Title:

DTRC Analysis of flow mixing in L type of mixing head

New Mix Head Type Test

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DTRC flowing analysis

The current outcomes of velocity for two cases at time 0.75 s after impinging of two materials inside the head are shown in Figures 1. It can be seen that heading part always has the highest speed among the other parts of the Mixing Head. It is found that the impinging point occurs about the middle of the head for two cases; however for case 1 and case 2 the impinging point intend to locate above the inlet ports.

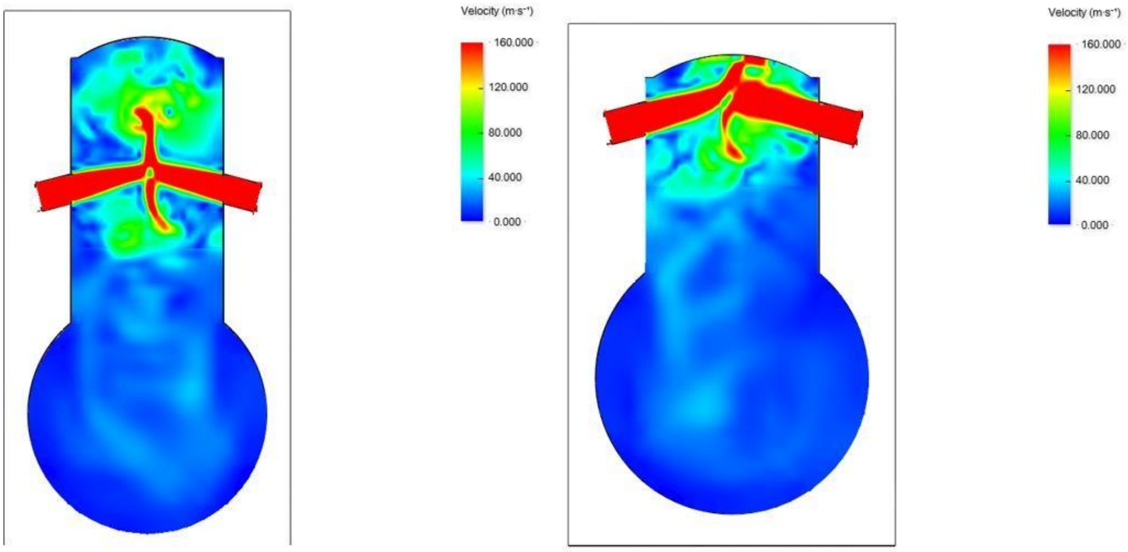


Figure 1: *Velocity field at time 0.75 for (left case 1-DTRC, right case2-L TYPE)*

Void for Free Foam

DTRC

L-TYPE

Foam Cross Section

DTRC

L-TYPE

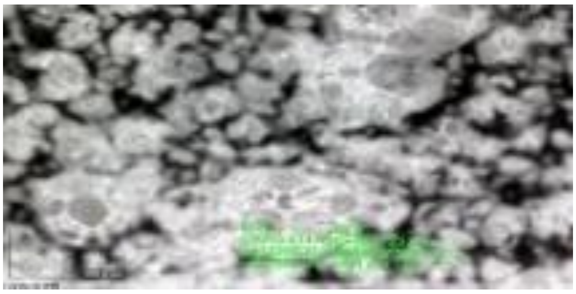
Laminar Flow

DTRC

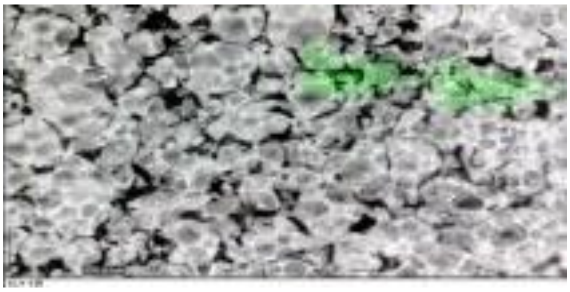
L-TYPE

Mixing Efficiency

DTRC



L-TYPE



1.1.1 Surface 6

Figures 19, 20 and 21 show that the mixed fluid moves with large variation in the head part. Laminar flow occurs at the end of main chamber where no large variations occurred.

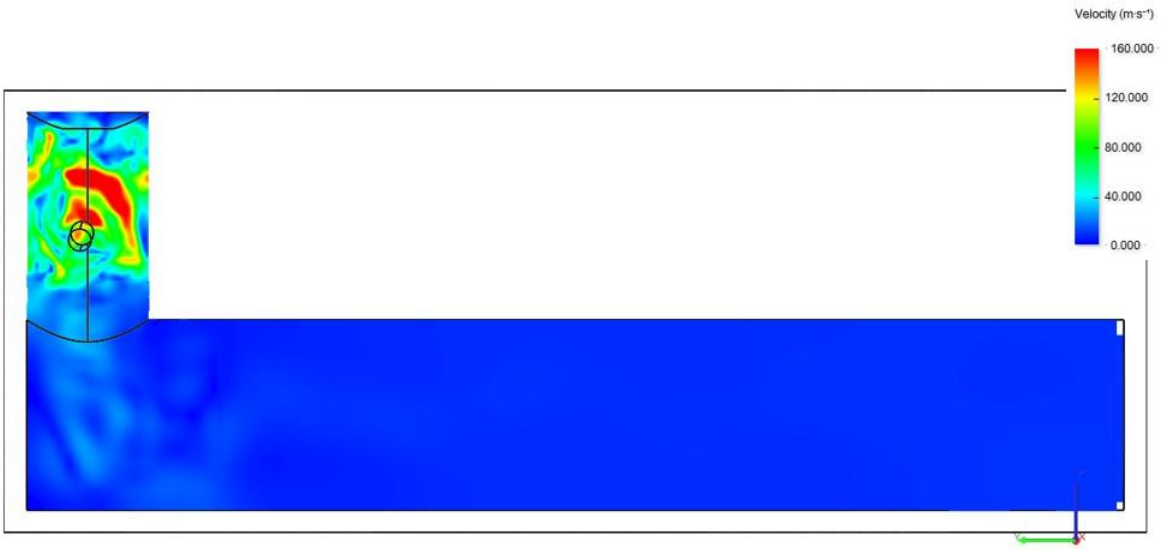


Figure 2: *Velocity field at time 0.75 for case 1*

Figure 3: *Velocity field at time 0.75 for case 2*

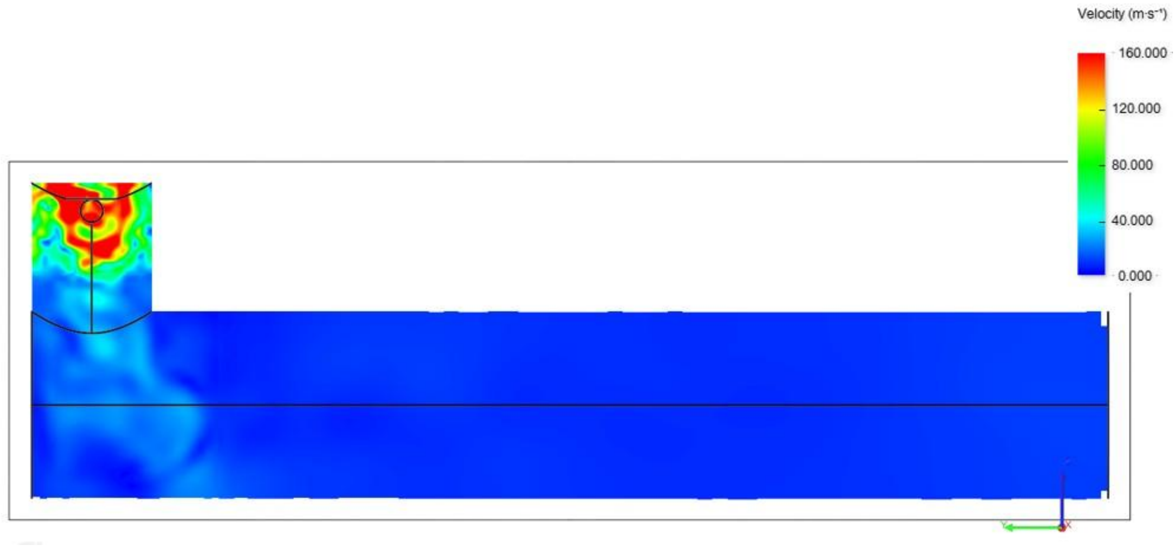


Figure 4: *Velocity field at time 0.75 for case 3*

1.2. Pressure distribution

The total pressure (in Pa) is the addition of dynamic pressure and the static pressure:

The first term is the dynamic pressure. The pressure shown at the Post-Processing is a gauge total pressure. The static pressure (in Pa) is defined as:

where ρ stands for the fluid density, is the speed of sound and γ is the adiabatic index. Noted, a stiff state equation is used for fluids and the pressure shown at the Post-Processing is a gauge static pressure.

1.2.1 Surface 5

The present results from three cases were obtained at time 0.75 s after injection of the materials inside the head. Impinging streams have the stagnation point. Usually the point is located in the center of the mixing head where two fluids smash each other. In the stagnation point, the streams have the static pressure which equal to the total. The high pressure makes the streams to spread laterally. Case 1 has the region of the low pressure to spread which is bigger than the other cases.

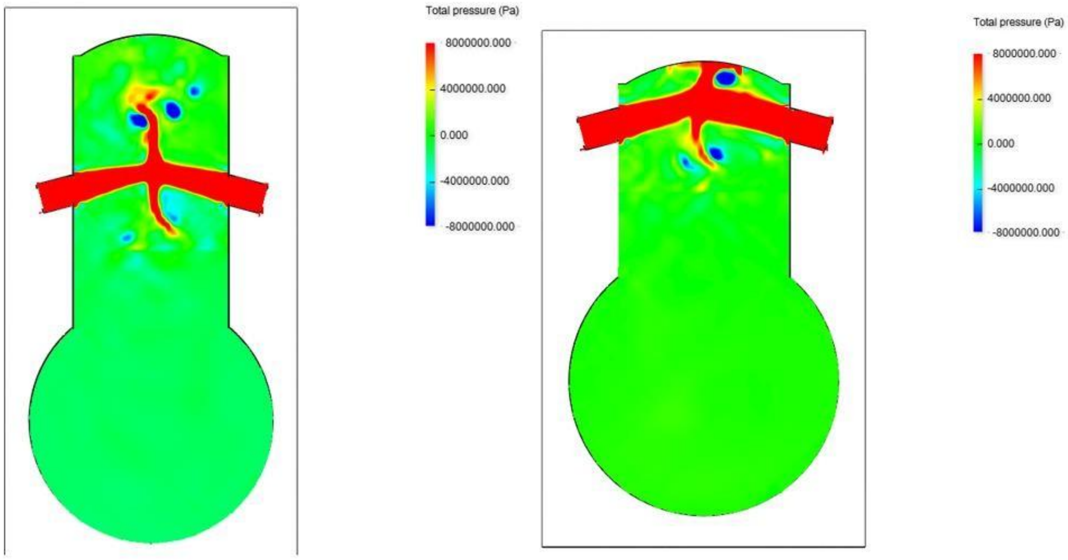


Figure 5: *Total Pressure field at time 0.75 for (left case 1, right case2)*

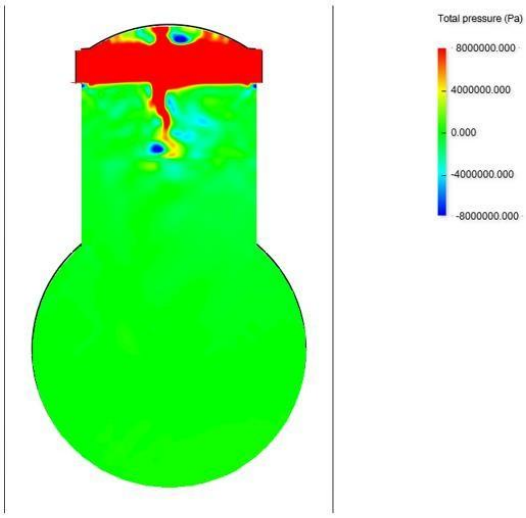


Figure 6: *Total Pressure field at time 0.75 for case 3*

3.2.3 Surface 7

As it can be seen from figures 24, 25 and 26 the maximum pressure can be obtain at the center of the surface where the impinging point occurs. In addition the speed of the velocity is significantly high where the pressure is in the peak point.

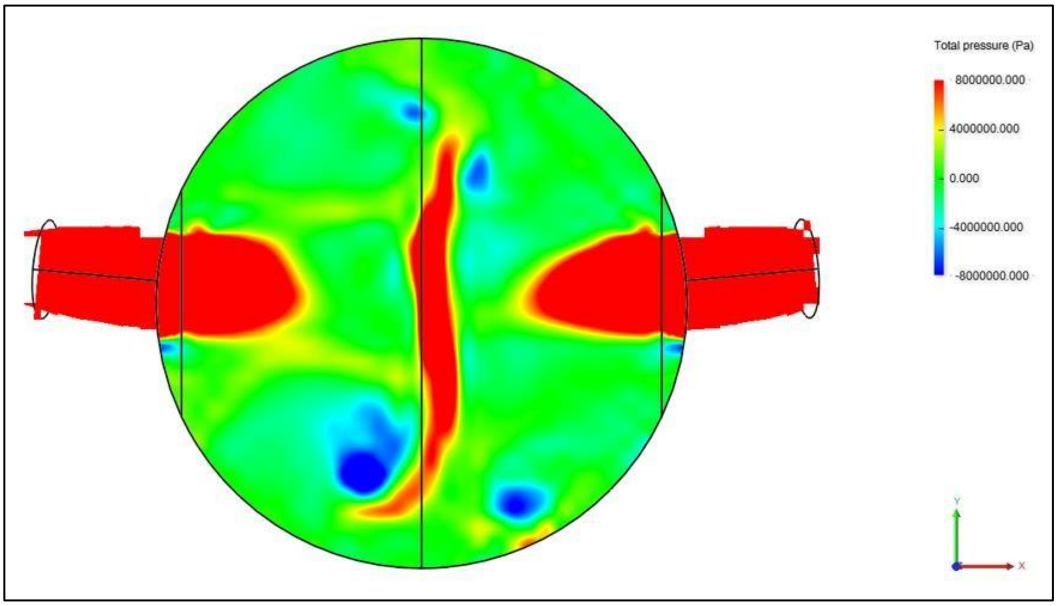


Figure 7: *Total Pressure field at time 0.75 for case 1*

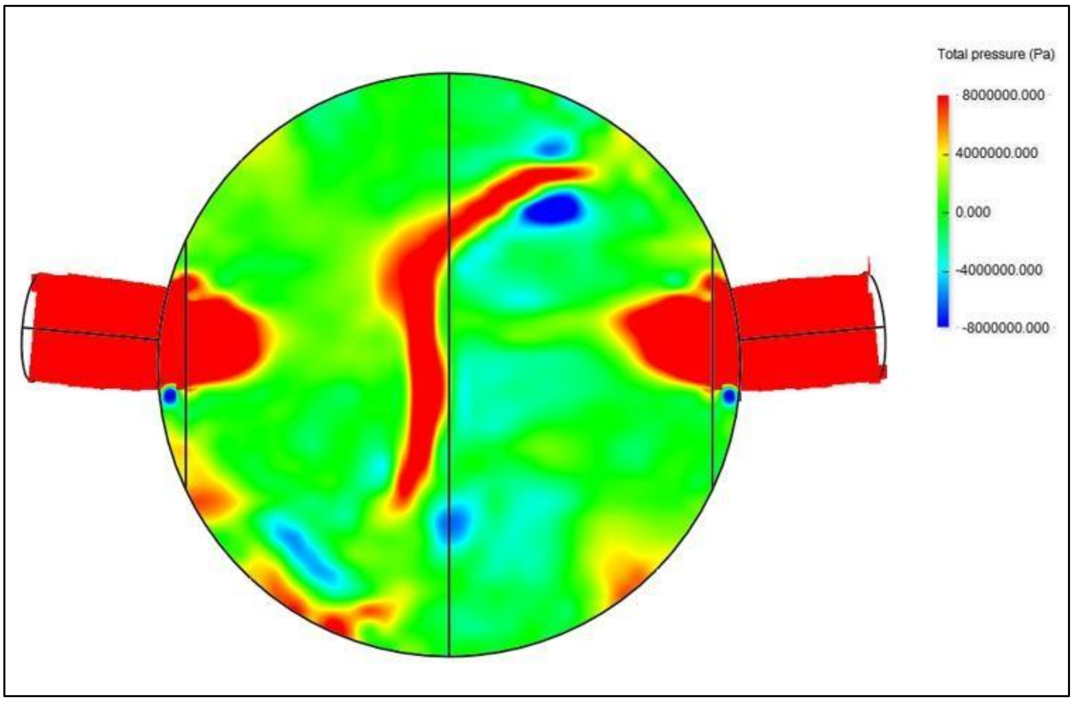


Figure 8: *Total Pressure field at time 0.75 for case 2*

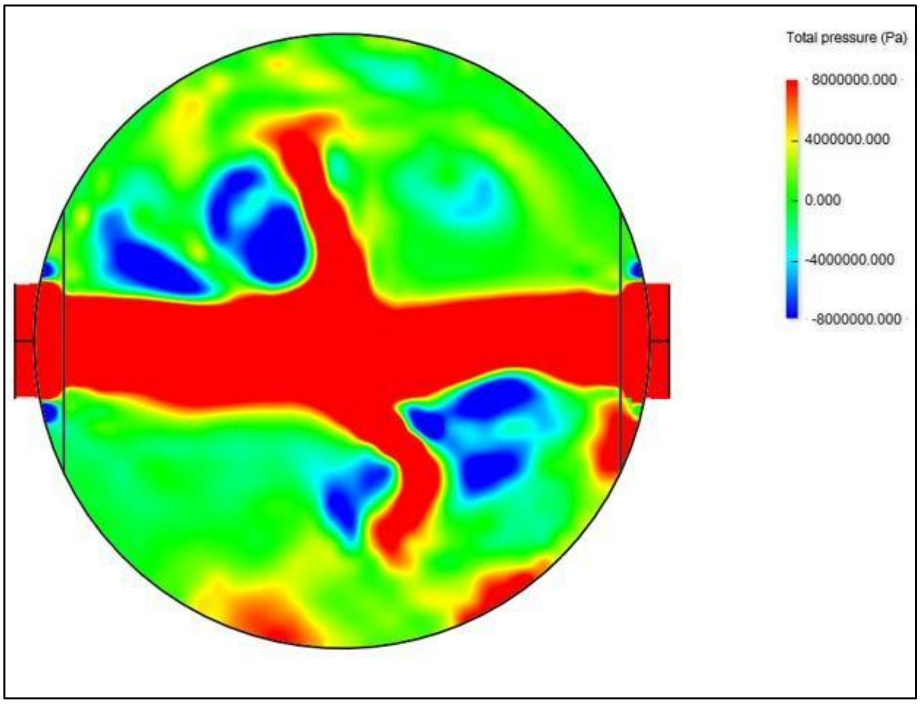


Figure 9: *Total Pressure field at time 0.75 for case 3*

1.3. Turbulence intensity

The turbulence kinetic energy can be calculated based on the closure method, i.e. a turbulence model. Generally, the TKE can be quantified by the mean of the turbulence normal stresses.

The turbulence intensity, also often referred to as turbulence level, is defined as:

where is the mean velocity, and the root-mean-square of the turbulent velocity fluctuations which

can be described as:

$$\sqrt{\ }$$

with k the turbulent kinetic energy. The mean velocity U is computed from the three mean velocity components:

$$\sqrt{\ }$$

It is noted, in the results part all the figures of turbulent intensity are given as a fraction of unity.

1.3.1 Surface 5

The turbulence levels measured in the mixing layer of the four jets studied are now analysed. Turbulence being mainly produced by velocity gradient and the ratios of the root-mean-square velocity fluctuations. The turbulence intensities are seen to be quite flat along the main chamber. The better mixing can be obtained in the turbulence flow where occurs in the head of the Mixing Head for three cases (figures 27, 28, 29, 30, 31 and 32).

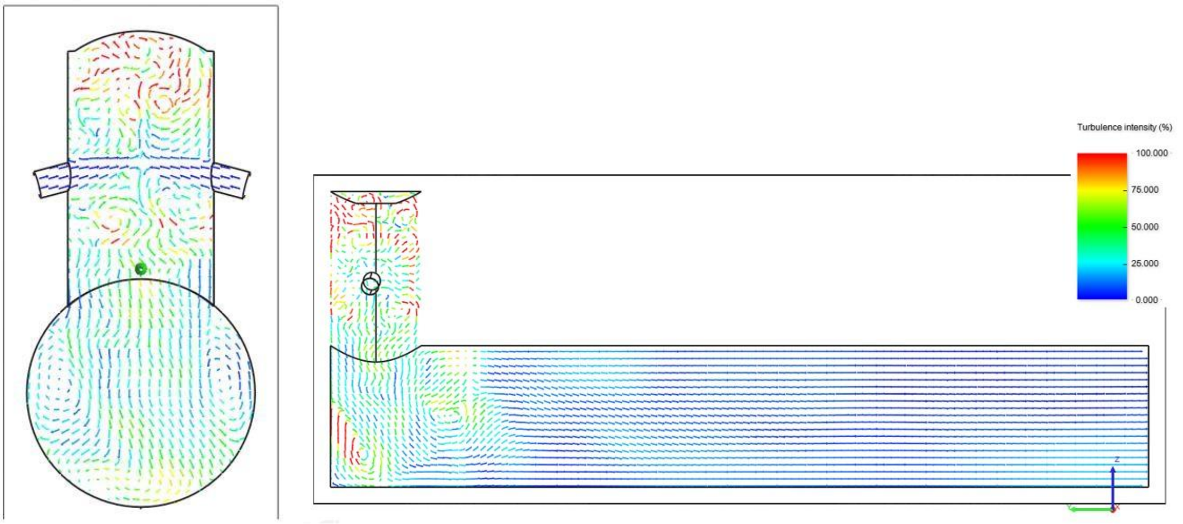


Figure 10: *Velocity vectors colored by turbulence intensity at time 0.75 for case 1*

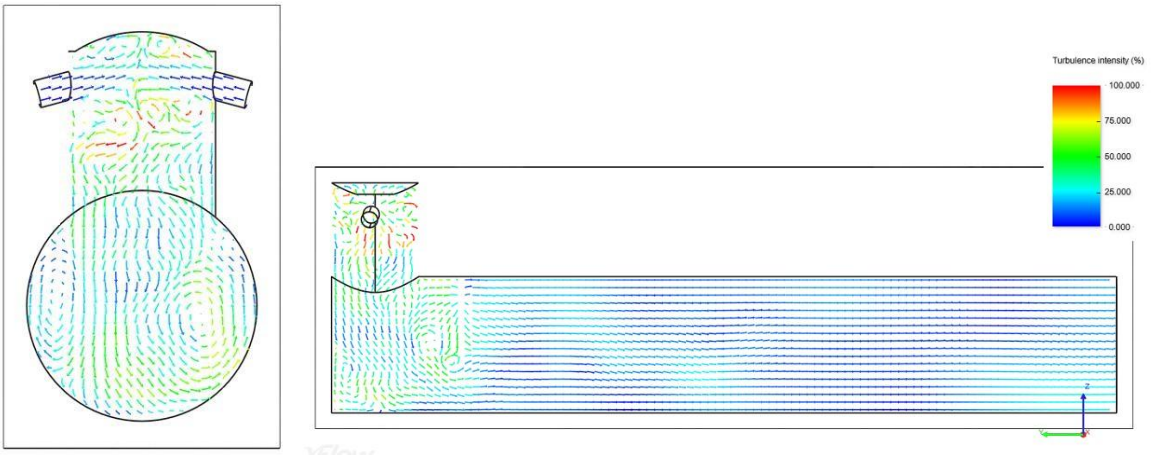


Figure 11: *Velocity vectors colored by turbulence intensity at time 0.75 for case 2*

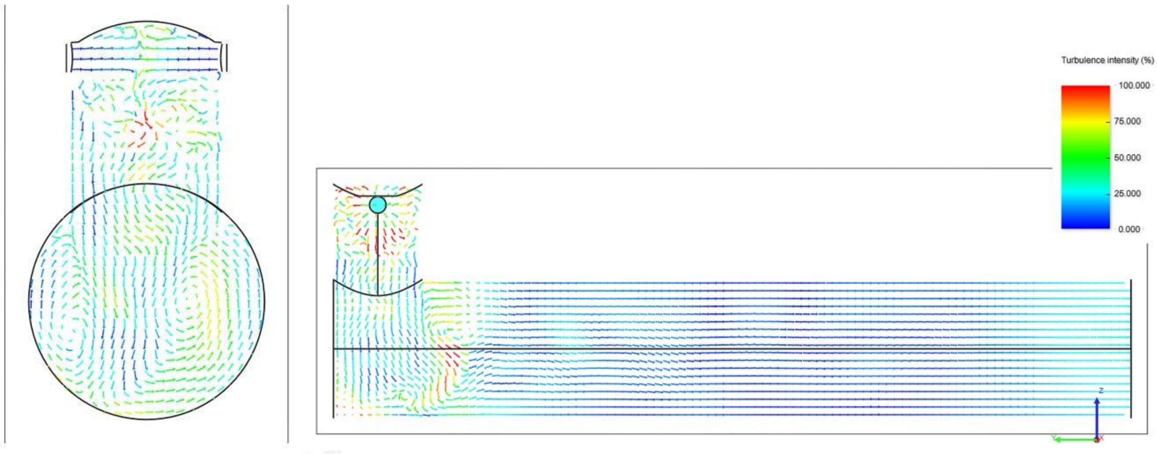


Figure 12: *Velocity vectors colored by turbulence intensity at time 0.75 for case 3*

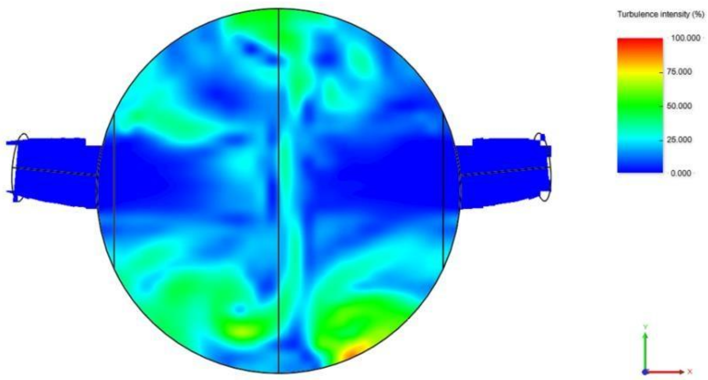


Figure 13: *turbulence intensity field in surface 7 at time 0.75 for case 1*

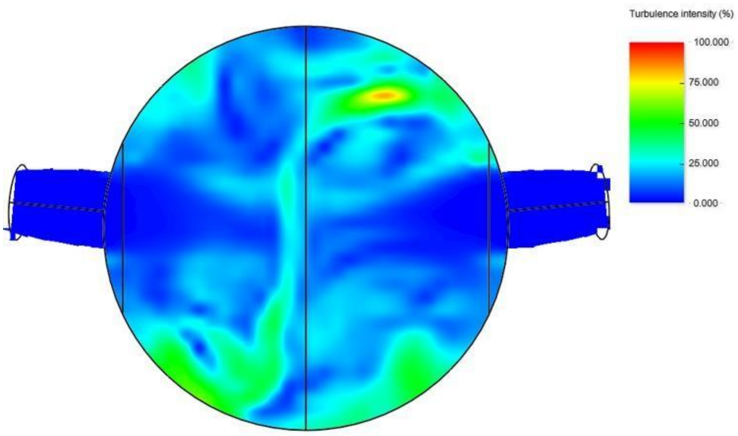


Figure 14: *turbulence intensity field in surface 7 at time 0.75 for case 2*

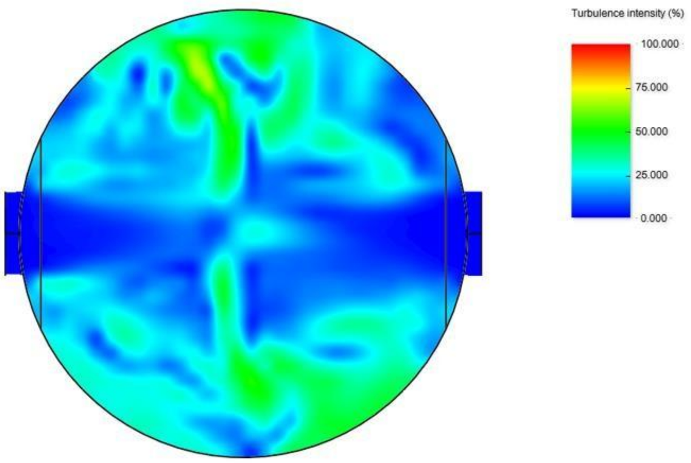


Figure 15: *turbulence intensity field in surface 7 at time 0.75 for case 3*

1.4. Concentration

1.4.1 Surface 1

Fig. 33 shows that concentrations of the substances are mixed evenly. The mixing is proper in this case where it is seen that no large variations occurred. Figs. 34 and 35 show that mixing are not evenly distributed. There is a large variation of mixing among these two cases.

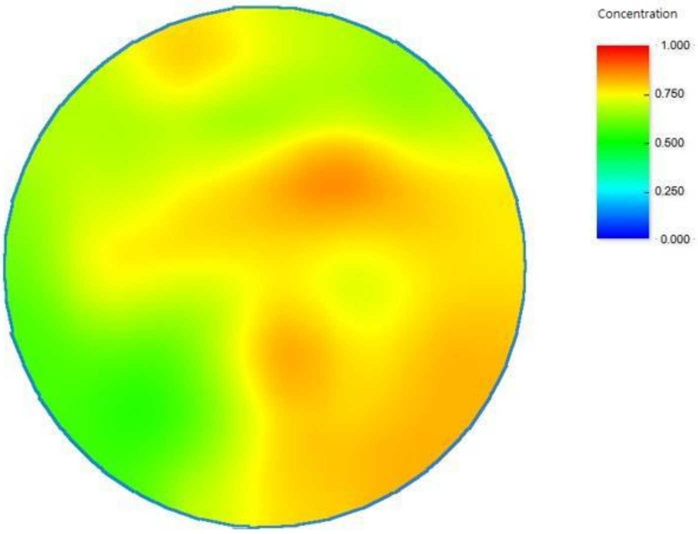


Figure 16: *Concentration field at time 0.75 for case 1*

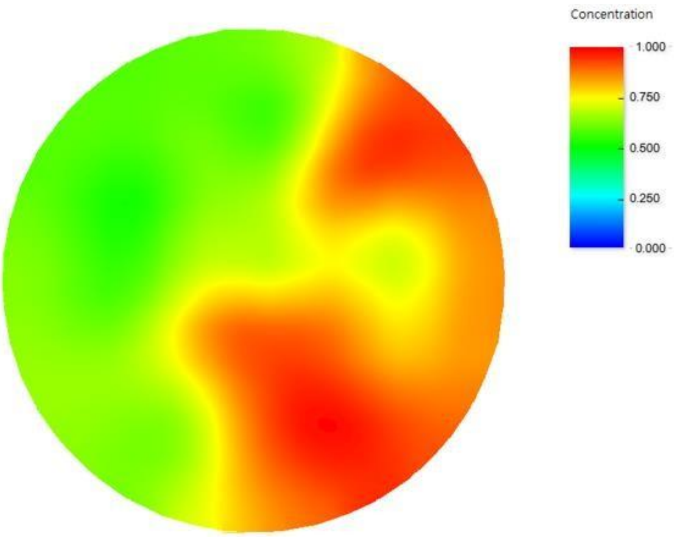
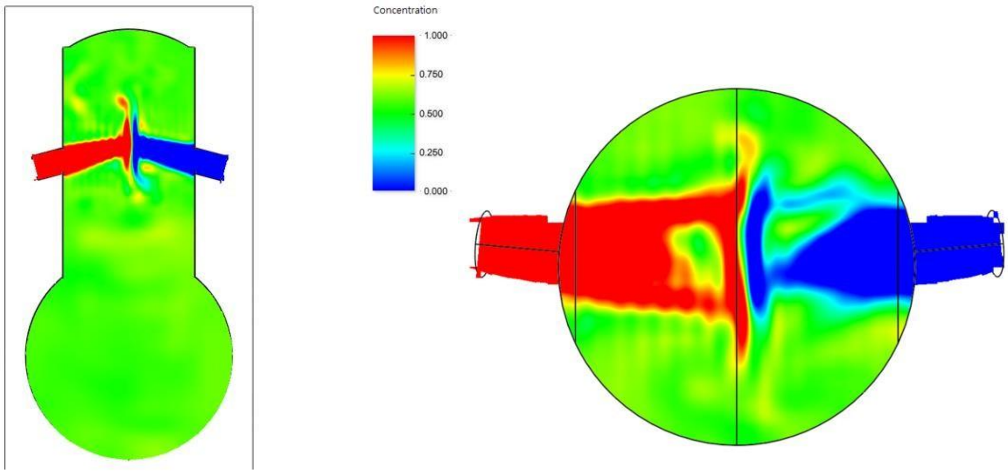


Figure 17: *Concentration field at time 0.75 for case 2*

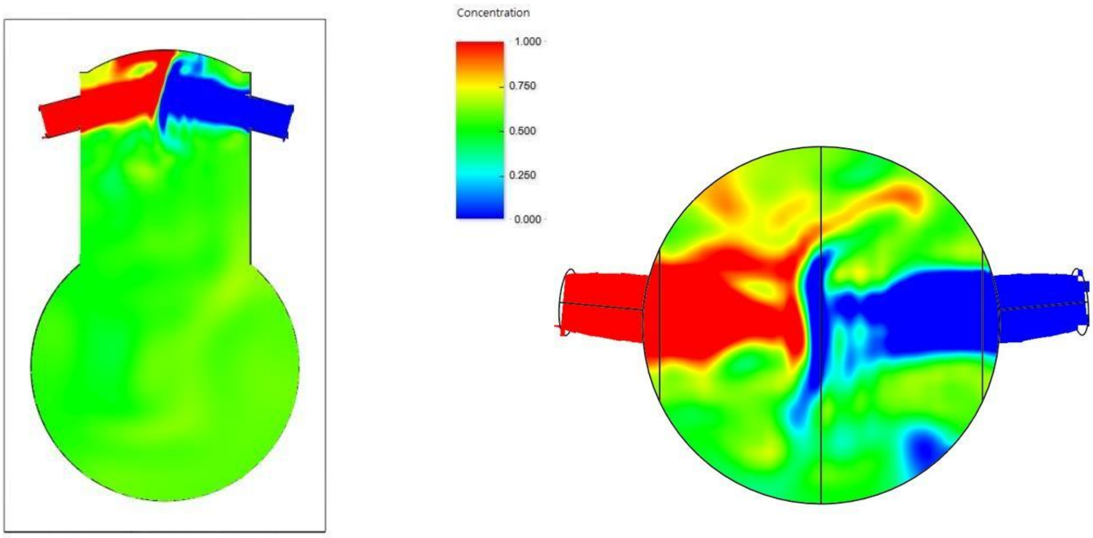
1.4.2 Surface 5

Fig. 36 shows that concentration is mixed properly. The mixing occurs at the middle of the head. In this case it is seen that different concentration are evenly distributed on each side. Fig 37 shows that the mixing occurring on the top of the chamber. The mixing concentration is almost striking on the top of the chamber wall. Fig 38 illustrates that mixing occurs in the middle of the head. The different concentration changes can be seen in these cases.



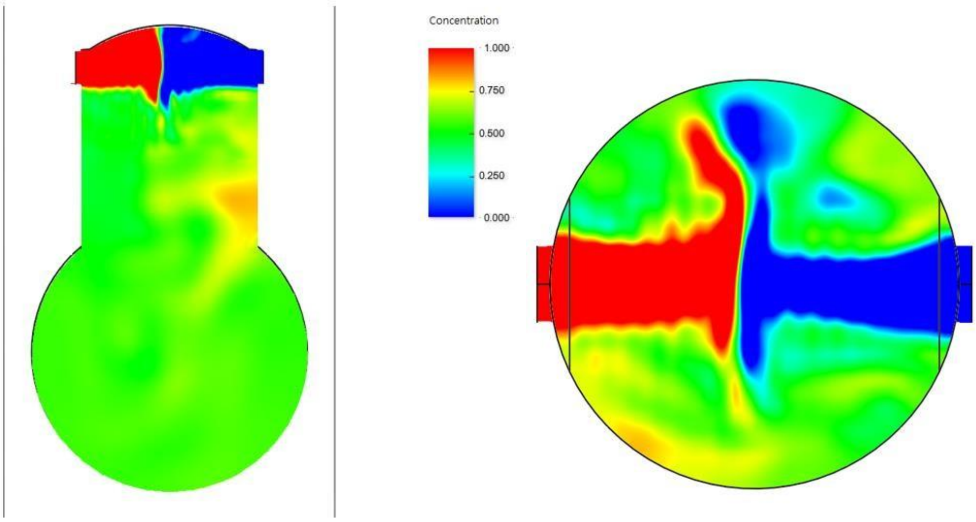
(a) (b)

Figure 18: *Concentration field at time 0.75 for case 1; a) surface 5, b) surface 7*



(a) (b)

Figure 19: *Concentration field at time 0.75 for case 2; a) surface 5, b) surface 7*



(a) (b)

Figure 20: *Concentration field at time 0. 75 for case 3; a) surface 5, b) surface 7*

1.4.3 Concentration Comparison

Fig. 40 compares the standard deviation of concentration of three cases in 1.5 s, where fluctuating patterns need to be analyzed. Therefore the mean value of the standard deviation is prepared and three cases are compared based on the mean standard deviation value for each surface. It is mentioned, of all results, the most important is the density of distribution along the Mixing Head which best measures the quality of the mixed fluids. As it can be seen from the figures, case1 has the best mixing quality among the others at surface 1 and surface 2; however mixing process in case 1 cannot as good as case 3 as the speed of mixed fluid in case 1 decrease faster than case 3 inside the main chamber. Also, Case 2 has the largest variation of mixing among the other cases.

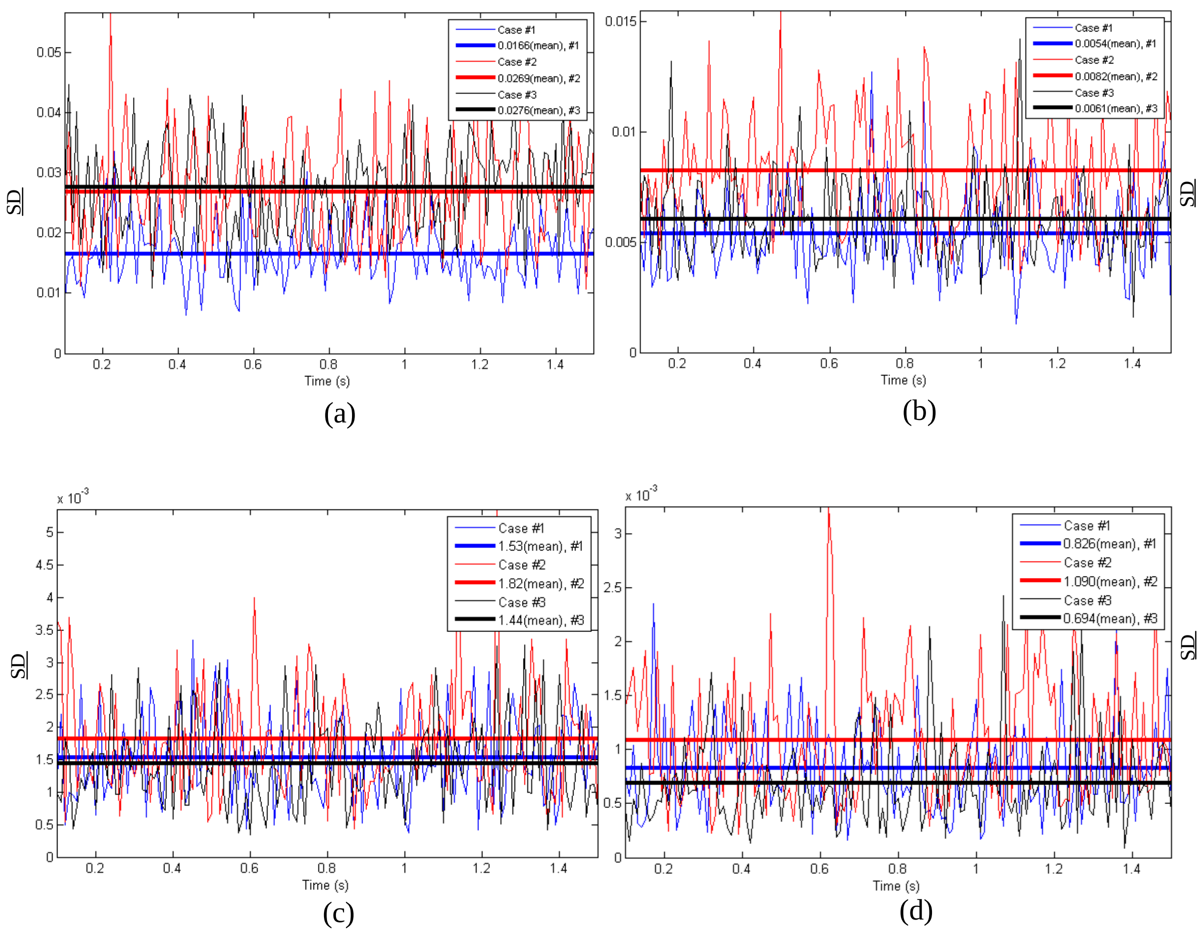


Figure 21: *Comparison of Standard Deviation respect to time for 4 cutting surfaces; a) Surface 1, b) Surface 2, c) Surface 3 and d) Surface 4*