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Numerical simulation of the flow field analysis in the mixing twin jets

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Abstract

The aim of this work is to simulate numerically the twin jets flow; the dimensionless spacing b between tow nozzles is ranging from theses values 2.39, 1.89 and 1.5. The equations which simulate the flow are solved by the CFD code Fluent 6.3.26 and the turbulence model k-epsilon is activated in order to simulate the energy turbulence. The most result which is obtained was the increasing of the turbulence energy when the Reynolds number is growing; however the results show also that the twin jets attracts actually.

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Keywords: twin jets, CFD, K-epsilon, energy turbulence

1. Introduction

The multiple jets are the most important flows studied because of their frequent presence in the nature and of their use in various industrial applications.

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The twin jets are the object of numerous works in the 70, the problem of the multiple jets is more particularly the interaction of such jets, which is the objective of this Study because of his big variety of industrial application such as

- The homogenization of the temperature in ovens
- Insure a good mixture in burners
- Improve the combustion in engines

The effect of spacing between two jets was studied by Lin et al. [1, 2] they were noticed that the normalized value of fusion and combination point are constant(s/h varied between 30 at 40). Tanaka [3, 4] studied the effect of spacing on the velocity decay, the radius of the maximum velocity arc, the lateral distribution of velocity, the turbulence and static pressure. They showed that within the area of attraction of the two jets, the jet axis follows an arc and deflects because of unsymmetrical mixing on each side of the jet. They also concluded that the positions of the maximum velocity and maximum pressure of the combined jet were independent of the Reynolds number and depend only on the geometrical pattern. Yuu et al. [5] measured turbulent properties of two interacting parallel plane jets using hot-wire anemometry. They concluded that the turbulence was homogeneous and isotropic at small scales except for in the merging region. Okamoto et al. [6] investigated the interaction of twin round turbulent jets using velocity and static pressure measurements. They described how the twin jets interact and join in an ellipse at a downstream distance and become similar to a circular jet further downstream.

Lai et al. [7] compared the performance of three turbulence models (standard k-3, RNG and Reynolds stress model RSM) for two dimensional Parallel jets and were analyzed the regions of twin jets by LDA measurements and CFD simulations. Yin et al. [8] experimentally determined the flow field characteristics. They observed a clear separation of the twin jets near the nozzle, and interaction of the two jets, and mixing and merging to a single jet. Pandey et al. [9] studied the effects of pressure ratio (Pe/Pa), the spacing (B) between two jets and Mach numbers (Me) on the flow field along the flow and lateral directions were examined. The main finding results was that the width of the twin jets spreads linearly downstream and grows with B and The merging length of the two jets can be increased either by reducing B or increasing Mach number.

The purpose of this study is an analysis of interaction between two parallel axisymmetric jets generated by two uniform parallel. The simulations were taken into account with four velocities values, which are 10, 15, 20 and 25 m/s respectively.

Nomenclature

a_p	The center coefficient
a_{np}	The influence coefficients for the neighboring cells
b	The contribution of the constant part of the source term
B	Dimensionless Spacing, $B = s / D$
S	Spacing between two nozzles axis
Re	Reynolds number, $\mathrm{Re} = \overline{U}D / \nu$
$\overline{U}$	The mean velocity at jet exit
D	Diameter of nozzle, m
L	Dimensionless range, L= x/D
k	Turbulent kinetic
P	Pressure
u	Mean velocity
x	Axial coordinate
s_{ij}	Strain tensor
Greek letters	
μ	Dynamic viscosity, kg $m^{-1}s^{-1}$
ν	Viscosity of the gas
ρ	Fluid density, kg m^{-3}
ε	Dissipation rate
τ_{ij}	Stress tensor
Φp	General variable at a cell p

2. Problem description

Figure 1 shows the numerical configuration. The twin jets flow was generated by two uniform nozzles ax symmetric and parallel. Two nozzles with 44 mm inner diameter and 300 mm in length were used to generate a twin jets. The range L=x/D of the measurements along the flow direction is from 6.82 to 40. The spacing B= s/D between two nozzles was adopted at 2.39, 1.89 and 1.5.