify Boundary Types — Ash — Wall

Pick entity :face, face ash siklon seperti ditunjukkan gambar 3



Procesur Meshing

2. Meshing Geometry

a. Mesh—face

Pick face, select smua face

Select elements: Tri

Select Type : Pave

Check spacing : Apply

Enter interval size 0,5

Press Apply.

b. Mesh — Volume

Pick volume, select smua volume

Select elements: Tet/hybrid

Select Type : Tgrid

uncheck spacing : Apply

Press Apply.

c. File — Export — Mesh

3. Setting Fluent Parameters

a. File — Read — Case

b. Define — Models — Solver

c. Define — Models — Viscous

d. Define — Discrete Phase Model

- Point Properties

- Turbulen Dispersion

e. Define — Materials

- Density for air

- Density for inert particle ash

f. Define — Operating Condition

g. Define — Boundary Condition

- Zone — In , Press Set

- Zone — Ash , Press Set

- Zone — Wall, Press Set

h. Solve — Controls — Solution

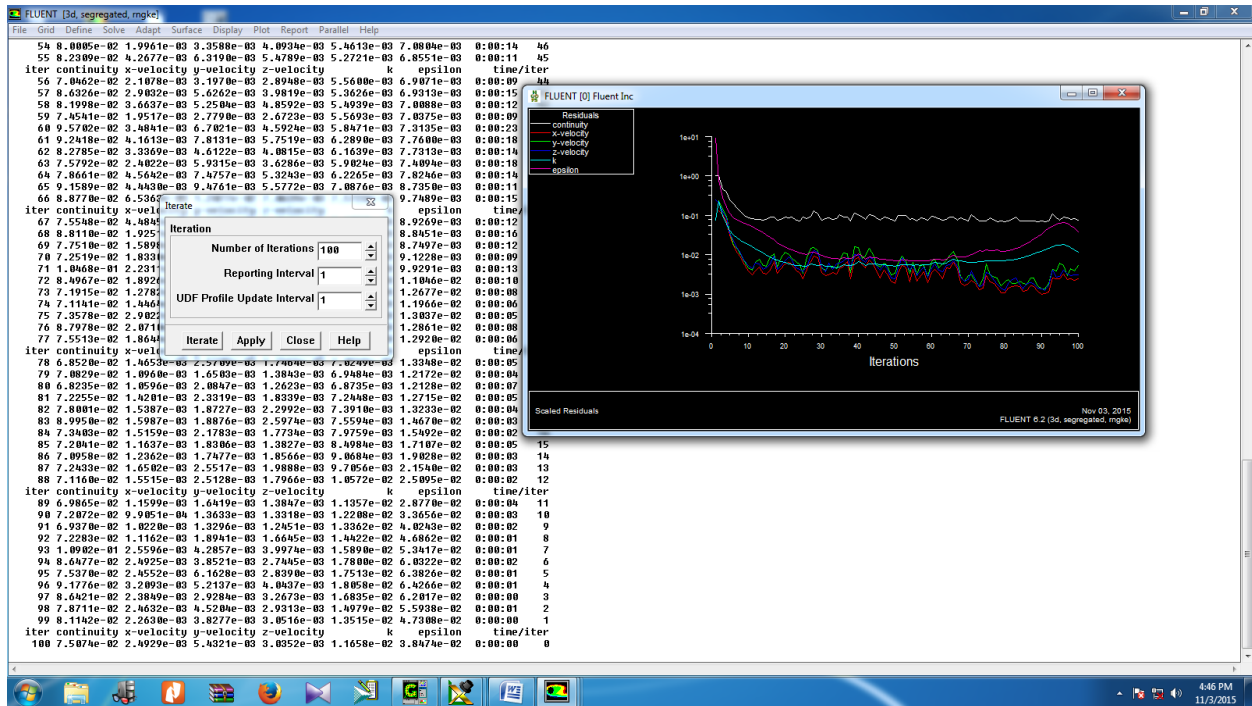
i. Solve — Initialize — Initialize..., Press Init

j. Solve — Monitor — Residual

k. File — Write — Case

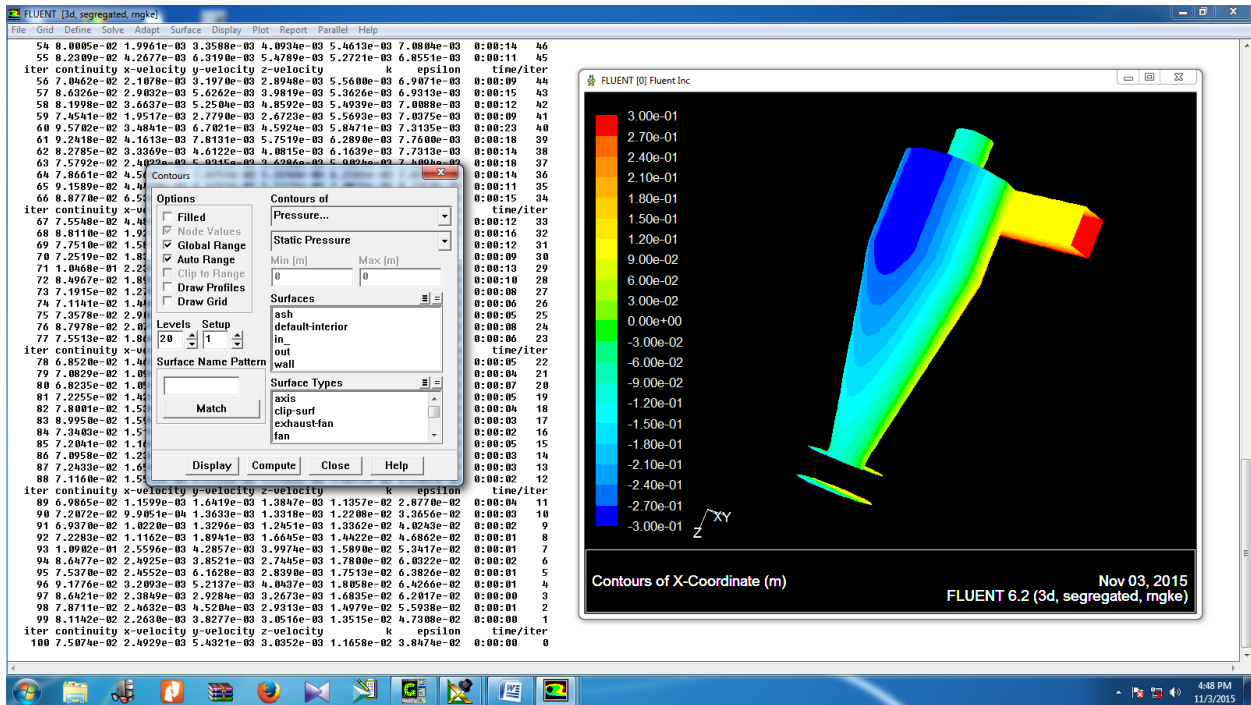
4. Performing Calculation

a. Solve — Iterate

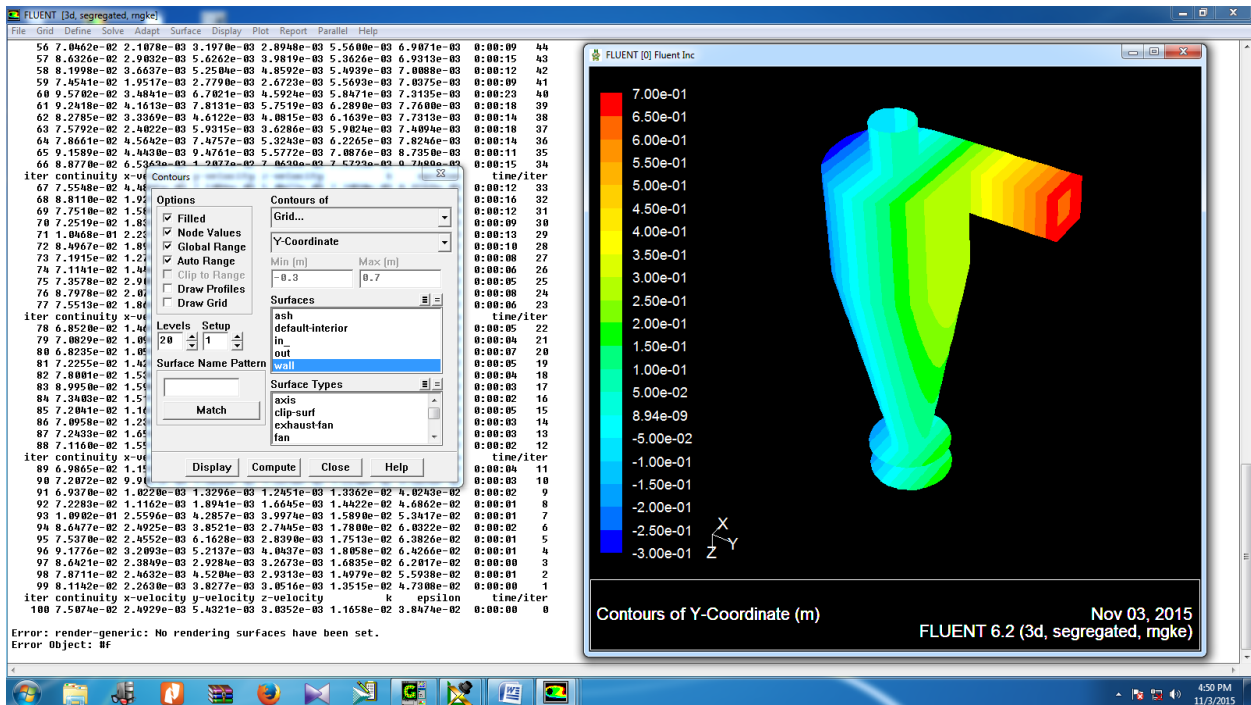


b. Display — Contours

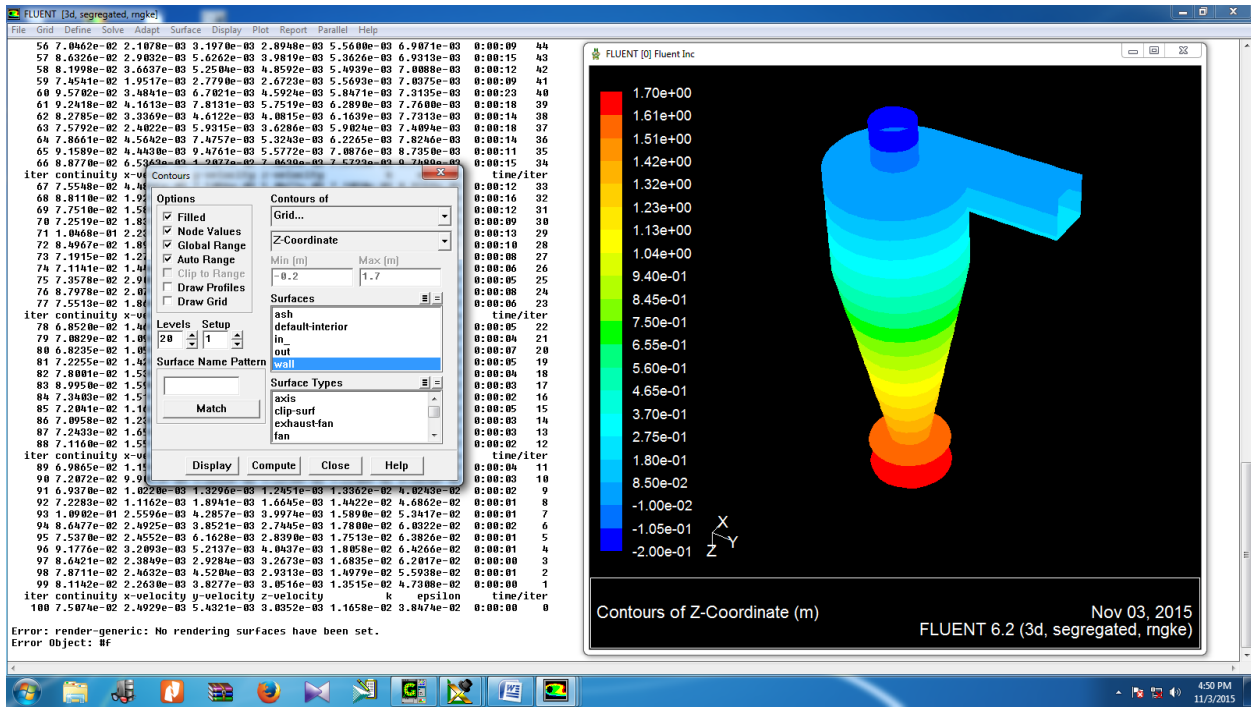
- X Coordinat



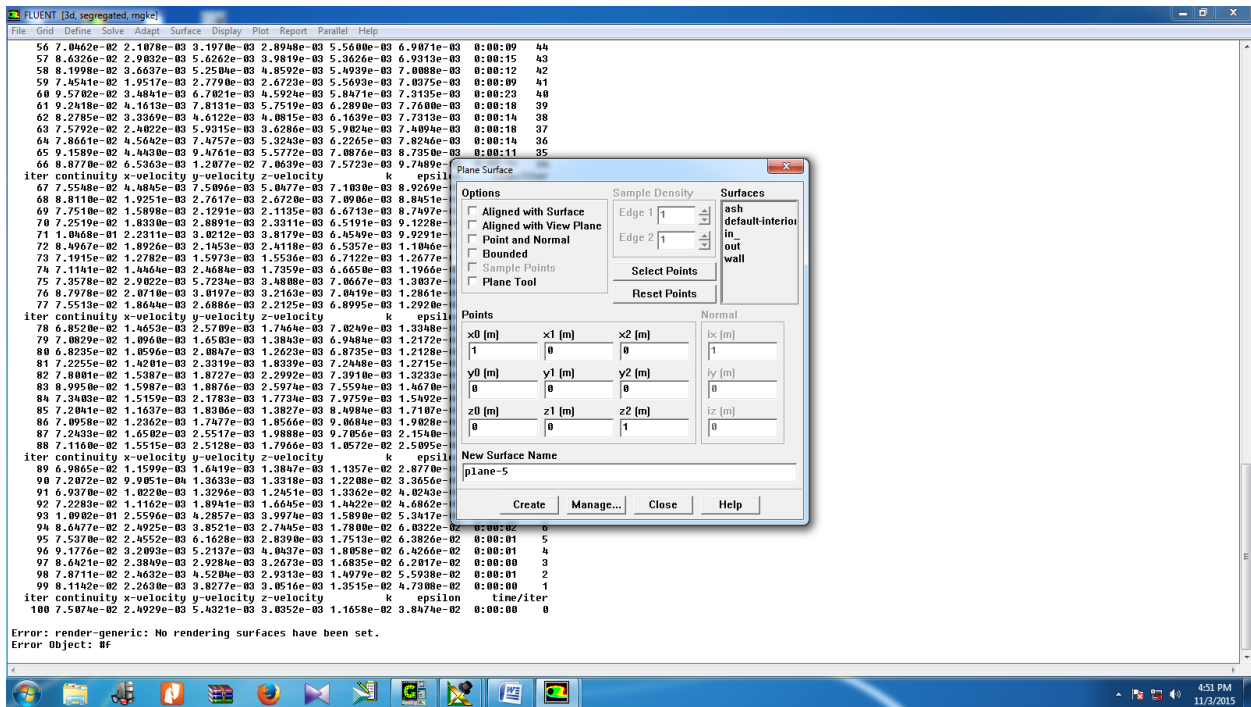
■ Y Coordinat



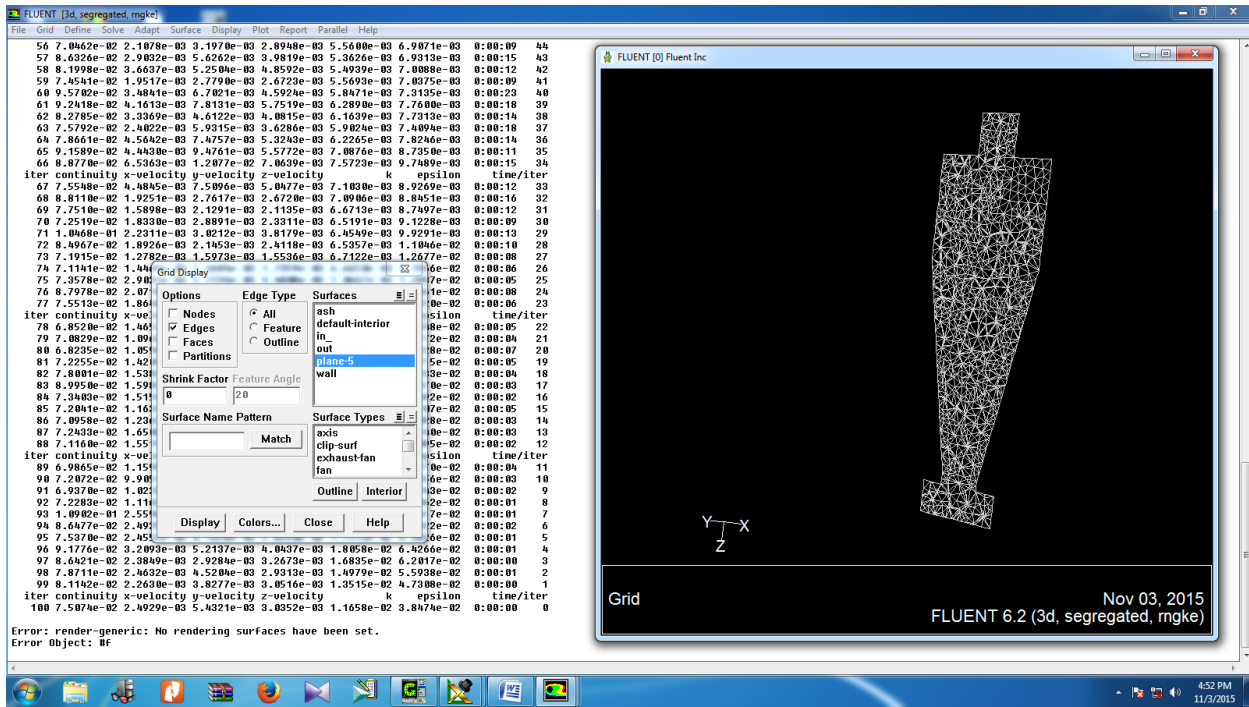
■ Z Coordinat



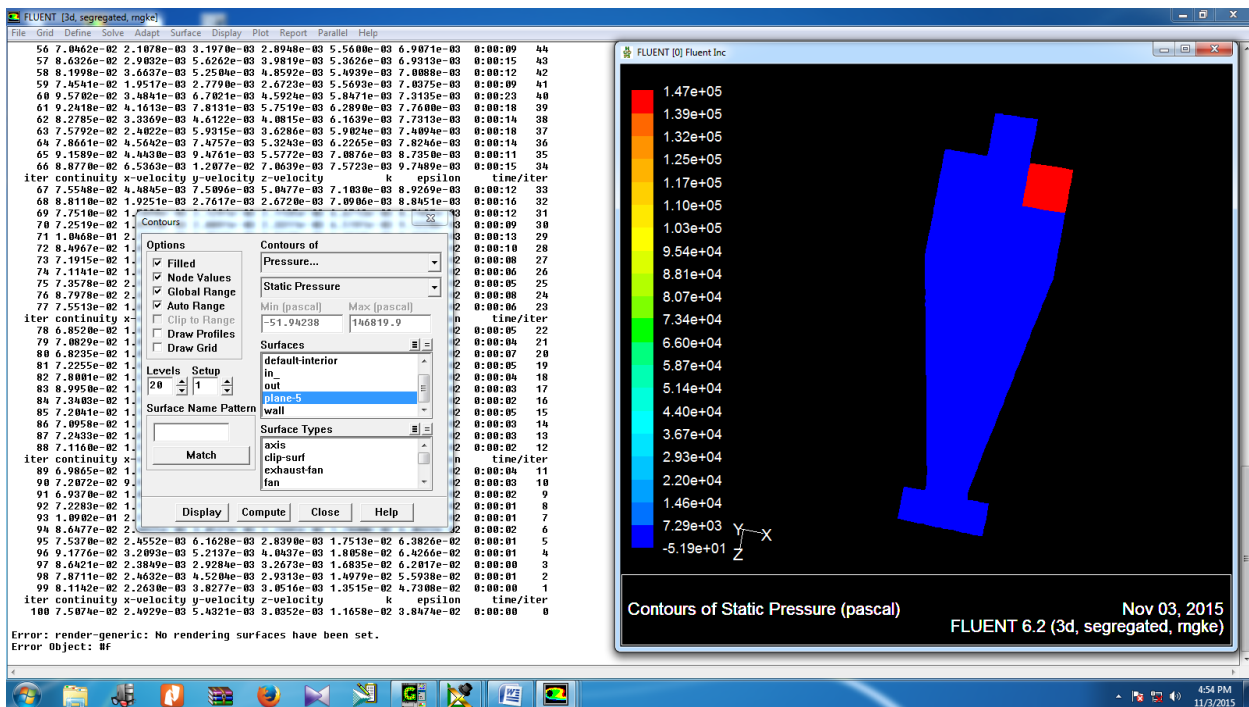
c. Surface — Plane



d. Display — Grid

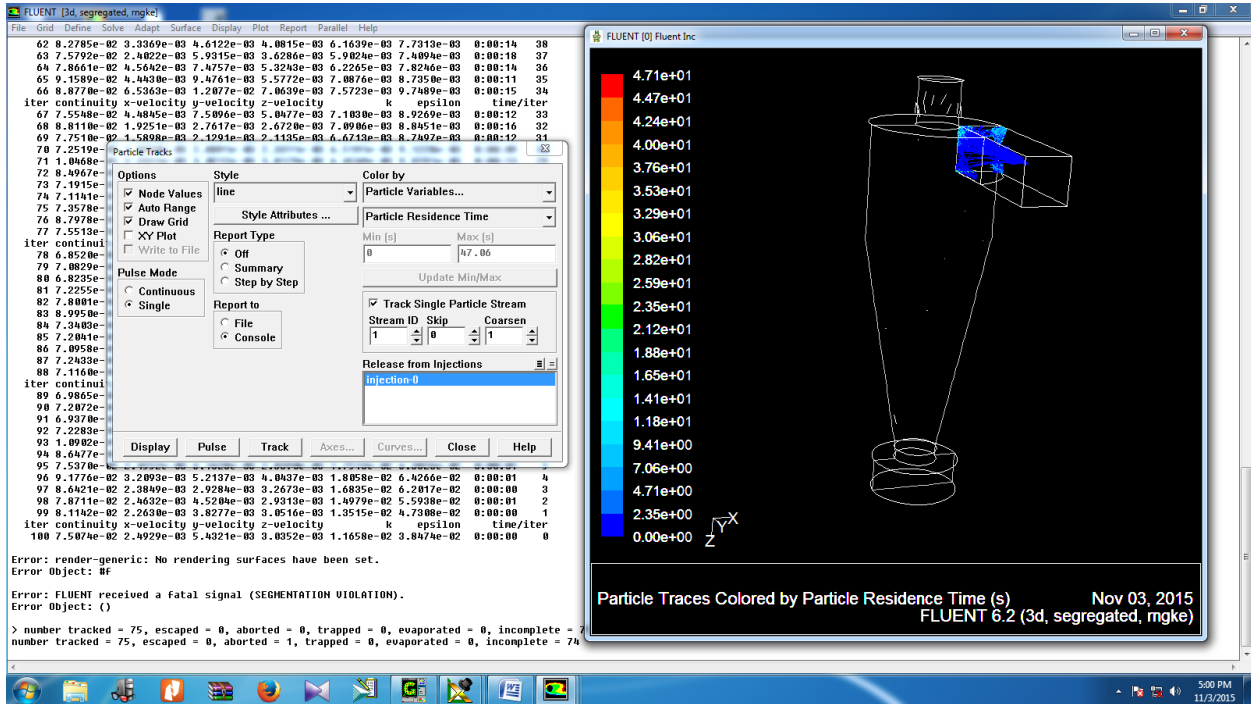


- e. Display – Contours
- Select Pressure

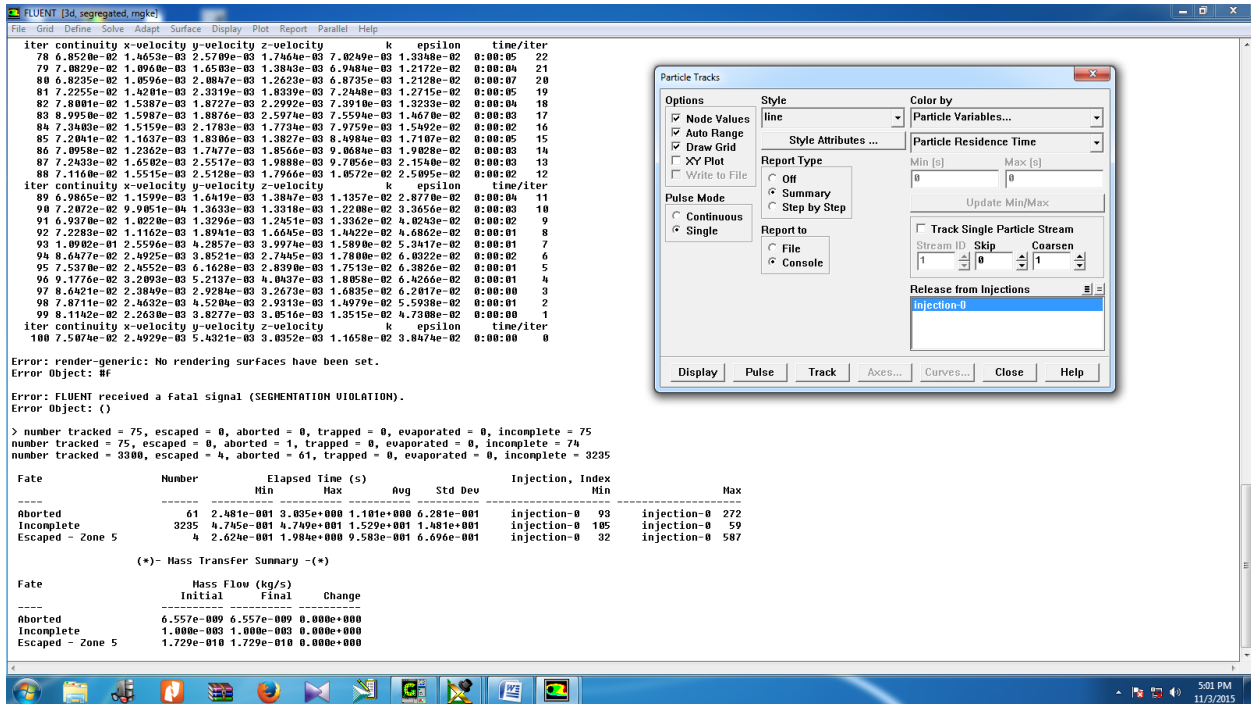


- Select Draw Grid

- Activated Draw Grid



- Deselect Track Single Particle Stream
 - With Velocity Magnitude 7,98



➤ With Velocity Magnitude 10.8

The screenshot shows the ANSYS FLUENT interface with a fatal error message and a Particle Tracks dialog box open.

Error Message:

```

Error: render-generic: No rendering surfaces have been set.
Error Object: bf
Error: FLUENT received a fatal signal (SEGMENTATION VIOLATION).
Error Object: ()
> number tracked = 75, escaped = 0, aborted = 0, trapped = 0, evaporated = 0, incomplete = 75
number tracked = 75, escaped = 0, aborted = 1, trapped = 0, evaporated = 0, incomplete = 74
number tracked = 3300, escaped = 4, aborted = 61, trapped = 0, evaporated = 0, incomplete = 3235
  
```

Particle Tracks Dialog Box:

- Options:**
 - Node Values
 - Auto Range
 - Draw Grid
 - XY Plot
 - Write to File
- Style:**
 - line
 - Style Attributes ...
- Color by:**
 - Particle Residence Time
 - Min [s]: 0, Max [s]: 0
 - Update Min/Max
- Report Type:**
 - Off
 - Summary
 - Step by Step
- Pulse Mode:**
 - Continuous
 - Single
- Report to:**
 - File
 - Console
- Track Single Particle Stream:**
 - Stream ID: 1, Skip: 0, Coarsen: 1
- Release from Injections:**
 - injection-0

Mass Transfer Summary (1st instance):

Fate	Number	Elapsed Time (s)				Injection, Index		Max	
		Min	Max	Avg	Std Dev	Min	Max		
Aborted	61	2.481e-001	3.035e+000	1.101e+000	6.281e-001	injection-0	93	injection-0	272
Incomplete	3235	4.745e-001	4.749e+001	1.529e+001	1.481e+001	injection-0	105	injection-0	59
Escaped - Zone 5	4	2.624e-001	1.998e+000	9.583e-001	6.696e-001	injection-0	32	injection-0	587

Mass Transfer Summary (2nd instance):

Fate	Number	Elapsed Time (s)				Injection, Index		Max	
		Min	Max	Avg	Std Dev	Min	Max		
Aborted	61	3.090e-001	3.417e+000	1.259e+000	6.978e-001	injection-0	91	injection-0	273
Incomplete	3237	4.148e-001	4.732e+001	1.530e+001	1.481e+001	injection-0	210	injection-0	419
Escaped - Zone 5	2	6.631e-001	1.590e+000	1.126e+000	4.634e-001	injection-0	47	injection-0	46

Mass Transfer Summary (3rd instance):

Fate	Number	Elapsed Time (s)				Injection, Index		Max	
		Min	Max	Avg	Std Dev	Min	Max		
Aborted	61	3.090e-001	3.417e+000	1.259e+000	6.978e-001	injection-0	91	injection-0	273
Incomplete	3237	4.148e-001	4.732e+001	1.530e+001	1.481e+001	injection-0	210	injection-0	419
Escaped - Zone 5	2	6.631e-001	1.590e+000	1.126e+000	4.634e-001	injection-0	47	injection-0	46

Mass Flow Summary (kg/s):

Fate	Mass Flow (kg/s)		
	Initial	Final	Change
Aborted	6.557e-009	6.557e-009	0.000e+000
Incomplete	1.000e-003	1.000e-003	0.000e+000
Escaped - Zone 5	1.729e-010	1.729e-010	0.000e+000

Mass Flow Summary (kg/s) - 2nd instance:

Fate	Mass Flow (kg/s)		
	Initial	Final	Change
Aborted	5.740e-009	5.740e-009	0.000e+000
Incomplete	1.000e-003	1.000e-003	0.000e+000
Escaped - Zone 5	5.700e-011	5.700e-011	0.000e+000