Investigation of the Process of Localization of Disturbances in Unlinear Equations

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***Abstract*— The investigation of the process of localization disturbances are passed, which defianting of *LC* – the regime with aggravation in gas-liquid mixture.**

Keywords—unlinear equation; equation of Reley; localization of disturbance; wave processes in two-phase systems

I. INTRODUCTION

Submit the action of liquid with small-dispergional in its gas in the porous environment .The equation of the action of single-measure stream of gas-oil mixture with reckoning of the inersional members has the following view: [3]

$$\frac{1}{m}\frac{\partial\omega}{\partial t}+\frac{1}{m}\left(\omega\frac{\partial}{\partial x}\left(\frac{\omega}{m}\right)\right)=-\frac{1}{\rho}\frac{\partial p}{\partial x}-\frac{1}{\rho}\frac{\mu}{k}\omega \tag{1}$$

where t is time, x is co-ordinate, w is speed of the action of mixture , ρ is compactness of mixture, P pressure, μ is viscosity, k is pervious, m is porosity.

It is possible to neglect the disturbance with the interaction among the bubbles and submit the action of each bubble independently from other bubbles for condition that the distance between the bubbles of gas bigger of their radius and essential smaller of the length of wave or width.on the foundation of the equation of Reley and elementary direct of gomogenous model, which connects radius of bubble R with compactness ρ -[2] ,the equation writes in the form:

$$\sigma P=a_0^2\sigma\rho+\frac{4}{3}\frac{\nu}{(1-\varphi_0)\varphi_0}\frac{d\sigma\rho}{dt}+\frac{R_0^2}{3(1-\varphi_0)\varphi_0}\frac{d^2\sigma\rho}{dt^2} \tag{2}$$

where R_0 is the balance radius of gas bubble , ν is the kinetic viscosity, $\varphi_0=\frac{4}{3}\pi R^3N\rho$ is the actually volume gas-substance, N is numerous of bubbles in one mass of mixture;

$$a_0^2=P_0(1-\varphi_0)\varphi_0\rho$$

is the expression for low-frequency approcsymatic of the speed of sound in two-phase space.

The porous space is few compressibility:

$$m\approx\alpha\rho;\alpha=\frac{m_0}{\rho_0}+\beta\alpha_0^2-\frac{\beta P_0}{\rho_0}, \tag{3}$$

where $\beta\langle\langle 1$ is coefficient of compressibility of porous space.

Using the methods of unlinear wave dynamic, and so the row of transformations, connecting compactness ρ with speed of mixture w, we get one equation concerning w, showing the action of gas-liquid mixture in the porous space [3].

$$\frac{\partial w}{\partial t}+\frac{w}{\alpha\rho_0}\frac{\partial w}{\partial x}-\eta\frac{\partial^2 w}{\partial x^2}+\chi\frac{\partial^3 w}{\partial x^3}+\frac{\alpha\mu}{2k}w=0 \tag{4}$$

where

$$2\eta=\frac{4}{3}\frac{\nu}{(1-\varphi_0)\varphi_0};2\chi=\frac{1}{3}\frac{R_0^2a_0}{(1-\varphi_0)\varphi_0}.$$

In this case coefficient has the meaning of compactness viscosity, appearing with reckoning of disciplinal losses on the boundary of separation phases. The member from the third derivative describes the influence of the dispercional effects for the action of two-phase mixture in whole. It is famous that in the process of the spreading of disturbances ,dissipation balances the unlinear effects and assist for the installition of the stationary forms of the wave.

Give some he first limited spreading of speed:

$$w(x,0)=w_0(x) \tag{5}$$

Avtomodel decisions of the mission (4)-(5) are investigated:

$$w(x,t)=g(t)\theta(\xi),$$

where

$$\xi=x/\varphi(t) \tag{6}$$

Putting (6) in (4) determinations the functions:

$$g(t)=\left(1-\frac{t}{\tau}\right)^{2/3},\ \varphi(t)=\left(1-\frac{t}{\tau}\right)^{1/3} \tag{7}$$

where τ is arbitrary parameter of devision of variable. The mission has the avtomodel decision:

$$w(x,t)=\left(1-\frac{t}{\tau}\right)^{-2/3}\theta(\xi),\ \xi=x(1-\frac{t}{\tau})^{-1/3} \quad (8)$$

where $\theta(\xi)$ is the decision of equation

$$\chi\frac{d^3\theta}{d\xi^3}+\frac{1}{\alpha\rho_0}\theta\frac{d\theta}{d\xi}+\frac{1}{3\tau}\xi\frac{d\theta}{d\xi}+\frac{2}{3\tau}\theta=0 \quad (9)$$

So

$$x=\xi\left(1-\frac{t}{\tau}\right)^{1/3}\text{, then } 0\le t\le tf\text{ ,}$$

halfwidth of area of spreading disturbance is shorten. Decision $w(x,t)$ is the decision of the regime with aggravation. In this case halfwidth of the first division $w_0(x)$ is bigger than halfwidth of decision $w(x,t)$ when $0\le t\le tf$ .We see the localization of disturbances. When $\xi\to\infty$ then decision of equation (9) has asymptotic [3]:

$$\theta\to c\xi^{-2} \quad (10)$$

From (10) and (6) we get that the main member of asymptotic decomposition of the speed with $x\to\infty$

$$w(x,t)\to cx^{-2} \quad (11)$$

does not depend on time. It shows on the localization of disturbances; speed increases in the regime with aggravation in shortening area near the centre of symmetry, but out of that area it aspires to the constant spreading of speed, it means to definite of the following expression(11).

Analogous investigations of the process of localization disturbances which defianting of LC-the regime with aggravation in gas-liquid mixture are concluded with reckoning of the action of source.

The member which takes into consideration the action of source in the equation of inseparable is inserted:

$$\frac{\partial(\rho m)}{\partial t}=-\frac{\partial(\rho w)}{\partial x}+q(w) \quad (12)$$

The equation which descriptions the action of gas-liquid mixture in porous spare is written in the following view:

$$\frac{\partial w}{\partial t}+\frac{w}{\alpha\rho_0}\frac{\partial w}{\partial x}-\eta\frac{\partial^2 w}{\partial x^2}+\chi\frac{\partial^3 w}{\partial x^3}+\frac{\alpha\mu}{2k}w+\frac{q(w)}{2}-\eta\alpha\frac{\partial q(w)}{\partial(x)}=0 \quad (13)$$

The automodel decisions of missions (13),(5) in view (6) are investigated.

Submit the case when the source with the degree mode depends on w:

$$q(w)=q_0w^x+\sigma_0 w$$

Putting (6) in equation (13) when $\eta=0$ determinates the function $g(t)$ and $\varphi(t)$ with the formulas (7) where $\theta(\xi)$ is the decision of equation.

$$\chi\frac{d^3\theta}{d\xi^3}+\frac{1}{\alpha\rho_0}\theta\frac{d\theta}{d\xi}+\frac{1}{3\tau}\xi\frac{d\theta}{d\xi}+\frac{2}{3\tau}\theta+q_0\frac{\theta^{5/2}}{2}=0 \quad (14)$$

We will look for the equation answering the following boundary conditions:

$$\frac{d^3\theta}{d\xi^3}-_{\xi\to\infty}>0,\theta\frac{d\theta}{d\xi}-_{\xi\to\infty}>0,\theta^p-_{\xi\to\infty}>0,P>1$$

When $\xi\to\infty$ then decision of equation has asymptotic (10). Therefore the main member of asymptotic decomposition of the speed does not depend on time [4].

Now submit the automodel decision of the mission with valiable of pervious. A law of inflexion of pervious on layer applies middle-aged:

$$k(x)=k_0\left(\frac{x}{h}\right)^j$$

where k_0 is coefficient of pervious for $x=h$, h is capacity of layer. It is not difficult to persuade if $j=3$ then the decision is automodel and has the view (8). Function satisfies to ordinary differencial equation:

$$\chi\frac{d^3\theta}{d\xi^3}+\frac{1}{\alpha\rho_0}\theta\frac{d\theta}{d\xi}+\frac{1}{3\tau}\xi\frac{d\theta}{d\xi}+\left(\frac{2}{3\tau}+\frac{\mu}{2k_0}\frac{h^3}{\xi^3}\right)\theta+q_0\frac{\theta^{5/2}}{2}=0$$

We see $\theta(\xi)$ has asymptotic if $\xi\to\infty$ it means that going on the localization of disturbances[4].

Submit the mission (13),(5)by setting debit which distributions follow the square of deposit ;except the general action of mixture from each element of volume layer it is possible to productive the selection of mixture for setting intensive.

In that case the compactness of debit determinations by formula q/x or w^x/x .It is not difficult to persuade for $\gamma=2$ the decision is auto model. The equation concerning with $\theta(\xi)$ has the following view:

$$\chi\frac{d^3\theta}{d\xi^3}+\frac{1}{\alpha\rho_0}\theta\frac{d\theta}{d\xi}+\frac{1}{3\tau}\xi\frac{d\theta}{d\xi}+\left(\frac{2}{3\tau}+\frac{\alpha}{2}\frac{\mu}{k_0}\frac{h^3}{\xi^3}\right)\theta+\frac{1}{\xi}\frac{\theta^2}{2}=0.$$

II. CONCLUSION

Function $\theta(\xi)$ has asymptotic if $\xi \to \infty$. The decision $w(x,t)$ determinates by formula (8) and has asymptotic if $x \to \infty$ (11) [4].

In all submitting chances:

a) by presence source
b) by variable pervious
c) uniformly spreading debit there is the localization of disturbances which defianting of *LC*-the regime with aggravation in gas-liquid mixture in porous environment. The speed increases in regime with aggravation next o the centre of symmetry but out of this area aspires to constant spreading of speed.

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