Influence side position jet of under distribution of axis symmetric non-isothermal jet

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***Abstract**: In current paper is making an approximate numerical investigation of the vertical axis-symmetric non-isothermal jet at a certain simplification of the dependence of the expansion of the flow boundary layer. M mathematical model is make and it is retain non-isothermal flow*

***Key words:** numerical investigation, axis – symmetrical jet, mathematical model*

IMTRODUCTION

Exported in vertical directions hazards can under the influence of wind to lead to contamination of large areas. An important issue is the problem of smoke formation and its distribution and its possible evacuation [2], [3]. After evacuation of the premises in his environment shall pay attention to its distribution in the vertical and horizontal direction.

In many cases in engineering practice in combustion in boilers and gas turbine engines is observe interaction of a turbulent flow with flowing surrounding jet. Both flow are distribute at some angle α_0 between their axes in the initial section of the jet and in the most general case the density, respectively their temperature are different.

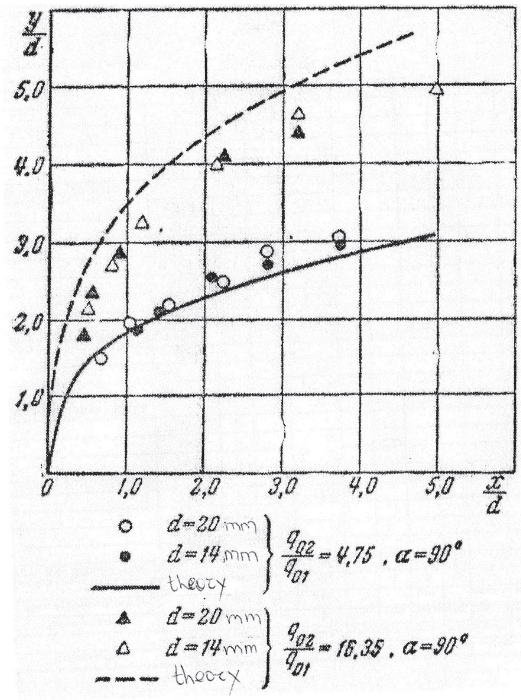

Fig.1

From an environmental point of view vertical non-isothermal jets lead to environmental pollution. An acceptable solution taking into account the two-phase flow is given in [4], [5].

The task can be formulated by reacting of non-isothermal flows located above an some angle α_0 in space

Receiving at this interaction flow has curvature trajectory, which is a function of the initial value of the parameters, velocity, density and temperature.

Besides curvature of the trajectory is observed deformation of velocity field. In figure 1 are implement results by experienced research according GS Shtandorov cited in [1]. Jet with initial diameter $d_0 = 20mm$ flowing with velocity $w_0 = 77,6 m/s$ at cross section flow with velocity $u_0 = 35,6 m/s$. Distances from the primary section l/d vary to $l/d = 3,8$. Axis - symmetrical (round) jet is deflected by the cross-section and assume "horseshoe-shaped" form. The core of the jet disappear at $l/d = 1$ as the deviation of air particles in the boundary layer along the periphery is the most significant and leads to the formation of the above mentioned form.

According Abramovich [1] as a result of the effects of surrounding flow is possible horseshoe ends of velocity profile to merge and to arises further circulation areas. According Abramovich [1] (Figure 2) are obtain conjugated circulating vortices whose axes are parallel with the axis of the jet. It has been proved that if there is higher velocity of the outer flow and the angle of inclination of the jet, the more rapidly disappears the initial section and it is more heavily distorted of trajectory.

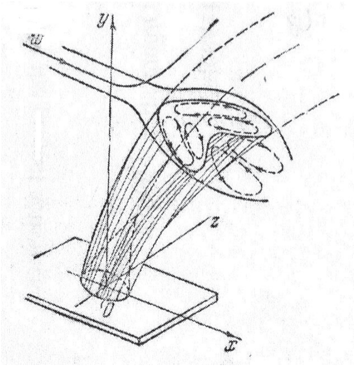

Fig.2

According to [1] the form of the jet stream attack the surrounding flow and with sufficient accuracy can be determine experimentally obtain equation:

$$\frac{x}{d}=\frac{q_{01}}{q_{02}}\left(\frac{y}{d}\right)^{2,55}+\frac{y}{d}\left(1+\frac{q_{01}}{q_{02}}\right)\cot g\alpha_0 \quad (1)$$

Wherein: x and y are coordinates, x at the surface from where flowing the stream, and y at vertical, d - an initial diameter, α_0 - angle for flowing of jet, q_{01} and q_{02} - the dynamic pressure of the two flows:

$$q_{01}=\rho_1\frac{u_0^2}{2};q_{02}=\rho_2\frac{w_0^2}{2} \quad (2)$$

MATHEMATICAL MODEL

The problem can be solved if acceptance is make that one element of the curvature jets acts two forces: pressure of surrounding flow and centrifugal force per unit mass of the jet

$$\rho_u u_0^2 hR\sin^2\alpha=-2\rho_c w^2 S_n \quad (3)$$

It is assuming according [1] for radius of curve is obtain:

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

Where y' and y'' are derivatives on y at x

The decision of (3) using (4) leads to expression:

$$\frac{y'^3}{y''}=-\frac{2S_0}{h}\frac{\rho_c w_0^2}{\rho_u u_0^2}\sin\alpha_0 \quad (5)$$

It is assuming that

$$h\rho_c u_0^2 = const. \qquad (6)$$

For changing h at "horseshoe" cross-section is assume according to [1] empirical relationship:

$$h = 2,25d_0 + al \qquad (7)$$

Where for a can be use known values at free jets $a = 2z$, and for initial section:

$$S_0 = \frac{\pi d_0^2}{4} \qquad (8)$$

Then equation (5) obtain the type:

$$\frac{y'^3}{y''} = -2\frac{\pi d_0^2}{9d_0 + 0,88l}\frac{\rho_c w_0^2}{\rho_u u_0^2}\sin\alpha_0 \qquad (9)$$

Length l of curvature trajectory of the jet is define by expression:

$$l = \int_0^x \sqrt{1 + y'^2}\,dx \qquad (10)$$

The determination of l is neseccary to calculate equation (9) it can be make with several approximations. Initially, in the expression for h (equation 7) where replace l with x:

$$h = 2,25d_0 + 0,22x \qquad (11)$$

Then for equation (9) follows

$$\frac{y'^3}{y''} = 2\frac{\pi d_0^2}{9d_0 + 0,88x}\frac{\rho_c w_0^2}{\rho_u u_0^2}\sin\alpha_0 \qquad (12)$$

It is entering the substitution $y' = U$ respectively $y'' = \frac{dU}{dx}$

$$\frac{dU}{U^3} = -0,4\frac{k}{\pi\delta_0}\left(5\delta_0 + 0,22x\right)dx \qquad (13)$$

Where: $\delta_0 = 0,4d_0; k = \frac{\rho_c u_0^2}{\delta_0 \rho_u u_0^2 \sin^2\alpha_0}$

After integrating of (13) is obtain:

$$\frac{1}{U} = \frac{dx}{dy} = \pm\sqrt{\frac{4k}{\pi}\left(x + \frac{0,22x^2}{\delta_0}\right) + \cot g^2\alpha_0} \qquad (14)$$

When y is reintegrating for its positive value follow:

$$\frac{y}{d_0} = \pm\sqrt{39a}\ln\frac{10 + \frac{x}{d_0} + \sqrt{\left(\frac{x}{d_0}\right)^2 + \frac{20x}{d_0} + 7a\cot g^2\alpha_0}}{10 + \sqrt{7a}\cot g\alpha_0} \qquad (16)$$

Where $a = \frac{1}{k\delta_0}$

For vertical flowing jets $\left(\alpha_0 = \frac{\pi}{2}\right)$ is obtain:

$$\frac{y}{d_0} = 14,4\sqrt{a}\lg\left[1 + 0,1\frac{x}{d_0}\left(1 + \sqrt{1 + \frac{20d_0}{x}}\right)\right] \qquad (17)$$

On the base of receiving above equation17 it can be determinate the trajectory of the curvature flow according of initial conditions of flowing:

- Velocity w_0, diameter d_0, density ρ_c of the jet.
- Velocity u_0 and density of the "attacking "surrounding flow.

- Angle of incline α_0 of the flowing flow according to surrounding jet.

CONCLUSION

In current work is make a mathematical model which allows a relatively quick way to calculate the trajectory of the curved jet. It is taking into account the effect of basic parameters.

LITERATURE

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