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SIMULATION OF THE CROSSWIND AND THE STEAM ADDITION EFFECT ON THE FLARE FLAME WUSNAH1*, YUNARDI2, NOVI SYLVIA1, ELWINA3, YAZID BINDAR4 1 Chemical Engineering Dept., University of Malikussaleh, Lhokseumawe 2 Chemical Engineering Dept., Syiah Kuala University, Banda Aceh 3 Chemical Engineering Dept., State Polytechnics of Lhokseumawe, Lhokseumawe 4 Energy and Processing System of Chemical Engineering Dept.,

Faculty of Industrial Technology, Bandung Institute of Technology, Bandung *Email : wusnah@yahoo.com Abstact This paper presents the outcomes got from the utilization of Computational Fluid Dynamics (CFD) to demonstrating the crosswind and steam expansion impact on a fierce non-premixed fire. A pre-processor programming GAMBIT was utilized to set up the design, discretisation, and limit states of the fire being explored.

The business programming Fluent 6.3 was utilized to play out the computations of stream and blending fields just as burning. Standard k-e and vortex dissemination models were chosen as solvers for the portrayal of the choppiness and ignition, individually. The consequences of all counts are introduced in the types of shape profiles.

During the examination, the treatment was performed by setting a speed of fuel at 20 m/s with fluctuated cross-wind speed at 3.77 m/s, 7.5 m/s and 10 m/s, and steam/fuel proportion at 0.14, 0.25 and 2.35. The consequences of the examination demonstrated that the standard k-e disturbance model related to Eddy Dissipation Model speaking to the ignition was equipped for delivering solid wonders of the stream field and receptive scalars field in the violent non-premixed fire being researched.

Different consequences of the examination demonstrated that expanding the speed of the crosswind, when the fuel speed was kept consistent, essentially influenced the stream field, temperature and species focuses in the flare fire. Then again, when the speed of the fuel was shifted at the steady crosswind speed, the expanding speed of the fuel gave positive effect as it empowered to balance the impact of crosswind on the flare fire.

The speed of the crosswind very impact of burning effectiveness, from aftereffect of the examination indicated that expanding the speed of the crosswind fundamentally influenced the ignition productivity, other consequence of the inverstigation demonstrated that steam expansion will very affecting ignition, excelsior the steam/fuel proportion results the ignition proficiency decline. Key words: CFD, steam addition, turbulent non-premixed flame, standard k-e, eddy dissipation model.

Introduction The fire normal for a stack in stable (quiet) environment condition was totally different when it breezy. In some research (Fairweather and friends, 1992; Sinai, 1994; and Jhonson, 2000) showed that wind in high speed on the chimney lowering the combustion efficiency. In addition, a fire will be twist into the breeze with littler size of the fire so diffused oxygen is getting littler.

With the decrease in the gracefully of air into the fire, it caused defective ignition and delivers more undesirable contaminations. The productivity of a fire is viewed as equivalent to the ignition proficiency. The greatness of the absolute CO_2 division of consuming fire communicated as flare fire productivity, it unequivocally affected by some extraordinary working conditions and configuration conditions. The fire productivity and gas outflows now and then changed as a result of the distinctions conditions.

One of it was the changed of wind velocity. In general, the flame of a chimney known have >95% efficiency of combustion.

However, the effects of wind speed for the proficiency of smokestack fire and outflows results are as yet concentrated by the scientists, both in the trial and computational.

Investigated by Johnson and Kastiuk (2000) indicated that the burning proficiency of fireplace was relying upon the speed of wind on the smokestack surface. Decay ignition effectiveness could hindrance with increment the speed of yield fuel. It was the consequence of their trial research concentrate on a stack with width 37.2mm.

Regardless of whether it can demonstrated in a reproduction, its need further exploration. From Wusnah (2011) explored realized that the breeze speed significantly impact the produce of flare fire where it impacts the aftereffect of ignitions discharged into the climate likewise, however in the event that an extra of steam whether decrease the negative effect happened in view of the impact of wind speed where the increases of steam mean to lessen the effect of smoke from hydrocarbon burning, hence this exploration done to respond to the inquiry above.

The increments of steam to flare focused on if while here and there the development of sediment on hydrocarbon ignition in the flare then the steam would diminish residue arrangement itself. Steam known as a technique to expand the energy, it additionally can squeezing the development of shoot in this manner diminishing the quantity of poisons from the ignition procedure in the smokestack. The expansion of steam in a specific proportion can improve the productivity of ignition (Areas,2006).

Wusnah (2011) explored clarify that crosswind speed in excess of 3,77 m/s at speed of fuel 20 m/s, the flare fire structure unequivocally impact by crosswind and as a result of that the not ignition was windblown. Hence, its need to know the impact of steam expansion in that condition to lessen smokeless flare so as to not contaminated nature.

From this research known that the variety of wind velocity and addition of steam, against the flame that produces both qualitative as well as quantitative. To achieve it, a stimulation model of computational fluids dynamic used to show and analyzed the influence of cross-wind velocity and addition of steam against the efficiency of combustion produced.

Simulation Methodology The geometry of a flare flame was considered to be similar to a nozzle in which a fuel was issued into atmosphere and burnt. Figure 1 showed the configuration of the geometry of the domain of calculation drawn using Gambit mesh generator where the nozzle is located at the bottom of the domain. Figure 1. Three-dimensional Geometry of the flare flame domain The flow field calculation was performed using Fluent 6.3 (Fluent. Inc.,

2005) CFD ware of which serves as a processor as well as post-processor, with standard k-e selected to represent the mixing fields. The fuel in this flame is assume to be propane. Upon the flow field calculation reaching convergence, the combustion calculation was started. The Eddy Dissipation Model (EDM) was selected to represent the reactive scalar field in the flame.

Radiation resulted from the combustion was represented with a simple P1 model. The study was performed by setting a velocity of fuel at 20 m/s with varied cross-wind velocity at 3.77 m/s, 7.5 m/s and 10 m/s, and steam/fuel ratio at 0.14, 0.25 and 2.35.

Results and Discussion The steam addition effect for various cross-wind conditions In cross-wind 3.

77 m/s showed from the calculation result or combustion efficiency continued to decline with steam addition. A significant decline in combustion efficiency for S 2.35. It happened because of in cross-wind velocity 3.77 m/s cannot offset the number of steam in the flow of fuel where caused the imperfectly combustion and made the combustion efficiency leads and decrease.

Table 1 . The rate of species (105 kg/s) and the calculation result of the efficiency cross-wind velocity 3.77 m/s Cross-wind Velocity (m/s) _S _C3H8 in _CO2 out _? _ _ _0.14 _9.8 _9.7 _99.3 _ _3.77 _0.25 _8.1 _7.3 _92.1 _ _ _2.35 _3.7 _1.2 _34 _ _ Table 2 . The rate of species (105 kg/s) and the calculation result of the efficiency cross-wind velocity 7.5

m/s Kecepatan Angin Silang (m/s) _S _C3H8 in _CO2 out _? _ _ _0.14 _5.9 _5.8 _98.3 _ _7.5 _0.25 _5.1 _4.9 _96 _ _ _2.35 _2.1 _0.4 _0.19 _ _ The combustion efficiency in cross-wind velocity 7.5 m/s shown at table 2 above. Steam addition (S) until 0.25 can be done because not decrease the efficiency occurs but at S 2.35 intolerable because the smallness combustion efficiency result.

However at cross-wind 10 m/s, the addition of steam strongly not effective given because the combustion efficiency obtained did not show the value of combustion efficiency which allowed for flare flame more than 95%. It is because of the fuel velocity given 20 m/s cannot offset the cross-wind velocity 10 m/s causing the imperfect combustion process. Table 3 .

The rate of species (105 kg/s) and the calculation result of the efficiency cross-wind velocity 10 m/s Kecepatan Angin Silang (m/s) _S _C3H8 in _CO2 out _? _ _ _0.14 _4.7 _3.8 _81.4 _ _10 _0.25 _3.8 _1.9 _31.7 _ _ _2.35 _0.8 _0.07 _0.09 _ _ Cross-wind strongly influences the combustion efficiency, it shown from the calculation result of combustion efficiency.

The higher of cross-wind velocity made combustion efficiency decrease. It’s happened because the high cross-wind and some fuel not yet perfectly combustion but has blown by wind. It’s also strongly influence by the amount of fuel given for counteract the influence of the cross-wind.

However in this research, the velocity of fuel was constant 20 m/s. Meanwhile due to the addition of a steam in the flow of fuel (S) also influence the result of combustion produced. The increasing of value (S) seemingly made the decline of combustion efficiency, but the decline was significant happened in the cross-wind speed 10 m/s, in S 2.35, the combustion was imperfect and it can be identified by combustion efficiency value produce. It was the great addition of steam not recommended for the flare operation.

The temperature contour Figure 2 show the temperature contours which produced in various velocity of cross-wind and various S value was given. The differences of contour picture colors show the differences temperature value which produce by each flame. From that contour show that the value of S which given in various wind velocity strongly influence to the combustion temperature produce, where the contours result can be known that the temperature of flame decreases the growing number of steam given in fuel flow, it showed in S value (2,35).

In high S value can caused the extinguished flame most notably when a high cross-wind velocity and it shown from the temperature contour at cross-wind 10 m/s, it made the released of hydrocarbon compounds into atmosphere and allegedly also of smallness efficiency produce from it combustion burning process.

/ U8= 3,77 m/det S = 2,35 Figure 2. Temperature contours in cross-wind velocity 3, 77 m/s for various S value.

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U8 = 7,5 m/det S = 0,25 _U8= 7,5 m/det S = 2,35 _U8= 10 m/det S = 0,14

Figure 3. Temperature contours for cross-wind 7,55 m/s for various S values.

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U8= 10 m/det S = 0,14 _U8= 10 m/det S = 0,25 _U8= 10 m/det S = 2,35

Daftar Pustaka _Figure 4. Temperature contours for cross-wind 10 m/s for various S values

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