Influence of environment at distribution of non-isothermal jet

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Abstract: *In current work is solving integral conditions for the quality of movement with taking into account Archimedes forces and equation for conversation of heat content. In dependence for define on the width of the stream is used initial value of the temperature and also is use that the flow is non-isothermal*

Key words: *integral condition, environment, initial value*

INTRODUCTION

At fires, leakage of harmful substances into the atmosphere, the pipeline rupture is occur upward turbulent jet whose density differs significantly from that of the surrounding air

In calm weather with no wind, the resulting flow is distribute vertically, and smoke and harmful gases flowing of a specified height according to the temperature and humidity of the air. The presence of the horizontal flow of air (wind) leading to equalize of the axis of the upward stream. This curvature (changing the direction of the torch) depends of the velocity and direction of wind.

When there are fires in cities, the wind may transfer the fire to neighboring objects (buildings, industrial plants, schools, etc.). If the gas pipeline is rupture that leading to gassing the environment. In this case, the presence of wind could act in two ways: either will lead to dissipation and reducing the concentration of gas or could be turned into an unwanted direction, depending on the terrain and will increase undesirable and dangerous concentration

Similarly is the impact of the leackage of harms of industrial production.

From an environmental point of view the issue of vertical non-isothermal jets is very intresting problem [5], [6]., As they relate to the distribution of harmful smoke and gases into the environment. In this aspect can be handled problems with the formation, movement and evacuation of smoke and harmful out of work zone [2], [3].

Regard to this decision shall be considered a direct effect of the wind in the surface boundary layer and it is assuming the absence of stratification of its speed and air temperature. From an environmental point of view, it is necessary to take into account the presence of rising flows of air which occurs at a certain temperature and relief conditions. You can mention the so-called. inversion of the temperature and so on.

MODEL OF THE FLOW

It is considering the gas stream flowing in the vertical direction in the vertical direction in the air. In general it can be assume the existence of a certain inclination of the flowing jet at an angle α , which will give more versatility and applicability of the tasк. Both flows: jet and wind have different velocities, density and temperature. This task is considering as non-isothermal and wind velocities and the flow in the initial section is assume to be constant ie $u = const.$ and $w_0 = const.$ The consideration is happen in the plane $x - y$ and with u is referred wind velocity and with w the velocity of the flowing stream. In general decision will not to comment on reasons for the arising of the jet and and its nature. It will be assumed that its initial velocity is constant ($w_0 = const$).

Approach is used by [1]. On figure 1 is considered an element of the "curvature" jet. It is assume that on it is act two forces balance to each other: force form dynamic pressure of wind Δp and inertial forces due to the curvature of the jet ΔI :

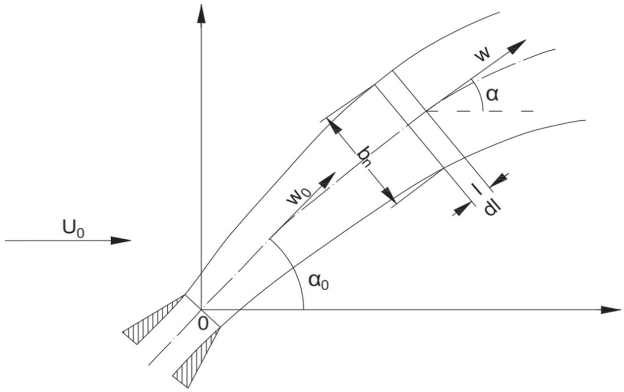

Fig.1

$$\Delta p = \rho_в \frac{u^2}{2} h \sin^2 \alpha dl \tag{1}$$

$$\Delta I = \rho_c \frac{w^2}{R} Scdl \tag{2}$$

where: h - width of the jet in current section, Sc - face, R - local radius of curvature

Equality of the both forces is lead to the expression:

$$\rho_b u^2 h \sin^2 \alpha = -2\rho_c \frac{w^2}{R} S_c \tag{3}$$

From equation (3) is obtain the radius of curvature of the trajectory:

$$R = \frac{\left(1 + y'^2\right)^{1,5}}{y''} \tag{4}$$

where y' and y'' are first and second derivation of the trajectory of the axis on the jet x:

$$y' = \frac{dy}{dx} = tg\alpha \tag{5}$$

At geometry consideration it can be written:

$$\sin \alpha = \frac{tg\alpha}{\sqrt{1 + tg^2\alpha}} = \frac{y''}{\sqrt{1 + y'^2}} \tag{6}$$

As it is known in the turbulent flows, the quality of movement is keep constant at its length [1]. This mean that the quality of movement in any section will be equal to the initial, namely:

$$\rho_c w^2 S_c \sin \alpha = \rho_{c0} w_0^2 S_0 \sin \alpha_0 \tag{7}$$

Parameters with subscript „0“ are relate to initial section.

Taking into account the equation. (4) and substituting in (7) is obtain :

$$R \sin^2 \alpha = \frac{y'^3}{y''} \tag{8}$$

After using of equation (3) follows:

$$R \sin^3 \alpha = \frac{2S_{c0}\rho_{c0} w_0^2}{h\rho_b u_0^2} \sin \alpha_0 = \frac{y'^3}{y''} \tag{9}$$

The substation is made:

$$\frac{dy}{dx} = y' = U \tag{10}$$

And form (10) follows:

$$y'' = \frac{dU}{dx} \tag{11}$$

Replace (10) and (11) in (9), and after separation of the variables are obtain:

$$\frac{dz}{z^3} = -\frac{h\rho_b w_0^2}{2S_{c0}\rho_{c0}u_0^2 \sin\alpha_0} dx \tag{12}$$

It is assuming a constant value of the wind velocity u_0, the density of the ambient air ρ_b at $h = const.$, and from this is following the condition:

$$h\rho_b u_0^2 = const. \tag{13}$$

NUMERICAL SOLUTION

In flat axis symmetric stream flowing through a openening with infinite length $h = const.$ In this case can be determine the rate of flow in the initial section:

$$b_0 = \frac{Su_0}{h} \tag{14}$$

At assuming $u_0 = const.; \rho_b = const.$(wind parameters) is obtain the equation for z:

$$z = \frac{dy}{dx} = \pm\sqrt{\frac{\delta_0 \rho_{c0} w_0^2 \sin\alpha}{\rho_b u_0^2 x + C_1}} \tag{15}$$

Respectively on the reciprocal value of z:

$$\frac{1}{z} = \frac{dx}{dy} = \pm\sqrt{\frac{\rho_b u_0^2 x + C_1}{\delta_0 \rho_{c0} w_0^2 \sin\alpha}} \tag{16}$$

According to [1] from the analysis of 15 ÷ 16 the conclusion is that z has a real values for both the root of the equation:

- At $\alpha_0 < \frac{\pi}{2}$ is taking "+" sign because the derivative is $\frac{dy}{dx} > 0$.

- At $\alpha_0 > \frac{\pi}{2}$, is taking "-" sign corresponds according to fig. 2 the zone immediately after the curvature of the trajectory of the jet under the influence of the wind velocity u_0 and the new intersection of the axis y. The point of intersection of this axis is determined by eq. 16 at accepted "+" sign and value for $x = 0$.

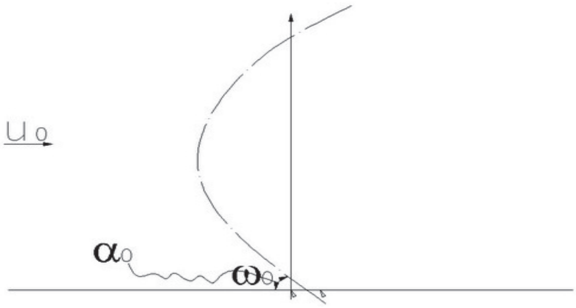

Fig.2

The constant C_1 is defined from the initial condition:

$$x = 0; y = 0; \frac{dy}{dx} = tg\alpha_0 \qquad (17)$$

From here for C_1 следва:

$$C_1 = \frac{\delta_0 \rho_{c0} w_0^2 \sin\alpha_0 \cot g\alpha_0}{\rho_b u_0^2} = \frac{\cot g^2 \alpha_0}{m} \qquad (18)$$

Parameter m has value:

$$m = \frac{\rho_b u_0^2}{\delta_0 \rho_{c0} w_0^2} \qquad (19)$$

Parameter m has positive value for whole possible angle of incline of the jet $0 \le \alpha_0 \le \pi$.

At accepted indications magnitude is $\frac{dx}{dy}$ determined by the equation:

$$\frac{dx}{dy} = \pm\sqrt{mx + \cot g^2 \alpha} \qquad (20)$$

Integral of (20) is as follow:

$$\pm\frac{2}{m}\sqrt{mx + \cot g^2 \alpha_0} = y + C_2 \qquad (21)$$

From initial condition of leakage of the jet:

$$x = 0, y = 0 \qquad (22)$$

Then for C_2 follow:

$$C_2 = \frac{2}{m}\cot g\alpha_0 \qquad (23)$$

At accepted condition for the constant value of the wind and its density (in the absence of stratification) ($\rho_b = const., u_0 = const$)

In the equation of the trajectory of the jet follows:

$$y = \frac{2}{m}\left(\pm\sqrt{mx + \cot g^2 \alpha_0} - \cot g\alpha_0\right) \qquad (24)$$

ANALYSIS OF RESULTS

Equation (24) has two real roots. The sign "-" in front of the square root gives a solution for $\alpha_0 > \frac{\pi}{2}$. For value of $x = 0$ (beginning of coordinate system $x - y$) has two roots at y: $y = 0$ and $y > 0$, which give the intersection of the trajectory of the jet axis y.

NUMERICAL INVESTIGATION

The initial width of the burning semi axis δ_0 is account in the direction at normal to the direction of flowing. The main parameters that influence at flow are: the initial value of the flow parameters: velocity w_0, density ρ_{c0}, angle of flowing α_0 and the width of semi axis of the fire and the corresponding value of the wind – velocity u_0 and density ρ_b.

Analysis of numerical results show the influence of the velocity at the trajectory of burning semi-axis with width $h = 1m$. When there is a wind velocity $u = 5, 10, 15 m/s$ this lead to export of hot torch (fig.3).

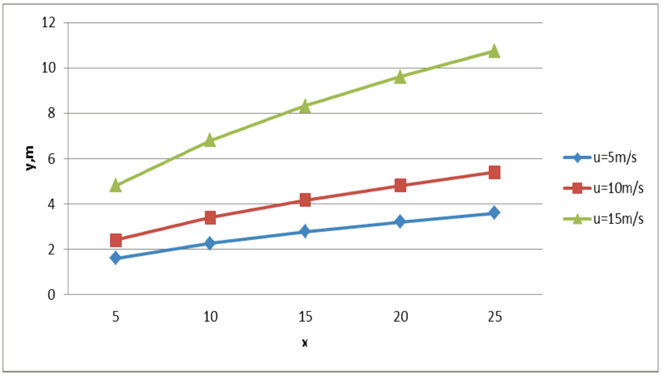

Fig.3

CONCLUSION

Information which is receive can be use when fires are investigate, dangerous form contaminant with gas or harmful.

LITERATURE

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Paper is reviewed.