

**Հեղուկների և գազերի
կիրառական մեխանիկա**

Դասախոսություն 1

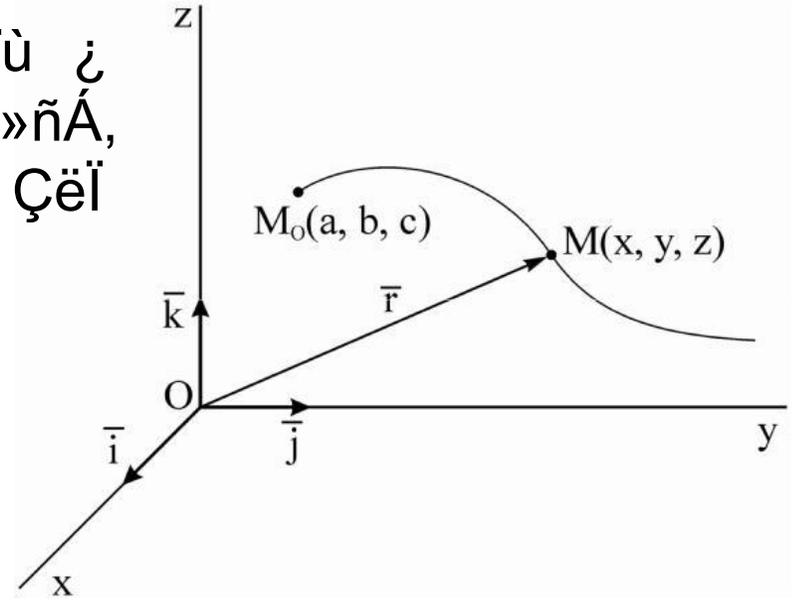
Թ^o Ô à ô Î Ø Æ æ² ì² Ú ð Æ
Î Æ Ü^o Ø² î Æ Î²

1.1 $\vec{r} = \vec{r}(a, b, c, t)$

$\vec{r} = \vec{r}(a, b, c, t)$

$$\vec{r} = \vec{r}(a, b, c, t) \quad 1.1$$

$\vec{r} = \vec{r}(a, b, c, t)$



$\vec{r} = \vec{r}(a, b, c, t)$

$$x = x(a, b, c, t), \quad y = y(a, b, c, t), \quad z = z(a, b, c, t): \quad 1.2$$

Fig. 1.1

Đ³í³ë³ñáõÙÝ»ñÇ (1.2) Ñ³Ù³İ³ñ·Çó İ³ñáÕ »Ýù ëİ³Ý³É İÇÝ»Ù³İÇİ³ÛÇ ÙÛáõë μÝáõÃ³·ñÇãÝ»ñÁ

$$\begin{aligned}
 V_x &= \frac{dx}{dt} = \frac{\partial x}{\partial t} + \frac{\partial x}{\partial a} \cdot \frac{da}{dt} + \frac{\partial x}{\partial b} \cdot \frac{db}{dt} + \frac{\partial x}{\partial c} \cdot \frac{dc}{dt} = \frac{\partial x}{\partial t}, \\
 V_y &= \frac{dy}{dt} = \frac{\partial y}{\partial t} + \frac{\partial y}{\partial a} \cdot \frac{da}{dt} + \frac{\partial y}{\partial b} \cdot \frac{db}{dt} + \frac{\partial y}{\partial c} \cdot \frac{dc}{dt} = \frac{\partial y}{\partial t}, \\
 V_z &= \frac{dz}{dt} = \frac{\partial z}{\partial t} + \frac{\partial z}{\partial a} \cdot \frac{da}{dt} + \frac{\partial z}{\partial b} \cdot \frac{db}{dt} + \frac{\partial z}{\partial c} \cdot \frac{dc}{dt} = \frac{\partial z}{\partial t}.
 \end{aligned}
 \tag{1.3}$$

(1.3) μ³Ý³Ó³»ñÁ ëİ³Ý³ÉÇë Ñ³İİÇ ħ ³éÝİ»É, áñ a, b, c-Ý Ñ³ëİ³İáõÝ »Ý`

$$\frac{da}{dt} = \frac{db}{dt} = \frac{dc}{dt} = 0;
 \tag{1.4}$$

Đ»ÕáõİÇ Ù³ëÝÇİÝ»ñÇ ³ñ³.³óáõÙÁ İáñáİİÇ Ñ»İ³Û³É μ³Ý³Ó³»ñÁİ`

$$\begin{aligned}
 a_x &= \frac{dV_x}{dx} = \frac{\partial V_x}{\partial t} = \frac{\partial^2 x}{\partial t^2}, \\
 a_y &= \frac{dV_y}{dt} = \frac{\partial V_y}{\partial t} = \frac{\partial^2 y}{\partial t^2}, \\
 a_z &= \frac{dV_z}{dt} = \frac{\partial V_z}{\partial t} = \frac{\partial^2 z}{\partial t^2}.
 \end{aligned}
 \tag{1.5}$$

$\Phi = \Phi(x, y, z, t)$
 $\vec{v} = \vec{v}(x, y, z, t)$
 $\vec{v} = v_x \vec{e}_x + v_y \vec{e}_y + v_z \vec{e}_z$
 $\vec{v} = \vec{v}(x, y, z, t)$

$$\begin{aligned}
 v_x &= v_x(x, y, z, t), \\
 v_y &= v_y(x, y, z, t), \\
 v_z &= v_z(x, y, z, t):
 \end{aligned}
 \tag{1.6}$$

$\vec{v} = \vec{v}(x, y, z, t)$
 $\vec{v} = v_x \vec{e}_x + v_y \vec{e}_y + v_z \vec{e}_z$
 $\vec{v} = \vec{v}(x, y, z, t)$

$\vec{v} = \vec{v}(x, y, z, t)$
 $\vec{v} = v_x \vec{e}_x + v_y \vec{e}_y + v_z \vec{e}_z$

$$a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}, \quad a_y = \frac{dv_y}{dt} = \frac{d^2y}{dt^2}, \quad a_z = \frac{dv_z}{dt} = \frac{d^2z}{dt^2} :
 \tag{1.7}$$

Üİ³İÇ áõÝ»Ý³Éáí, áñ Ñ»Õáõİ Ù³ëÝÇİÇ x, y, z İááñ¹ÇÝ³İÝ»ñÁ ÷á÷áËİáõÙ »Ý Áëİ Å³Ù³Ý³İÇ, İáõÝ»Ý³Ýù

$$a_x = \frac{\partial V_x}{\partial t} + \frac{\partial V_x}{\partial x} \cdot \frac{dx}{dt} + \frac{\partial V_x}{\partial y} \cdot \frac{dy}{dt} + \frac{\partial V_x}{\partial z} \cdot \frac{dz}{dt}$$

Կամ

$$a_x = \frac{\partial V_x}{\partial t} + V_x \frac{\partial V_x}{\partial x} + V_y \frac{\partial V_x}{\partial y} + V_z \frac{\partial V_x}{\partial z}, \quad 1.8$$

$$a_y = \frac{\partial V_y}{\partial t} + V_x \frac{\partial V_y}{\partial x} + V_y \frac{\partial V_y}{\partial y} + V_z \frac{\partial V_y}{\partial z},$$

$$a_z = \frac{\partial V_z}{\partial t} + V_x \frac{\partial V_z}{\partial x} + V_y \frac{\partial V_z}{\partial y} + V_z \frac{\partial V_z}{\partial z} :$$

²ñ³.³óÙ³Ý í»İİáñÁ İÉÇÝÇ`

$$\bar{a} = \frac{d\bar{V}}{dt} = \frac{\partial \bar{V}}{\partial t} + V_x \frac{\partial \bar{V}}{\partial x} + V_y \frac{\partial \bar{V}}{\partial y} + V_z \frac{\partial \bar{V}}{\partial z} : \quad 1.9$$

(1.9)-Á ëÇÙİáÉÇİ Ó`áí İ³ñáÕ »Ýù ·ñ»É`

Կամ

$$\bar{a} = \frac{\partial \bar{V}}{\partial t} + (V_x \frac{\partial}{\partial x} + V_y \frac{\partial}{\partial y} + V_z \frac{\partial}{\partial z}) \bar{V} \quad 1.10$$

$$\bar{a} = \frac{\partial \bar{V}}{\partial t} + (\bar{V} \cdot \text{grad}) \bar{V} :$$

Դասախոսություն 2

2.2 Flux of a Vector Field through a Surface

Let S be a surface in space. The flux of a vector field \mathbf{V} through S is defined as the surface integral of the normal component of \mathbf{V} over S .

$$\Phi = \iint_S \mathbf{V} \cdot \mathbf{n} \, ds \quad (2.2)$$

where \mathbf{n} is the unit normal vector to the surface S . If $\mathbf{V} = V_x \mathbf{i} + V_y \mathbf{j} + V_z \mathbf{k}$ and $\mathbf{n} = n_x \mathbf{i} + n_y \mathbf{j} + n_z \mathbf{k}$, then $\mathbf{V} \cdot \mathbf{n} = V_x n_x + V_y n_y + V_z n_z$.

Thus

$$\Phi = \iint_S [V_x \cos(n_x) + V_y \cos(n_y) + V_z \cos(n_z)] \, ds \quad (2.3)$$

$$\Phi = \iint_S [V_x \, dydz + V_y \, dxdz + V_z \, dxdy] \quad (2.4)$$

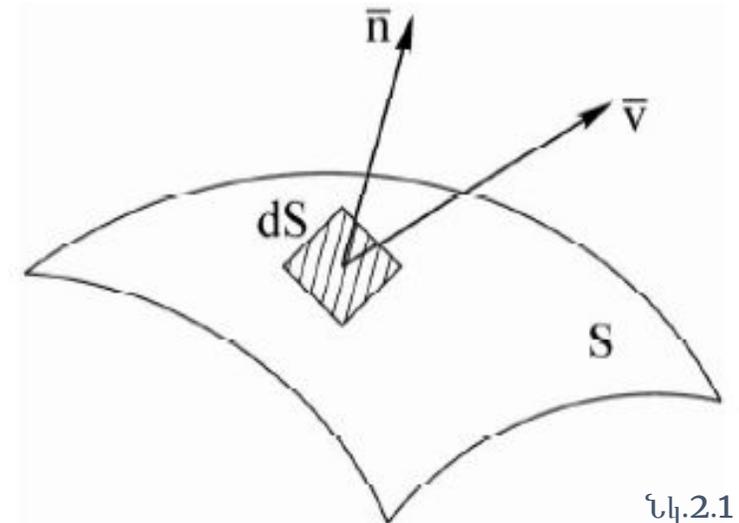


Fig. 2.1

2.3) Η συνθήκη αδιαβάθμισης (ή αδιαθεσιμότητας) του υγρού εκφράζεται ως εξής:

$$\oiint_S [V_x \cos(nx) + V_y \cos(ny) + V_z \cos(nz)] ds = \iiint_{\Delta\tau} \left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \right) d\tau \quad (2.5)$$

2.4) Η συνθήκη αδιαβάθμισης του στερεού εκφράζεται ως εξής:

$$\iiint_{\Delta\tau} \left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \right) d\tau = \left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \right)_{M_n} \cdot \Delta\tau, \quad (2.6)$$

2.5) Η συνθήκη αδιαβάθμισης του αερίου εκφράζεται ως εξής:

$$\operatorname{div} \bar{V} = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} : \quad (2.7)$$

2.6) Η συνθήκη αδιαβάθμισης του στερεού εκφράζεται ως εξής:

$$\oiint_S V_n ds = \iiint_{\tau} \operatorname{div} \bar{V} d\tau : \quad (2.8)$$

2.7) Η συνθήκη αδιαβάθμισης του αερίου εκφράζεται ως εξής:

$$\Gamma = \oint_L \bar{V} d\bar{r} = \oint_L (V_x dx + V_y dy + V_z dz), \quad (2.9)$$

ú·íí»Éáí ĩáñ³·Çí ÇÝí»·ñ³ÉÇó Ù³İ»ñ̄·áõÛÃ³ÛÇÝÇÝ ³ÝóÝ»Éáõ êĩáùëÇ ρωÝ³Ó̄·Çó ĩáõÝ»Ý³Ýù`

$$\oint_L (V_x dx + V_y dy + V_z dz) = \iint_S \left[\left(\frac{\partial V_z}{\partial y} - \frac{\partial V_y}{\partial z} \right) dydz + \left(\frac{\partial V_x}{\partial z} - \frac{\partial V_z}{\partial x} \right) dx dz + \left(\frac{\partial V_y}{\partial x} - \frac{\partial V_x}{\partial y} \right) dx dy \right], \quad 2.10$$

²ñ³·áõÃÛ³Ý í»İĩáñÇ éáĩáñ ĩáĩíaõÙ ĸ ³ÛÝ Ω í»İĩáñÁ, áñÇ áñáÛ»İóÇ³Ý»ñÁ úx, úy, úz ³é³ÝóùÝ»ñÇ íñ³ Ñ³Û³á³ĩ³ëË³Ý³ρωñ Ñ³ĩ³ë³ñ »Ý

$$\Omega_x = \frac{\partial V_z}{\partial y} - \frac{\partial V_y}{\partial z}, \Omega_y = \frac{\partial V_x}{\partial z} - \frac{\partial V_z}{\partial x}, \Omega_z = \frac{\partial V_y}{\partial x} - \frac{\partial V_x}{\partial y} \quad 2.11$$

ωϋηλρλ

$$\text{rot } \bar{V} = \bar{\Omega} = \left(\frac{\partial V_z}{\partial y} - \frac{\partial V_y}{\partial z} \right) \bar{i} + \left(\frac{\partial V_x}{\partial z} - \frac{\partial V_z}{\partial x} \right) \bar{j} + \left(\frac{\partial V_y}{\partial x} - \frac{\partial V_x}{\partial y} \right) \bar{k} : \quad 2.12$$

Ð³βίÇ ³éÝ»Éáí (2.9), (2.10) " (2.11) μ³Ý³Ó̄»ñÁ, ĩáõÝ»Ý³Ýù`

$$\Gamma = \oint_L \bar{V} d\bar{r} = \iint_S \bar{\Omega} n^0 ds = \iint_S \Omega_n ds, \quad 2.13$$

Դասախոսություն 3

3.1 $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$ $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$

$\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$ $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$ $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$ $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$

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1. $\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$

$\frac{1}{2} \rho_0 \frac{dV}{dt} = \int_V \rho \frac{dV}{dt}$

$$\int_{\tau_0} \rho_0(a,b,c,t_0) da db dc = \int_{\tau} \rho(x,y,z,t) dx dy dz \quad 3.1$$

u hwzqh wnlutlnd, nη x = x(a,b,c,t), y = y(a,b,c,t), z = z(a,b,c,t), (3.1)-nlu x, y, z ÷á÷áË³İ³ÝÝ»ñÇó ³ÝóÝ»Éáí a, b, c ÷á÷áË³İ³ÝÝ»ñÇÝ, İëİ³Ý³Ýù`

$$\int_{\tau_0} (\rho_0 - \rho \cdot l) da db dc = 0, \quad 3.2$$

áñi»Õ | -Ý Ó³÷áËáõÃÛ³Ý áñáßÇãÝ ¿ (Ú³İápÇ³ÝÁ)`

$$I = \begin{vmatrix} \frac{\partial x}{\partial a} & \frac{\partial y}{\partial a} & \frac{\partial z}{\partial a} \\ \frac{\partial x}{\partial b} & \frac{\partial y}{\partial b} & \frac{\partial z}{\partial b} \\ \frac{\partial x}{\partial c} & \frac{\partial y}{\partial c} & \frac{\partial z}{\partial c} \end{vmatrix} : \quad 3.3$$

ø³ÝÇ áñ Í³í³ÉÇ dadbdc i³ññÁ İ³Ù³íañ ¿, " »ÝÃ³ÇÝi»·ñ³É ýáõÝİóÇ³Ý ³ÝÁÝ¹Ñ³i, ³ã³ (3.2)-Çó İëi³Ý³Ýù`

$$\rho_0 = \rho \cdot I, \quad 3.4$$

áñÁ Ñ³Ý¹Çë³ÝáõÙ ¿ ³ÝË½»ÉÇáõÃÛ³Ý Ñ³í³ë³ñáõÙÁ È³·ñ³ÝÅÇ ÷á÷áË³İ³ÝÝ»ñái:

2. ²ÝË½»ÉÇáõÃÛ³Ý Ñ³í³ë³ñáõÙÁ Էլլերի փոփոխականներով

Համաձայն

բանաձևի կստանանք`

$$Q = \iint_S V_n ds$$

$$Q = \iint_S \rho V_n ds : \quad 3.3$$

Ομογενή (2.5) ρωύ³Ό΄ζό`

$$\begin{aligned} \iint_S \rho V_n ds &= \iint_S [\rho V_x \cos(nx) + \rho V_y \cos(ny) + \rho V_z \cos(nz)] ds = \\ &= \iiint_\tau \left[\frac{\partial(\rho V_x)}{\partial x} + \frac{\partial(\rho V_y)}{\partial y} + \frac{\partial(\rho V_z)}{\partial z} \right] d\tau : \end{aligned} \quad 3.4$$

Υποθέτουμε

$$\iiint_\tau \left[\frac{\partial(\rho V_x)}{\partial x} + \frac{\partial(\rho V_y)}{\partial y} + \frac{\partial(\rho V_z)}{\partial z} \right] d\tau = - \iiint_\tau \frac{\partial \rho}{\partial t} d\tau : \quad 3.5$$

²Ûëï»Õζό, Ñ³βίζ ³έΎ»Εάί, άñ τ-Υ Ι³U³U³Ι³Υ ζ, Ιëï³Υ³Υù`

$$\frac{\partial \rho}{\partial t} + \frac{\partial(\rho V_x)}{\partial x} + \frac{\partial(\rho V_y)}{\partial y} + \frac{\partial(\rho V_z)}{\partial z} = 0 \quad 3.6$$

άñÁ Ñ»Õάõïζ ³ΎË½»ÉζάõÃÛ³Ύ Ñ³í³ë³ñάõÛΎ ζ ¾ÛÉ»ñζ ÷ά÷άË³í³ΎΎ»ñάί:

àñάβ Ó³÷άËάõÃÛάõΎΎ»ñζό Ñ»íά, (3.6)-Á Ι³ñ»Éζ ζ ·ñ»É Ñ»íÛ³É ï»ëùάί`

$$\frac{d\rho}{dt} + \rho \cdot \text{div} \bar{V} = 0 : \quad 3.7$$

2. Έξω από τον όγκο $\rho = \text{const}$ (3.7) - Άρα $\nabla \cdot \bar{V} = 0$

$$\text{div } \bar{V} = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} = 0 \quad (3.8)$$

2. Έξω από τον όγκο (3.4) - Στόμα $\nabla \cdot \bar{V} = 0$

$$\rho \oint_S V_n ds = \rho \iiint_V \text{div } \bar{V} d\tau = 0, \quad (3.9)$$

3. Έξω από τον όγκο $\rho = \text{const}$ (3.7) - Άρα $\nabla \cdot (\rho \bar{V}) = 0$

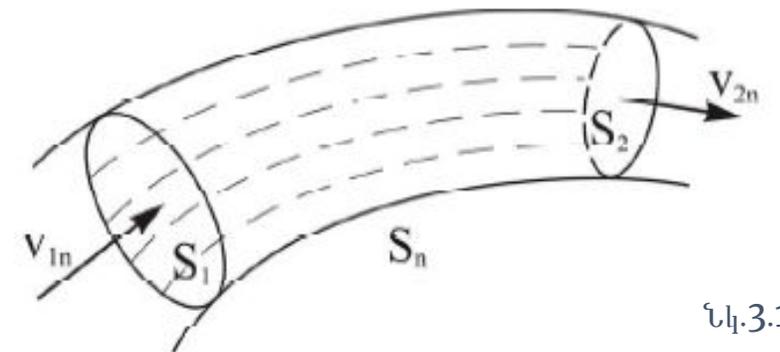
$$\frac{\partial(\rho V_x)}{\partial x} + \frac{\partial(\rho V_y)}{\partial y} + \frac{\partial(\rho V_z)}{\partial z} = 0 \quad (3.10)$$

ή

$$\text{div}(\rho \bar{V}) = 0 \quad (3.11)$$

3. Έξω από τον όγκο (3.9) $\rho = \text{const}$, $\nabla \cdot \bar{V} = 0$

$$Q = \rho \oint_S V_n ds = \rho \iint_{S_1} V_{1n} ds + \rho \iint_{S_2} V_{2n} ds + \rho \iint_{S_n} V_n ds = 0, \quad (3.12)$$



3.1

$\rho \frac{d}{dt} \left(\frac{1}{2} v^2 \right) + \nabla \cdot (\rho \mathbf{v} v) = -\nabla \cdot (\rho \mathbf{v} \mathbf{v}) - \nabla p$

$\rho \frac{d}{dt} \left(\frac{1}{2} v^2 \right) + \nabla \cdot (\rho \mathbf{v} v) = -\nabla \cdot (\rho \mathbf{v} \mathbf{v}) - \nabla p$

$$-V_1 S_1 + V_2 S_2 = 0 \quad 3.13$$

$$V_1 S_1 = V_2 S_2 = \text{const} \quad 3.14$$

$\rho \frac{d}{dt} \left(\frac{1}{2} v^2 \right) + \nabla \cdot (\rho \mathbf{v} v) = -\nabla \cdot (\rho \mathbf{v} \mathbf{v}) - \nabla p$

$$\frac{\partial \rho}{\partial t} + \frac{1}{r} \frac{\partial(\rho V_r r)}{\partial r} + \frac{1}{r} \frac{\partial(\rho V_\varphi)}{\partial \varphi} + \frac{\partial(\rho V_z)}{\partial z} = 0, \quad 3.15$$

$\rho \frac{d}{dt} \left(\frac{1}{2} v^2 \right) + \nabla \cdot (\rho \mathbf{v} v) = -\nabla \cdot (\rho \mathbf{v} \mathbf{v}) - \nabla p$

$$\frac{\partial \rho}{\partial t} + \frac{1}{r} \frac{\partial(\rho V_r r^2)}{\partial r} + \frac{1}{r \sin \vartheta} \frac{\partial(\rho V_\vartheta \sin \vartheta)}{\partial \vartheta} + \frac{1}{r \sin \vartheta} \frac{\partial(\rho V_\psi)}{\partial \psi} = 0: \quad 3.16$$

3.2 «yáñÛ³óÇ³ÛÇ³ñ³·áõÃÛ³Ý Ã»Ý½áñ

Đ»Õáõİ iÇñáõÛÃÇ ¹»yáñÛ³óÛ³Ý Ñ»İ³Ýùáí, iÇñáõÛÃÇ Û³ëÝÇİÝ»ñÁ ëİ³ÝáõÛ »Ý Éñ³óáõóÇã ³ñ³·áõÃÛáõÝ: ²Û¹ V_D ³ñ³·áõÃÛáõÝÁ á³ÛÛ³Ý³íañí³İ ħ ε₁, ε₂, ε₃, θ₁, θ₂, θ₃ Û» ÍáõÃÛáõÝÝ»ñáí, ÁÝ¹ áñáõÛ

$$\begin{aligned}
 V_{D\xi} &= \frac{\partial\phi}{\partial\xi} = \varepsilon_1\xi + \frac{1}{2}\theta_2\zeta + \frac{1}{2}\theta_3\eta, \\
 V_{D\eta} &= \frac{\partial\phi}{\partial\eta} = \varepsilon_2\eta + \frac{1}{2}\theta_3\xi + \frac{1}{2}\theta_1\zeta, \\
 V_{D\zeta} &= \frac{\partial\phi}{\partial\zeta} = \varepsilon_3\zeta + \frac{1}{2}\theta_1\eta + \frac{1}{2}\theta_2\xi:
 \end{aligned}
 \tag{3.17}$$

ε₁ -Ç ýÇ½Çİ³İ³Ý ÇÛ³ëİÁ á³ñ½»Éáõ Ñ³Û³ñ »ÝÃ³ñ»Ýù, áñ İ»ÕÇ ħ áõÝ»ó»É ³ÛÝáÇëÇ ¹» yáñÛ³óÇ³, áñÇ Á³Û³Ý³İ, ε₁ ≠ 0, Çëİ ε₂=ε₃=θ₁=θ₂=θ₃=0: ²Ûë ¹»áùáõÛ (3.17)-Çó ÍáõÝ» Ý³Ýù

$$V_{D\xi} = \varepsilon_1\xi, \quad V_{D\eta} = 0, \quad V_{D\zeta} = 0:
 \tag{3.18}$$

³óÇ ³Û¹,

$$\varepsilon_1 + \varepsilon_2 + \varepsilon_3 = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} = \text{div } \bar{V}
 \tag{3.19}$$

(3.19)Û»ÍáõÃÛáõÝÁ Ñ³Ý¹Çë³ÝáõÛ ħ ÁÝİñí³İ Í³³ÉÇ Ñ³ñ³ϱtñ³İ³Ý ÷á÷áË³İ³ÝáõÃÛáõÝÁ ÛÇ³íañ Á³Û³Ý³İ³ÛÇçáóáõÛ:

θ_3 - ζ $y_{\zeta} \frac{1}{2} \zeta \dot{\Gamma}^3 \dot{\Gamma}^3 \dot{Y}$ $\zeta \dot{U}^3 \ddot{e} \dot{i} \dot{A}$ $\dot{a}^3 \dot{n} \frac{1}{2} \dot{\gg}$ $\dot{E} \dot{a} \dot{o}$ $\dot{N}^3 \dot{U}^3 \dot{n}$ $\dot{A} \dot{Y}^1 \dot{a} \dot{o} \dot{Y}$ $\dot{\gg}$ $\dot{E} \dot{a} \dot{i}$ (3.17) - $\dot{a} \dot{o} \dot{U}$ $\theta_3 \neq 0$, $\zeta \dot{e} \dot{i}$ $\varepsilon_1 =$
 $\varepsilon_2 = \varepsilon_3 = \theta_1 = \theta_2 = 0$ $\dot{I} \dot{a} \dot{o} \dot{Y}$ $\dot{\gg}$ $\dot{Y}^3 \dot{Y} \dot{u}$

$$V_{D\zeta} = \frac{1}{2} \theta_3 \eta, \quad V_{D\eta} = \frac{1}{2} \theta_3 \zeta, \quad V_{D\zeta} = 0: \quad 3.20$$

$\dot{U} \dot{e} \dot{a} \zeta \dot{e} \dot{a} \dot{i}$ $\varepsilon_1, \varepsilon_2, \varepsilon_3, \theta_1, \theta_2, \theta_3$ \dot{U} $\dot{\gg}$ $\dot{I} \dot{a} \dot{o} \dot{A} \dot{U} \dot{a} \dot{o} \dot{Y} \dot{Y}$ $\dot{\gg}$ $\dot{n} \dot{A}$ $\dot{A} \dot{Y}^1 \dot{N}^3 \dot{Y} \dot{a} \dot{o} \dot{n}$ $\dot{\gg}$ $\dot{a} \dot{u} \dot{a} \dot{o} \dot{U}$ $\rho \dot{Y} \dot{a} \dot{o} \dot{A}^3 \cdot \dot{n} \dot{a} \dot{o} \dot{U}$ $\dot{\gg}$ \dot{Y}
 $\dot{A} \dot{Y} \dot{i} \dot{n} \dot{i}^3 \dot{I}$ \dot{N} $\dot{\gg}$ $\dot{O} \dot{a} \dot{o} \dot{I}$ $\dot{i} \zeta \dot{n} \dot{a} \dot{o} \dot{U} \dot{A} \zeta$ $\dot{\gg}$ $\dot{y} \dot{a} \dot{n} \dot{U}^3 \dot{o} \zeta^3 \dot{Y}$ $\dot{\gg}$ $\dot{n}^3 \dot{Y} \dot{o}$ $\dot{Y} \dot{i}^3 \dot{Y} \dot{a} \dot{o} \dot{U}$ $\dot{\gg}$ \dot{Y} $\dot{\gg}$ $\dot{y} \dot{a} \dot{n} \dot{U}^3 \dot{o} \zeta^3 \dot{U} \zeta$
 $\dot{a} \dot{o} \dot{A} \dot{U}^3 \dot{Y}$ $\dot{\cdot}$ $\dot{a} \dot{n} \dot{i}^3 \dot{I} \zeta \dot{o} \dot{Y}$ $\dot{\gg}$ \dot{n} : $\dot{U} \dot{\beta}^3 \dot{Y}^3 \dot{I} \dot{a} \dot{o} \dot{U}$ $\dot{\gg}$ \dot{Y}

$$\phi = \begin{pmatrix} \varepsilon_1 & \frac{1}{2} \theta_3 & \frac{1}{2} \theta_2 \\ \frac{1}{2} \theta_3 & \varepsilon_2 & \frac{1}{2} \theta_1 \\ \frac{1}{2} \theta_2 & \frac{1}{2} \theta_1 & \varepsilon_3 \end{pmatrix} \quad 3.21$$

$\dot{\gg}$ $\dot{Y} \dot{i}^3 \dot{Y} \dot{a} \dot{o} \dot{U}$ $\dot{\gg}$ $\dot{y} \dot{a} \dot{n} \dot{U}^3 \dot{o} \zeta^3 \dot{U} \zeta$ $\dot{a} \dot{o} \dot{A} \dot{U}^3 \dot{Y}$ \dot{A} $\dot{\gg}$ $\dot{Y} \frac{1}{2} \dot{a} \dot{n}$: $\dot{U} \dot{e}$ $\dot{\gg}$ $\dot{a} \dot{u} \dot{a} \dot{o} \dot{U}$ \dot{A} $\dot{\gg}$ $\dot{Y} \frac{1}{2} \dot{a} \dot{n} \dot{A}$ $\dot{N}^3 \dot{U}^3 \dot{a}^3 \dot{\div}$ $\dot{\zeta}$ $\dot{\gg}$
 $\rho \dot{Y} \dot{a} \dot{n} \dot{a} \dot{\beta} \dot{i} \dot{a} \dot{o} \dot{U}$ $\dot{\zeta}$ \dot{i} $\dot{\gg}$ \dot{o} \dot{U} $\dot{\gg}$ $\dot{I} \dot{a} \dot{o} \dot{A} \dot{U} \dot{a} \dot{o} \dot{Y} \dot{Y}$ $\dot{\gg}$ $\dot{n} \dot{a} \dot{i}$:

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$\mathbb{E}_t \left[\frac{1}{1+r} \left(\frac{1}{1+r} \mathbb{E}_t \left[\frac{1}{1+r} \mathbb{E}_t \left[\dots \right] \right) \right) \right]$

4.1 Ð»ÕáõĪ ĩÇñáõÛÃáõÙ ·áñláÕ áõÅ»ñÁ: Æ¹»³É³Ī³Ý Ñ» ÕáõĪ

Ð»ÕáõĪ τ ĩÇñáõÛÃáõÙ ·áñláÕ áõÅ»ñÁ ¹³ë³Ī³ñ·íaõÙ »Ý` ½³Ý·í³Ī³ÛÇÝ áõÅ»ñÇ " Ù³Ī»ñ"áõÛÃ³ÛÇÝ áõÅ»ñÇ:

$\frac{1}{4}$ ³Ý·í³Ī³ÛÇÝ ĩáãíaõÙ »Ý ³ÛÝ áõÅ»ñÁ, áñáÝù ĩÇñ³éí³Ī »Ý ĩÇñáõÛÃÇ Δτ Í³í³ÉáõÙ á³ñ÷³Ī³Ī $\frac{1}{2}$ ³Ý·í³ĪÇ íñ³, " áñÇ ³½¹»óáõÃÛáõÝÁ Ī³Ēí³Ī ãç, Ã» ³Û¹ Δτ Í³í³ÉÁ áõÝÇ± Çñ Ñ³ñ"³ÝáõÃÛ³Ý Û»ç ³ÛÉ Í³í³ÉÝ»ñ, Ã»` áã:

Ø³Ī»ñ"áõÃ³ÛÇÝ »Ý ĩáãíaõÙ ³ÛÝ áõÅ»ñÁ, áñáÝù ĩÇñ³éí³Ī »Ý Ñ»ÕáõĪÇ Û³ëÝÇĪÇ (ĩÇñáõÛÃÇ) Û³Ī»ñ"áõÛÃÇÝ " ç³ã»ë Ī³Ēí³Ī »Ý Ýñ³ Ñ³ñ"³ÝáõÃÛ³Ý Û»ç ·íÝíaÕ Û³ëÝÇĪÝ»ñÇó (ĩÇñáõÛÃÝ»ñÇó), ³ÛëÇÝùÝ ³ÛÝ áõÅ»ñÁ, áñáÝóái ÷áĒ³½¹áõÙ »Ý Ñ³ñ"³Ý Ñ»ÕáõĪ ĩÇñáõÛÃÝ»ñÁ " ĩÇñ³éí³Ī »Ý Ýñ³Ýó Û³Ī»ñ"áõÛÃÝ»ñÇÝ:

4.2 È³ñí³ÍáõÃÛ³Ý Ã»Ý½áñ

Ð»ÕáõİÇ İ³Û³Û³İ³Ý τ İÇñáõÛÃÁ ¹Çİ³ñİ»Éáí áñ»ë Û»Ë³ÝÇİ³İ³Ý Ñ³Û³İ³ñ. " Ýñ³ Ýİ³İÛ³Û³ İÇñ³é»
Éáí , ³É³Û³ρτñÇ ëİ½ρáõÝùÁ, İáõÝ»Ý³Ýù

$$\iiint_{\tau} (\bar{F} \cdot \rho) d\tau + \iint_S \bar{P}_n ds - \iiint_{\tau} \bar{a} \rho d\tau = 0, \quad 4.1$$

ø³é³ÝÇëİÇ ÛÛáõë ÝÇëİ»ñÇ ³ñİ³ùÇÝ ÝáñÛ³ÉÝ»ñÁ İÉÇÝ»Ý -i, -j, -k í»İİáñÝ»ñÁ, Çëİ Û³İ»ñ»
ëÝ»ñÁ` Ñ³Û³á³İ³ëË³Ý³ρωñ Δ·α, ΔS ·β, ΔS ·γ: (4.1)-Çó İáõÝ»Ý³Ýù`

$$\bar{F} \cdot \rho \cdot \Delta\tau + \bar{P}_n \Delta S + \bar{P}_{-x} \cdot \Delta S \cdot \alpha + \bar{P}_{-y} \cdot \Delta S \cdot \beta + \bar{P}_{-z} \cdot \Delta S \cdot \gamma - \bar{a} \rho \Delta\tau = 0, \quad 4.2$$

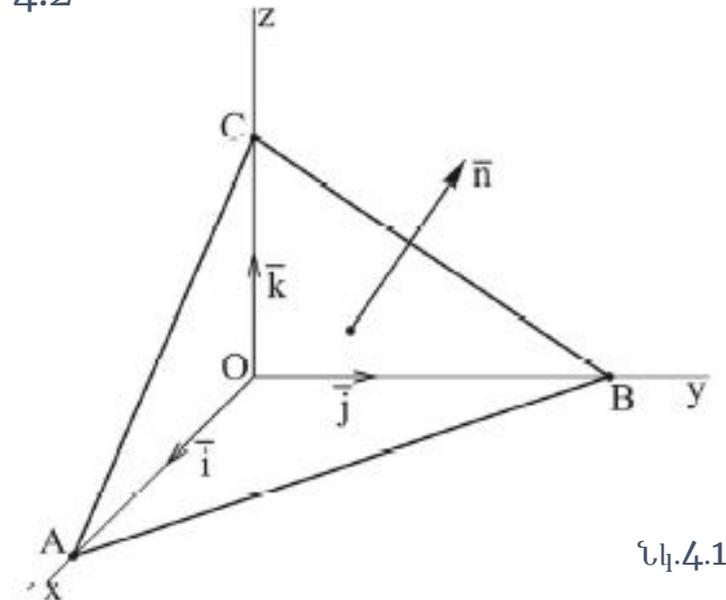
(4.2) Ñ³İ³ë³ñÛ³Ý Û»ç Ñ³İ³Ç ³éÝ»Éáí Δτ-Ç ³ñÁ»ùÁ " Ýİ³İÇ

áõÝ»Ý³Éáí, áñ $\bar{P}_n = -\underline{P}_n$, İáõÝ»Ý³Ýù

$$\frac{1}{3} (\bar{F} - \bar{a}) \rho h + \bar{P}_n - \alpha \bar{P}_x - \beta \bar{P}_y - \gamma \bar{P}_z = 0: \quad 4.3$$

(2.3)-áõÛ³ÝóÝ»Éáí ë³ÑÛ³ÝÇ »ñρ Ñ→0, İëİ³Ý³Ýù

$$\bar{P}_n = \alpha \bar{P}_x + \beta \bar{P}_y + \gamma \bar{P}_z : \quad 4.4$$



İı.4.1

ñáÛ»İ»Éáí (4.4)-Á Oxyz İááñ¹ÇÝ³İ³ÛÇÝ ³é³ÝóùÝ»ñÇ İñ³, İáõÝ»Ý³Ýù`

$$\begin{aligned}
 P_{nx} &= \alpha P_{xx} + \beta P_{yx} + \gamma P_{zx} , \\
 P_{ny} &= \alpha P_{xy} + \beta P_{yy} + \gamma P_{zy} , \\
 P_{nz} &= \alpha P_{xz} + \beta P_{yz} + \gamma P_{zz} :
 \end{aligned}
 \tag{4.5}$$

(4.5)-Á óáõÛó ĸ İ³ÉÇë, áñ É³ñí³İáõÃÛáõÝÁ Ñ»Õáõİ İÇñáõÛÃáõÛ »ñİñáñ¹ İ³ñ·Ç Ã»Ý½áñ³İ³Ý Û»İáõÃÛáõÝ ĸ, áñÁ áñáßİáõÛ ĸ 9 Û»İáõÃÛáõÝ»ñáí`

$$\Pi = \begin{pmatrix} P_{xx} & P_{yx} & P_{zx} \\ P_{xy} & P_{yy} & P_{zy} \\ P_{xz} & P_{yz} & P_{zz} \end{pmatrix} :
 \tag{4.6}$$

(4.6)-Á İáñİáõÛ ĸ É³ñí³İáõÃÛ³Ý Ã»Ý½áñ: ú·İİ»Éáí ¹³ë³İ³Ý Û»Ë³ÝÇİ³ÛÇ ûñ»ÝùÝ»ñÇó, İ³ñ»ÉÇ ĸ óáõÛó İ³É, áñ (4.6) Ã»Ý½áñÁ Ñ³Û³ã³÷ ĸ, ³ÛëÇÝùÝ`

$$P_{xy} = P_{yx}, \quad P_{yz} = P_{zy}, \quad P_{xz} = P_{zx} :
 \tag{4.7}$$

$\bar{P}_n = \bar{P}_{xx} = \bar{P}_{yy} = \bar{P}_{zz} = 0$: à ô ë ï Ç (4.5) - Ç ó Í á õ Ý » Ý³ Ý ù`

$$\alpha P_n = \alpha P_{xx}, \quad \beta P_n = \beta P_{yy}, \quad \gamma P_n = \gamma P_{zz} \quad 4.8$$

Ч ѡ Ѣ

$$P_n = P_{xx} = P_{yy} = P_{zz}, \quad 4.9$$

Á ë ï á ñ Ç, Ç¹ »³ É³ Ì³ Ý Ñ » Õ á õ Ì á õ Ù Ý á ñ Ù³ É × Ý ß á õ Ù Ý » ñ Á ï Ì Ù³ É Ì » ï á õ Ù ð á É á ñ á õ Õ á õ Æ Ù á õ Ý Ý » ñ á Ì Ç ñ³ ñ Ñ³ Ì³ ë³ ñ » Ý ï Ì³ É Ì³ ã » Ý Ñ³ ñ Æ³ Ì³ Ç¹ Ç ñ ù á ñ á ß á õ Ù Ç ó (ä³ ë Ì³ É Ç ù ñ » Ý ù Á):

² Ù ë á Ç ë á Ì, Ç¹ »³ É³ Ì³ Ý Ñ » Õ á õ Ì Ç Ù³ Ì » ñ ï á õ Æ³ Ù Ç Ý É³ ñ á õ Ù Ý » ñ Ý á õ Ý » Ý Ñ » ï Ì Ù³ É ï » ë ù Á`

$$\bar{P}_n = -P \cdot \bar{n}^0, \quad 4.10$$

á ñ ï » Õ P-Ý ï Ì Ù³ É Ì » ï á õ Ù × Ý ß á õ Ù Ý ç, n⁰ -³ ñ ï³ ù Ç Ý Ý á ñ Ù³ É Ç Ù Ç³ ï á ñ Ì » Ì á ñ Á:

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5.1 $\mathbf{AE}^1 \gg \mathbf{E}^3 \mathbf{I}^3 \mathbf{Y} \tilde{\mathbf{N}} \gg \mathbf{O} \mathbf{a} \mathbf{o} \mathbf{I} \mathbf{C} \beta^3 \mathbf{n} \mathbf{A} \mathbf{U}^3 \mathbf{Y} \mathbf{1} \mathbf{C} \mathbf{y} \gg \mathbf{n} \gg \mathbf{Y} \mathbf{o} \mathbf{C}^3 \mathbf{E}$ $\tilde{\mathbf{N}}^3 \mathbf{i}^3 \mathbf{e}^3 \mathbf{n} \mathbf{a} \mathbf{o} \mathbf{U} \mathbf{Y} \gg \mathbf{n} \mathbf{A}$

(4.1) $\tilde{\mathbf{N}}^3 \mathbf{i}^3 \mathbf{e}^3 \mathbf{n} \mathbf{U}^3 \mathbf{Y} \mathbf{U} \gg \mathbf{C} \tilde{\mathbf{N}}^3 \mathbf{B} \mathbf{I} \mathbf{C} \mathbf{3} \mathbf{e} \mathbf{Y} \gg \mathbf{E} \mathbf{a} \mathbf{i}$, $\mathbf{a} \mathbf{n} \mathbf{C} \mathbf{1} \gg \mathbf{E}^3 \mathbf{I}^3 \mathbf{Y} \tilde{\mathbf{N}} \gg \mathbf{O} \mathbf{a} \mathbf{o} \mathbf{I} \mathbf{C} \mathbf{U} \mathbf{C}^3 \mathbf{i} \mathbf{a} \mathbf{n} \mathbf{U}^3 \mathbf{I} \gg \mathbf{n} \gg \mathbf{e} \mathbf{C} \mathbf{i} \mathbf{n}^3 \mathbf{3} \mathbf{1} \mathbf{2} \mathbf{1} \mathbf{a} \mathbf{O}$
 $\mathbf{U}^3 \mathbf{I} \gg \mathbf{n} \mathbf{a} \mathbf{o} \mathbf{A}^3 \mathbf{U} \mathbf{C} \mathbf{Y} \mathbf{a} \mathbf{o} \mathbf{A} \gg \mathbf{n} \mathbf{C} \cdot \mathbf{E} \mathbf{E}^3 \mathbf{i} \mathbf{a} \mathbf{n} \mathbf{i} \gg \mathbf{I} \mathbf{i} \mathbf{a} \mathbf{n} \mathbf{A} \mathbf{a} \mathbf{n} \mathbf{a} \mathbf{B} \mathbf{i} \mathbf{a} \mathbf{o} \mathbf{U} \mathbf{;}$ (4.10) $\rho \omega \mathbf{Y}^3 \mathbf{O} \mathbf{a} \mathbf{i} \mathbf{;}$ (4.1) $\mathbf{C} \mathbf{U}^3 \mathbf{I} \gg$
 $\mathbf{n} \mathbf{a} \mathbf{o} \mathbf{A}^3 \mathbf{U} \mathbf{C} \mathbf{Y} \mathbf{C} \mathbf{Y} \mathbf{i} \gg \mathbf{n}^3 \mathbf{E} \mathbf{a} \mathbf{o} \mathbf{U} \mathbf{I}^3 \mathbf{i}^3 \mathbf{n} \gg \mathbf{E} \mathbf{a} \mathbf{i} \mathbf{O}^3 \mathbf{+} \mathbf{a} \mathbf{E} \mathbf{a} \mathbf{o} \mathbf{A} \mathbf{U} \mathbf{a} \mathbf{o} \mathbf{Y} \tilde{\mathbf{N}}^3 \mathbf{U}^3 \mathbf{O}^3 \mathbf{U} \mathbf{Y} \mathbf{1} \mathbf{a} \mathbf{o} \mathbf{e} \mathbf{-} \mathbf{u} \mathbf{e} \mathbf{i} \mathbf{n} \mathbf{a} \cdot \mathbf{n}^3 \mathbf{1} \mathbf{e} \mathbf{l} \mathbf{a} \mathbf{o}$
 $\rho \omega \mathbf{Y}^3 \mathbf{O} \mathbf{C} \mathbf{,} \mathbf{I} \mathbf{e} \mathbf{i}^3 \mathbf{Y}^3 \mathbf{Y} \mathbf{u} \mathbf{;}$

$$\iint_S \bar{\rho}_n ds = - \iint_S P n^0 ds = - \iint_S P [\cos(nx) \bar{i} + \cos(ny) \bar{j} + \cos(nz) \bar{k}] ds = - \iiint_\tau \left(\frac{\partial P}{\partial x} \bar{i} + \frac{\partial P}{\partial y} \bar{j} + \frac{\partial P}{\partial z} \bar{k} \right) d\tau = - \iiint_\tau \text{grad} P d\tau : \quad 5.1$$

$\mathbf{2} \mathbf{U} \mathbf{A} \mathbf{U} \mathbf{i} \gg \mathbf{O}^3 \mathbf{1} \mathbf{n} \gg \mathbf{E} \mathbf{a} \mathbf{i}$ (5.1) $\mathbf{-} \mathbf{A}$ (4.1) $\mathbf{-} \mathbf{a} \mathbf{o} \mathbf{U}$, $\mathbf{I} \mathbf{a} \mathbf{o} \mathbf{Y} \gg \mathbf{Y}^3 \mathbf{Y} \mathbf{u} \mathbf{;}$

$$\iiint (\bar{\mathbf{F}} - \bar{\mathbf{a}}) \rho d\tau - \iiint \text{grad} P d\tau = 0 .$$

$\mathbf{I}^3 \mathbf{U} \tilde{\mathbf{N}}^3 \mathbf{B} \mathbf{I} \mathbf{C} \mathbf{3} \mathbf{e} \mathbf{Y} \gg \mathbf{E} \mathbf{a} \mathbf{i}$, $\mathbf{a} \mathbf{n} \mathbf{\tau} \mathbf{-} \mathbf{Y} \mathbf{I}^3 \mathbf{U}^3 \mathbf{U}^3 \mathbf{I}^3 \mathbf{Y} \mathbf{+} \mathbf{a} \mathbf{u} \mathbf{n} \mathbf{i} \mathbf{C} \mathbf{n} \mathbf{a} \mathbf{o} \mathbf{U} \mathbf{A} \mathbf{;}$

$$\bar{\mathbf{a}} = \bar{\mathbf{F}} - \frac{1}{\rho} \text{grad} P : \quad 5.2$$

añáÛ»İóÇ³Ý»ñáí ¹ñ³Ýù İáõÝ»Ý³Ý Ñ»İÛ³É ï»ëùÁ`

$$\frac{dV_x}{dt} = F_x - \frac{1}{\rho} \frac{\partial P}{\partial x}, \quad \frac{dV_y}{dt} = F_y - \frac{\partial P}{\partial y}, \quad \frac{dV_z}{dt} = F_z - \frac{\partial P}{\partial z} \quad 5.3$$

Կամ

$$\begin{aligned} \frac{\partial V_x}{\partial t} + V_x \frac{\partial V_x}{\partial x} + V_y \frac{\partial V_x}{\partial y} + V_z \frac{\partial V_x}{\partial z} &= F_x - \frac{1}{\rho} \frac{\partial P}{\partial x}, \\ \frac{\partial V_y}{\partial t} + V_x \frac{\partial V_y}{\partial x} + V_y \frac{\partial V_y}{\partial y} + V_z \frac{\partial V_y}{\partial z} &= F_y - \frac{1}{\rho} \frac{\partial P}{\partial y}, \\ \frac{\partial V_z}{\partial t} + V_x \frac{\partial V_z}{\partial x} + V_y \frac{\partial V_z}{\partial y} + V_z \frac{\partial V_z}{\partial z} &= F_z - \frac{1}{\rho} \frac{\partial P}{\partial z}. \end{aligned} \quad 5.4$$

(5.4)-Á Ç¹»³É³İ³Ý Ñ»ÕáõİÇ ß³ñÀÛ³Ý ¹Çý»ñ»ÝóÇ³É Ñ³í³ë³ñáõÛÝ»ñÝ »Ý İ İááíáõÛ »Ý ¾ÛÉ» ñÇ Ñ³í³ë³ñáõÛÝ»ñ:

Æ¹»³É³İ³Ý Ñ»ÕáõİÇ ß³ñÅÜ³Ý ¹ħý»ñ»ÝóÇ³É Ñ³İ³ë³ñáõÜÝ»ñÄ ·É³Ý³İ³Ý r,φ,z İááñ¹ÇÝ³İ³ÛÇÝ Ñ³Ü³İ³ñ·áõÜ ·ñíaõÜ »Ý Ñ»İ³Û³É İ»ëùáı̇

$$\begin{aligned}
 \frac{\partial V_r}{\partial t} + V_r \frac{\partial V_r}{\partial r} + \frac{V_\varphi}{r} \frac{\partial V_r}{\partial \varphi} + V_z \frac{\partial V_r}{\partial z} - \frac{V_\varphi^2}{r} &= F_r - \frac{1}{\rho} \frac{\partial P}{\partial r}, \\
 \frac{\partial V_\varphi}{\partial t} + V_r \frac{\partial V_\varphi}{\partial r} + \frac{V_\varphi}{r} \frac{\partial V_\varphi}{\partial \varphi} + V_z \frac{\partial V_\varphi}{\partial z} + \frac{V_r V_\varphi}{r} &= F_\varphi - \frac{1}{\rho r} \frac{\partial P}{\partial \varphi}, \\
 \frac{\partial V_z}{\partial t} + V_r \frac{\partial V_z}{\partial r} + \frac{V_\varphi}{r} \frac{\partial V_z}{\partial \varphi} + V_z \frac{\partial V_z}{\partial z} &= F_z - \frac{1}{\rho} \frac{\partial P}{\partial z},
 \end{aligned}
 \tag{5.5}$$

Çëİ ·Ý¹³ÛÇÝ r, θ, ψ İááñ¹ÇÝ³İ³ÛÇÝ Ñ³Ü³İ³ñ·áõÜ`

$$\begin{aligned}
 \frac{\partial V_r}{\partial t} + V_r \frac{\partial V_r}{\partial r} + \frac{V_\theta}{r} \frac{\partial V_r}{\partial \theta} + \frac{V_\psi}{r \sin \theta} \frac{\partial V_r}{\partial \psi} - \frac{V_\theta^2 + V_\psi^2}{r} &= F_r - \frac{1}{\rho} \frac{\partial P}{\partial r}, \\
 \frac{\partial V_\theta}{\partial t} + V_r \frac{\partial V_\theta}{\partial r} + \frac{V_\theta}{r} \frac{\partial V_\theta}{\partial \theta} + \frac{V_\psi}{r \sin \theta} \frac{\partial V_\theta}{\partial \psi} + \frac{V_r V_\theta}{r} - \frac{\text{ctg} \theta}{r} V_\psi^2 &= F_\theta - \frac{1}{\rho r} \frac{\partial P}{\partial \theta}, \\
 \frac{\partial V_\psi}{\partial t} + V_r \frac{\partial V_\psi}{\partial r} + \frac{V_\theta}{r} \frac{\partial V_\psi}{\partial \theta} + \frac{V_\psi}{r \sin \theta} \frac{\partial V_\psi}{\partial \psi} + \frac{V_r V_\psi}{r} + \frac{\text{ctg} \theta}{r} V_\theta V_\psi &= \\
 = F_\psi - \frac{1}{\rho r \sin \theta} \frac{\partial P}{\partial \psi} &:
 \end{aligned}
 \tag{5.6}$$

5.2 $\mathcal{A}^1 \gg \mathcal{E}^3 \mathcal{I}^3 \mathcal{Y} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \quad \mathcal{1} \mathcal{C} \mathcal{Y}^3 \mathcal{U} \mathcal{C} \mathcal{I}^3 \mathcal{U} \mathcal{C} \quad \tilde{\mathcal{N}} \mathcal{C} \mathcal{U} \mathcal{Y}^3 \mathcal{I}^3 \mathcal{Y} \mathcal{E} \mathcal{Y}^1 \mathcal{C} \mathcal{n} \mathcal{Y} \quad \mathcal{I} \quad \mathcal{C} \mathcal{Y}^1 \mathcal{I} \gg \cdot \tilde{\mathcal{n}} \gg \mathcal{E} \acute{\mathcal{a}} \mathcal{I} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \quad \mathcal{B}^3 \mathcal{n} \mathcal{A} \mathcal{U}^3 \mathcal{Y} \quad \mathcal{1} \mathcal{C} \mathcal{Y} \gg$

$\tilde{\mathcal{n}} \gg \mathcal{Y} \acute{\mathcal{o}} \mathcal{C}^3 \mathcal{E} \tilde{\mathcal{N}}^3 \mathcal{I}^3 \mathcal{e}^3 \mathcal{n} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \mathcal{n} \mathcal{A} \quad \mathcal{I} \mathcal{n} \mathcal{I}^3 \mathcal{I} \quad \mathcal{3} \mathcal{n} \mathcal{I}^3 \mathcal{U} \mathcal{C} \mathcal{Y} \quad \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \gg \mathcal{n} \mathcal{C} \quad \cdot \quad \mathcal{e} \mathcal{I} \frac{1}{2} \rho \mathcal{Y}^3 \mathcal{I}^3 \mathcal{Y} \quad \acute{\mathcal{a}} \mathcal{o} \quad \gg \frac{1}{2} \mathcal{n}^3 \mathcal{U} \mathcal{C} \mathcal{Y} \quad \acute{\mathcal{a}}^3 \mathcal{U} \mathcal{U}^3 \mathcal{Y} \mathcal{Y} \gg \mathcal{n} \mathcal{C} \quad \mathcal{1} \gg$
 $\acute{\mathcal{a}} \mathcal{u} \acute{\mathcal{a}} \mathcal{o} \mathcal{U}, \quad \cdot \mathcal{I} \mathcal{Y} \gg \mathcal{E} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \quad \mathcal{3} \mathcal{n}^3 \cdot \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U}^3 \mathcal{Y}, \quad \times \mathcal{Y} \mathcal{B} \mathcal{U}^3 \mathcal{Y}, \quad \mathcal{E} \mathcal{i} \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U}^3 \mathcal{Y}, \quad \mathcal{C} \mathcal{e} \mathcal{I} \quad \acute{\mathcal{a}} \mathcal{a} \quad \mathcal{C} \frac{1}{2} \acute{\mathcal{a}} \mathcal{A} \gg \mathcal{n} \mathcal{U} \quad \mathcal{B}^3 \mathcal{n} \mathcal{A} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \mathcal{n} \mathcal{C} \quad \mathcal{1} \gg$
 $\acute{\mathcal{a}} \mathcal{u} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \quad \mathcal{Y}^3 \quad \mathcal{C} \gg \mathcal{n} \mathcal{U}^3 \mathcal{U} \mathcal{C} \mathcal{Y} \quad \mathcal{1}^3 \mathcal{B} \mathcal{i} \gg \mathcal{n} \mathcal{A} \quad \mathcal{I}^3 \mathcal{E} \mathcal{I}^3 \mathcal{I} \gg \mathcal{i} \mathcal{C} \quad \mathcal{I} \acute{\mathcal{a}} \mathcal{a} \mathcal{n}^1 \mathcal{C} \mathcal{Y}^3 \mathcal{I} \mathcal{Y} \gg \mathcal{n} \mathcal{C} \acute{\mathcal{o}} \quad \cdot \quad \mathcal{A}^3 \mathcal{U}^3 \mathcal{Y}^3 \mathcal{I} \mathcal{C} \acute{\mathcal{o}}: \quad \mathcal{I} \mathcal{n} \mathcal{I}^3 \mathcal{I} \quad \mathcal{E} \mathcal{Y}^1 \mathcal{C} \mathcal{n} \mathcal{A} \quad \mathcal{E} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \gg$
 $\mathcal{E} \acute{\mathcal{a}} \mathcal{o} \quad \tilde{\mathcal{N}}^3 \mathcal{U}^3 \mathcal{n} \quad \mathcal{B}^3 \mathcal{n} \mathcal{A} \mathcal{U}^3 \mathcal{Y} \quad \mathcal{1} \mathcal{C} \quad \mathcal{y} \gg \mathcal{n} \gg \mathcal{Y} \acute{\mathcal{o}} \mathcal{C}^3 \mathcal{E} \tilde{\mathcal{N}}^3 \mathcal{I}^3 \mathcal{e}^3 \mathcal{n} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \mathcal{n} \mathcal{C} \mathcal{Y} \quad \acute{\mathcal{a}} \gg \mathcal{i} \mathcal{u} \quad \mathcal{I} \quad \mathcal{U} \mathcal{C}^3 \acute{\mathcal{o}} \mathcal{Y} \gg \mathcal{E} \quad \mathcal{3} \mathcal{Y} \mathcal{E} \frac{1}{2} \gg \mathcal{E} \mathcal{C} \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U}^3 \mathcal{Y}$
 $\tilde{\mathcal{N}}^3 \mathcal{I}^3 \mathcal{e}^3 \mathcal{n} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{A}: \quad \acute{\mathcal{a}} \mathcal{o} \mathcal{O} \mathcal{O}^3 \mathcal{Y} \mathcal{I} \mathcal{U} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \quad \mathcal{1} \gg \mathcal{I}^3 \mathcal{n} \mathcal{I} \mathcal{U}^3 \mathcal{Y} \quad \mathcal{I} \acute{\mathcal{a}} \mathcal{a} \mathcal{n}^1 \mathcal{C} \mathcal{Y}^3 \mathcal{I}^3 \mathcal{U} \mathcal{C} \mathcal{Y} \quad \tilde{\mathcal{N}}^3 \mathcal{U}^3 \mathcal{I}^3 \mathcal{n} \cdot \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \quad \mathcal{1} \mathcal{n}^3 \mathcal{Y} \mathcal{u} \quad \gg \mathcal{Y}$

$$\begin{aligned} \frac{\partial V_x}{\partial t} + V_x \frac{\partial V_x}{\partial x} + V_y \frac{\partial V_x}{\partial y} + V_z \frac{\partial V_x}{\partial z} &= F_x - \frac{1}{\rho} \frac{\partial P}{\partial x}, \\ \frac{\partial V_y}{\partial t} + V_x \frac{\partial V_y}{\partial x} + V_y \frac{\partial V_y}{\partial y} + V_z \frac{\partial V_y}{\partial z} &= F_y - \frac{1}{\rho} \frac{\partial P}{\partial y}, \\ \frac{\partial V_z}{\partial t} + V_x \frac{\partial V_z}{\partial x} + V_y \frac{\partial V_z}{\partial y} + V_z \frac{\partial V_z}{\partial z} &= F_z - \frac{1}{\rho} \frac{\partial P}{\partial z}. \end{aligned}$$

5.7

$\acute{\mathcal{a}} \mathcal{n} \acute{\mathcal{a}} \gg \mathcal{e} \quad \mathcal{3} \mathcal{Y} \mathcal{I}^3 \mathcal{E} \quad \tilde{\mathcal{N}} \mathcal{C} \mathcal{Y} \cdot \gg \mathcal{n} \acute{\mathcal{a}} \mathcal{n}^1 \quad \frac{dp}{dt} + \rho \left(\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \right) = 0:$
 $\mathcal{I} \acute{\mathcal{a}} \mathcal{U} \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \quad \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \mathcal{C} \quad \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{Y} \gg \mathcal{n} \mathcal{C} \quad \mathcal{U} \mathcal{C} \quad \mathcal{1}^3 \mathcal{e}, \quad \acute{\mathcal{a}} \mathcal{n} \mathcal{C} \quad \tilde{\mathcal{N}}^3 \mathcal{U}^3 \mathcal{n} \quad \mathcal{E} \mathcal{i} \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \mathcal{A} \quad \mathcal{y} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \mathcal{I} \acute{\mathcal{o}} \mathcal{C}^3 \quad \mathcal{I} \quad \mathcal{U} \mathcal{C}^3 \mathcal{U} \mathcal{Y}$
 $\times \mathcal{Y} \mathcal{B} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{C} \acute{\mathcal{o}} \quad \rho = f(P):$

$^2U^1 \gg \text{a} \approx \text{U}, \gg \text{n} \mu \tilde{N} \gg \text{O} \approx \text{I} \zeta \text{E} \approx \text{A} \approx \text{U} \approx \text{Y} \text{A} \text{y} \approx \text{I} \approx \text{O} \zeta^3 \zeta \text{a} \approx \text{U} \zeta^3 \text{U}^1 \times \text{Y} \approx \text{U} \zeta \text{O}, \text{U}^1 \text{E} \approx \zeta \gg$
 $\tilde{N} \approx \text{U}^3 \text{e} \approx \text{I} \zeta \times \text{Y} \zeta \text{O}, \text{I} \zeta \times \text{I} \zeta \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{A} \approx \text{Y} \zeta \text{I} \approx \text{E} \zeta \mu^3 \text{n}^1 \text{i} \approx \text{e} \approx \text{U}, \text{a} \approx \text{n} \text{A} \text{Y} \approx \text{O} \zeta \text{O} \text{a}^3 \text{n} \frac{1}{2} \cdot \text{a} \approx \text{U} \text{Y} \text{A} \text{O} \approx \text{Y}^1 \approx \text{E} \approx \text{I} -$
 $\text{I} \text{E}^3 \text{a} \approx \text{U} \text{n} \text{A} \text{Y} \zeta \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{Y} \zeta$

$$P = \rho RT, \quad 5.8$$

$\text{D} \approx \text{O} \approx \text{I} \text{Y} \approx \text{n} \zeta \text{U}^1 \text{e} \text{i} \approx \text{e}^3 \text{I} \text{A} \text{A} \text{Y}^1 \approx \text{a} \approx \text{Y} \text{i}^1 \zeta \text{Y}^1 \text{i}^3 \text{Y} \approx \text{E} \rho \text{w} \text{n} \text{A} \approx \text{I} \text{E} \zeta \text{Y} \tilde{N} \gg \text{O} \approx \text{I} \text{Y} \approx \text{n} : \text{O} \approx \text{n} \rho \beta^3 \text{n} \text{A} \approx \text{U} \text{A} \zeta \frac{1}{2} \text{a} \approx \text{A} \approx \text{n} \text{U}$
 $\zeta \text{T} = \text{const}, \text{a}^3 (5.8) \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{A} (5.7) \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{Y} \approx \text{n} \zeta \tilde{N} \approx \text{i} \text{I}^{\frac{1}{2}} \text{U} \approx \text{U} \zeta \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{Y} \approx \text{n} \zeta \div \text{I}^3$
 $\tilde{N}^3 \text{U}^3 \text{I}^3 \text{n} \cdot V_x, V_y, V_z, P, \rho \text{Y} \tilde{N}^3 \text{U} \text{i} \text{Y} \approx \text{n} \zeta \text{Y} \text{I}^3 \text{i} \text{U}^3 \text{U} \rho : \text{U}^1 \text{Y}^1 \gg \text{a} \approx \text{U}, \gg \text{n} \rho \beta^3 \text{n} \text{A} \approx \text{U} \text{A} \zeta \frac{1}{2} \text{a} \approx \text{A} \approx \text{n} \text{U} \text{a} \zeta,$
 $\text{U}^1 \text{e} \zeta \text{Y} \text{u} \text{Y} \text{I} - \text{Y}^y \div \text{a} \div \text{a} \text{E} \approx \text{I} \approx \text{U} \zeta, \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{Y} \approx \text{n} \zeta (5.7) \text{I}^3 (5.8) \tilde{N}^3 \text{U}^3 \text{I}^3 \text{n} \cdot \text{A} \div \text{I}^3 \text{a} \zeta, \text{u}^3 \text{Y} \zeta \text{a} \approx \text{n} \approx \text{Y} \approx \text{Y} \text{u}$
 $\tilde{N} \zeta \text{Y} \cdot \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{i} \approx \text{o}^3 \text{Y} \tilde{N}^3 \text{U} \text{i} \text{Y} \approx \text{n} \text{A} \text{i} \text{V}_x, V_y, V_z, P, \rho, T : \text{U} \approx \text{U} \text{Y} \div \text{a} \div \text{a} \text{E}^3 \text{I}^3 \text{Y} \text{Y} \approx \text{n} \text{A} \text{i} \cdot \text{n} \text{i}^1 \text{i} \approx \text{o} \approx \text{n} \text{A} \text{n}^1$
 $\tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{Y} \zeta \zeta \text{Y} \approx \text{n} \cdot \zeta^3 \text{U} \zeta \tilde{N} \text{A} \approx \text{e} \approx \text{U} \zeta \tilde{N}^3 \text{i}^3 \text{e}^3 \text{n} \approx \text{U} \text{A}$

$$\varepsilon = C_{v\rho} \frac{dT}{dt} - \frac{jP}{\rho} \frac{d\rho}{dt}, \quad 5.9$$

Դասախոսություն 6

6.1 $\mathcal{E}^1 \gg \mathcal{E}^3 \mathcal{I}^3 \mathcal{Y} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \mathcal{B}^3 \tilde{\mathcal{h}} \mathcal{A} \mathcal{U}^3 \mathcal{Y}^1 \mathcal{C} \mathcal{Y} \gg \tilde{\mathcal{h}} \gg \mathcal{Y} \mathcal{O} \mathcal{C}^3 \mathcal{E} \tilde{\mathcal{N}}^3 \mathcal{i}^3 \mathcal{e}^3 \tilde{\mathcal{h}} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \tilde{\mathcal{h}} \mathcal{C} \mathcal{C} \mathcal{Y} \mathcal{i} \gg \cdot \tilde{\mathcal{h}} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{A}$

$\mathcal{N}^3 \tilde{\mathcal{h}}^{1/2} \cdot \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \mathcal{C} \mathcal{Y} \mathcal{i} \gg \cdot \tilde{\mathcal{h}}^3 \mathcal{E} \mathcal{Y} \gg \tilde{\mathcal{h}}^3$

3) $\mathcal{C} \mathcal{Y} \mathcal{i} \gg \tilde{\mathcal{h}} \cdot \mathcal{C}^3 \mathcal{U} \mathcal{C} \mathcal{C} \mathcal{Y} \mathcal{i} \gg \cdot \tilde{\mathcal{h}}^3 \mathcal{E} \mathcal{A}$, $\acute{\mathcal{a}} \mathcal{n} \mathcal{A} \mathcal{e} \mathcal{i}^3 \mathcal{o} \mathcal{i} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{C} \mathcal{C} \mathcal{Y}^1 \gg \mathcal{E}^3 \mathcal{I}^3 \mathcal{Y} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \mathcal{i} \mathcal{n}^3 \mathcal{1} \mathcal{n} \mathcal{i}^3 \mathcal{I} \tilde{\mathcal{N}} \gg \mathcal{i}^3 \mathcal{U}^3 \mathcal{E} \mathcal{e}^3 \tilde{\mathcal{N}} \mathcal{U}^3 \mathcal{Y}^3 \mathcal{I} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \tilde{\mathcal{h}} \mathcal{C} \mathcal{1} \gg \acute{\mathcal{a}} \mathcal{o} \mathcal{U}$

1. $\mathcal{B}^3 \tilde{\mathcal{h}} \mathcal{A} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{A} \mathcal{e} \mathcal{i}^3 \mathcal{o} \mathcal{C} \acute{\mathcal{a}} \mathcal{Y}^3 \tilde{\mathcal{h}} \mathcal{C}$

2. $\mathcal{N}^3 \mathcal{i}^3 \mathcal{u} \mathcal{C} \mathcal{Y} \acute{\mathcal{a}} \mathcal{o} \mathcal{A}^3 \mathcal{U} \mathcal{C} \mathcal{Y}^1 \mathcal{B} \mathcal{i} \mathcal{Y} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \mathcal{C} \acute{\mathcal{a}} \mathcal{i} \gg \mathcal{Y} \mathcal{O} \mathcal{C}^3 \mathcal{E}$,

$$\bar{\mathbf{F}} = -\text{grad} \Pi$$

$\acute{\mathcal{a}} \mathcal{n} \mathcal{i} \gg \mathcal{O} \mathcal{A} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \mathcal{U} \mathcal{C}^3 \mathcal{i} \acute{\mathcal{a}} \mathcal{n}$

$\mathcal{U}^2 \mathcal{e} \mathcal{e}^3 \tilde{\mathcal{N}} \mathcal{U}^3 \mathcal{Y}^3 \mathcal{I} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{Y} \gg \tilde{\mathcal{h}} \mathcal{C} \mathcal{1} \gg \acute{\mathcal{a}} \mathcal{o} \mathcal{U}$ $\bar{\mathbf{a}} = \bar{\mathbf{F}} - \frac{1}{\rho} \text{grad} P$ $\mathcal{B}^3 \tilde{\mathcal{h}} \mathcal{A} \mathcal{U}^3 \mathcal{Y}^1 \mathcal{C} \mathcal{Y} \gg \tilde{\mathcal{h}} \gg \mathcal{Y} \mathcal{O} \mathcal{C}^3 \mathcal{E}$

$\tilde{\mathcal{N}}^3 \mathcal{i}^3 \mathcal{e}^3 \tilde{\mathcal{h}} \mathcal{U}^3 \mathcal{Y} \gg \tilde{\mathcal{h}} \mathcal{i} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \acute{\mathcal{a}} \mathcal{O} \mathcal{U} \gg \tilde{\mathcal{h}} \mathcal{A} \mathcal{e} \mathcal{i}^3 \mathcal{E} \mathcal{U}^3 \mathcal{h}^3 \mathcal{a} \gg \mathcal{e} \mathcal{p} \omega \mathcal{q} \mathcal{U}^3 \mathcal{a} \mathcal{o} \mathcal{I} \gg \mathcal{E} \mathcal{a} \mathcal{i}$

$\mathcal{C} \mathcal{Y} \mathcal{i} \gg \cdot \tilde{\mathcal{h}} \gg \mathcal{E} \acute{\mathcal{a}} \mathcal{i} \tilde{\mathcal{N}} \gg \mathcal{O} \acute{\mathcal{a}} \mathcal{o} \mathcal{I} \mathcal{C} \tau \mathcal{i} \mathcal{C} \tilde{\mathcal{h}} \acute{\mathcal{a}} \mathcal{o} \mathcal{U} \mathcal{A} \acute{\mathcal{a}} \mathcal{i}$, $\tilde{\mathcal{N}}^3 \mathcal{B} \mathcal{i} \mathcal{C}^3 \mathcal{e} \mathcal{Y} \gg \mathcal{E} \acute{\mathcal{a}} \mathcal{i}$, $\acute{\mathcal{a}} \mathcal{n}$

$$\bar{\mathbf{a}} d\mathbf{r} = \left(\frac{d\bar{V}}{dt} \right) d\mathbf{r} = \bar{V} d\bar{V} = d\left(\frac{V^2}{2} \right)$$

$\mathcal{A} \mathcal{n} \acute{\mathcal{a}} \mathcal{B} \mathcal{O}^3 \mathcal{I} \mathcal{E} \acute{\mathcal{a}} \mathcal{o} \mathcal{A} \mathcal{U} \acute{\mathcal{a}} \mathcal{o} \mathcal{Y} \mathcal{Y} \gg \tilde{\mathcal{h}} \mathcal{C} \mathcal{o} \tilde{\mathcal{N}} \gg \mathcal{i} \acute{\mathcal{a}} \mathcal{i} \mathcal{e} \mathcal{i}^3 \mathcal{Y}^3 \mathcal{Y} \mathcal{U}$

$$dE_q + d\Pi_* = - \iiint_{\tau} \left(\frac{\partial p}{\partial x} dx + \frac{\partial p}{\partial y} dy + \frac{\partial p}{\partial z} dz \right) d\tau : \quad 6.1$$

2. $E_4 = \frac{1}{2} \iiint_{\tau} \rho V^2 d\tau$, $\Pi_* = \iiint_{\tau} P \rho d\tau$: 6.2

(6.1) - $\frac{dx}{dt} = V_x$, $\frac{\partial p}{\partial x} V_x = \frac{\partial}{\partial x} (P V_x) - P \frac{\partial V_x}{\partial x}$

... $\frac{d}{dt} (E_4 + \Pi_*) = - \iint_S \rho V_n ds + \iiint_{\tau} P \operatorname{div} \bar{V} d\tau$: 6.3

$$\frac{d}{dt} (E_4 + \Pi_*) = - \iint_S \rho V_n ds + \iiint_{\tau} P \operatorname{div} \bar{V} d\tau : 6.3$$

ρ) $\frac{d}{dt} \int_V \rho \mathbf{v} \cdot d\mathbf{V} = \int_V \rho \mathbf{v} \cdot \nabla \mathbf{v} + \int_V \rho \mathbf{f} \cdot d\mathbf{V}$, $\mathbf{v} = \nabla \Phi$, $\mathbf{v} \cdot \nabla \mathbf{v} = \nabla \left(\frac{v^2}{2} \right) - \nabla \times (\mathbf{v} \times \mathbf{v})$

1. $\mathbf{v} = \nabla \Phi$, $\mathbf{v} \cdot \nabla \mathbf{v} = \nabla \left(\frac{v^2}{2} \right) - \nabla \times (\mathbf{v} \times \mathbf{v})$
2. $\rho \mathbf{v} \cdot \nabla \mathbf{v} = \rho \nabla \left(\frac{v^2}{2} \right) - \rho \nabla \times (\mathbf{v} \times \mathbf{v})$, $\mathbf{F} = -\text{grad} \Pi$, $\mathbf{v} \cdot \nabla \mathbf{v} = \nabla \left(\frac{v^2}{2} \right) - \nabla \times (\mathbf{v} \times \mathbf{v})$
3. $\rho = \rho(P)$, $\mathbf{v} = \nabla \Phi$, $\rho = \rho(P)$:
 $\rho \mathbf{v} \cdot \nabla \mathbf{v} = \rho \nabla \left(\frac{v^2}{2} \right) - \rho \nabla \times (\mathbf{v} \times \mathbf{v})$

$$\frac{\partial \mathbf{v}}{\partial t} + \frac{1}{2} \text{grad} v^2 - \mathbf{v} \times \text{rot} \mathbf{v} = \mathbf{F} - \frac{1}{\rho} \text{grad} P, \quad 6.4$$

Υβίσι $\mathbf{v} = \nabla \Phi$, $\mathbf{v} \cdot \nabla \mathbf{v} = \nabla \left(\frac{v^2}{2} \right) - \nabla \times (\mathbf{v} \times \mathbf{v})$, (6.4)- $\rho \mathbf{v} \cdot \nabla \mathbf{v} = \rho \nabla \left(\frac{v^2}{2} \right) - \rho \nabla \times (\mathbf{v} \times \mathbf{v})$

$$\text{grad} \left(\frac{v^2}{2} + \Pi + \Phi \right) = \mathbf{v} \times \text{rot} \mathbf{v}, \quad 6.5$$

ημνη

$$\Phi = \int \frac{dP}{\rho}, \quad \frac{1}{\rho} \text{grad} P = \text{grad} \Phi : \quad 6.6$$

(6.5)- $\rho \mathbf{v} \cdot \nabla \mathbf{v} = \rho \nabla \left(\frac{v^2}{2} \right) - \rho \nabla \times (\mathbf{v} \times \mathbf{v})$, $\mathbf{v} = \nabla \Phi$, $\mathbf{v} \cdot \nabla \mathbf{v} = \nabla \left(\frac{v^2}{2} \right) - \nabla \times (\mathbf{v} \times \mathbf{v})$, $\rho \mathbf{v} \cdot \nabla \mathbf{v} = \rho \nabla \left(\frac{v^2}{2} \right) - \rho \nabla \times (\mathbf{v} \times \mathbf{v})$

ÍáõÝ»Ý³Ýù`

$$\text{grad} \left(\frac{V^2}{2} + \Pi + \Phi \right) \overline{e^0} = \frac{\partial}{\partial e} \left(\frac{V^2}{2} + \Pi + \Phi \right) = 0 \quad 6.7$$

ωjuuntηhg

$$\frac{V^2}{2} + \Pi + \Phi = \text{const} = c$$

ηωδ

$$\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} = c : \quad 6.8$$

²Ýë»ÕÙ»ÉÇ Ñ»ÕáõİÇ ¹»åùáõÙ (6.8)-Çó ÍáõÝ»Ý³Ýù`

$$\frac{V^2}{2} + \Pi + \frac{P}{\rho} = C : \quad 6.9$$

°Ã» ³½¹áÕ ³ñĩ³ùÇÝ áõÅ»ñÁ ÙÇ³ÛÝ Í³ÝñáõÃÛ³Ý áõÅ»ñ »Ý, ³å³ Π=g · z `` (6.9)-Çó ÍáõÝ»Ý³Ýù`

$$\frac{V^2}{2g} + z + \frac{P}{\rho g} = C : \quad 6.10$$

´»éÝáõÉÇÇ ÇÝİ»·ñ³ÉÇ ζÝ»ñ·»İÇİ ÇÙ³ëİÁ å³ñ½»Éáõ Ñ³Û³ñ (6.10)-Á Ý»ñĩ³Û³óÝ»Ýù`

$$\frac{V^2}{2} + zg + \frac{P}{\rho} = c \quad 6.11$$

´»éÝáõÉÇÇ ÇÝİ»·ñ³ÉÇ ζÝ»ñ·»İÇİ ÇÙ³ëİÝ ³ÛÝ ζ, áñ İİÛ³É ÑáëùÇ ·ÍÇ »ñĩ³Û³ùáÍ ÙÇ³íañ ½³Ý·Í³Í áõÝ»
óáÕ Ù³ëÝÇİÇ İÇÝ»İÇİ, ááİ»ÝóÇ³É `` ×ÝßÛ³Ý ζÝ»ñ·Ç³Ý»ñÇ ·áõÛ³ñÁ Å³Û³Ý³İÇ ó³Ýİ³ó³Í å³ÑÇ Ñ³ëİ³íaõÝ
ζ:

·) $\hat{I}a\beta\zeta\zeta \zeta\acute{Y}\grave{i}\rangle \cdot \tilde{n}^3\acute{E}\acute{A}$, $\acute{a}\tilde{n}\acute{A} \grave{e}\tilde{i}\acute{o}\acute{i}\acute{a}\acute{o}\grave{U} \zeta \zeta^1\rangle^3\acute{E}\acute{i}\acute{Y} \tilde{N}\rangle\acute{O}\acute{a}\acute{o}\acute{i}\zeta \acute{i}\tilde{n}^3 \acute{1}\tilde{n}\acute{i}\acute{I} \tilde{N}\rangle\acute{i}\acute{U}\acute{E} \acute{e}\acute{N}\acute{U}\acute{Y}\acute{3}\div\acute{3}\acute{i}\acute{a}\acute{o}\grave{U}\acute{Y}\rangle\tilde{n}\zeta \acute{1}\rangle\acute{a}\acute{u}\acute{a}\acute{o}\grave{U}$

1. $\beta^3\tilde{n}\acute{A}\acute{o}\grave{U}\acute{A} \acute{a}\acute{i}\rangle\acute{Y}\acute{o}\zeta^3\acute{E} \zeta$

2. ${}^3\frac{1}{2}\acute{1}\acute{a}\acute{O} \acute{3}\tilde{n}\acute{i}\acute{3}\grave{u}\zeta\acute{Y} \acute{a}\acute{o}\acute{A}\acute{3}\acute{U}\zeta\acute{Y} \acute{1}\acute{3}\beta\acute{i}\acute{Y} \acute{a}\acute{o}\acute{Y}\zeta \acute{a}\acute{i}\rangle\acute{Y}\acute{o}\zeta^3\acute{E}$

$$\bar{F} = \text{grad}U = -\text{grad}\Pi$$

3. $\tilde{N}\rangle\acute{O}\acute{a}\acute{o}\acute{i}\acute{A} \rho\tilde{w}\tilde{n}\acute{i}\tilde{n}\acute{a}\acute{a} \zeta$:

$\beta^3\tilde{n}\acute{A}\acute{U}\acute{3}\acute{Y} \acute{1}\zeta\acute{y}\rangle\tilde{n}\rangle\acute{Y}\acute{o}\zeta^3\acute{E} \tilde{N}\acute{3}\acute{i}\acute{3}\acute{e}\acute{3}\tilde{n}\acute{a}\acute{o}\grave{U}\acute{A} \cdot \tilde{n}\rangle\acute{E}\acute{a}\acute{i} \acute{E}\acute{3}\acute{U}\rho\zeta (6.4) \acute{i}\rangle\grave{e}\grave{u}\acute{a}\acute{i}$, $\acute{Y}\beta\acute{i}\acute{I} \acute{a}\acute{3}\acute{U}\acute{U}\acute{3}\acute{Y}\rangle\tilde{n}\zeta \acute{1}\rangle\acute{a}\acute{u}\acute{a}\acute{o}\grave{U} \acute{i}\acute{a}\acute{o}\acute{Y}\rangle\acute{Y}\acute{3}\acute{Y}\grave{u}$

$\acute{a}\tilde{n}\acute{i}\rangle\acute{O} \tilde{N}\acute{3}\beta\acute{i}\zeta \rangle\acute{Y} \acute{3}\acute{e}\acute{Y}\acute{i}\acute{I} \cup \frac{\partial}{\partial t}\text{grad}\varphi + \frac{1}{2}\text{grad}V^2 = -\text{grad}\Pi - \text{grad}\Phi$, $\acute{Y}\beta\acute{3}\acute{Y}\acute{3}\acute{i}\acute{a}\acute{o}\grave{U}\acute{Y}\rangle\tilde{n}\acute{A}$: (6.12)- $\acute{A} \acute{Y}\rangle\tilde{n}\acute{i}\acute{3}\acute{U}\acute{3}\acute{o}\acute{Y}\rangle\acute{E}\acute{a}\acute{i}$

$$\bar{V} = \text{grad}\varphi \quad \Phi = \int \frac{dP}{\rho}, \quad \frac{1}{\rho}\text{grad}P = \text{grad}\Phi$$

$\acute{i}\rangle\grave{e}\grave{u}\acute{a}\acute{i} \cdot \tilde{N}\acute{3}\beta\acute{i}\zeta \acute{3}\acute{e}\acute{Y}\rangle\acute{E}\acute{a}\acute{i}$, $\acute{a}\tilde{n} \beta^3\hat{r} \text{grad}\left(\frac{\partial\varphi}{\partial t} + \frac{V^2}{2} + \Pi + \Phi\right) = 0$ $\acute{3}\acute{Y} \acute{a}\acute{3}\acute{U}\acute{U}\acute{3}\acute{Y} \acute{a}\zeta$ 6.13

$\acute{1}\tilde{n}\acute{i}\acute{I}$, $\acute{i}\acute{a}\acute{o}\acute{Y}\rangle\acute{Y}\acute{3}\acute{Y}\grave{u}$

$\acute{a}\tilde{n}\acute{i}\rangle\acute{O} f(t)$ - $\acute{Y} \acute{A}\acute{3}\acute{U}\acute{3}\acute{Y}\acute{3}\acute{i}\zeta\acute{o} \acute{i}\acute{3}\acute{E}\acute{i}\acute{I} \acute{a}\tilde{n}$ $\frac{\partial\varphi}{\partial t} + \frac{V^2}{2} + \Pi + \Phi = f(t)$, 6.14

(6.14) - Á ĩáãíáõÛ ħ ĩáßçç çýí»·ñ³É, Áëï áñç »Ã» ç¹»³É³ĩ³Ý Ñ»Õáõĩç ß³ñÅÛ³Ý Å³Û³Ý³ĩ ρωί³ñ³ĩ³ĩ »Ý í» ñÁ Ýβί³ĩ á³ÛÛ³ÝÝ»ñÁ, ³á³ (6.14) Ñ³í³ë³ñáõÃÛ³Ý Ó³Ë Û³ëç ãáñë ³Ý¹³ÛÝ»ñç ·áõÛ³ñÁ ĩĩÛ³É á³ÑçÝ Ñ³ëĩ³íáõÝ ħ ĩçñáõÛÃç μάÉáñ ĩ»ĩ»ñáõÛ: °ñρ Ñ»ÕáõĩÁ ³Ýë»ÕÛ»Éç ħ " »ñρ ωϩηηη áõÅ»ñÁ ĩ³ÝñáõÃÛ³Ý áõÅ»ñ »Ý, (6.14) -Á ĩÁÝ¹áõÝç Ñ»ĩÛ³É ĩ»ëùÁ

$$\frac{\partial \varphi}{\partial t} + \frac{V^2}{2} + gz + \frac{P}{\rho} = f(t): \quad 6.15$$

Ä³Û³Ý³ĩç ĩĩÛ³É á³ÑçÝ f(t) ýáõÝĩóç³Ûç ³ñÅ»ùÁ ĩáñáβίç, »Ã» ³Û¹ á³ÑçÝ Ñ³ÛĩÝç ÉçÝç (6.14)-ç Ó³Ë Û³ëç ³ñÅ»ùÁ ĩçñáõÛÃç áñ ħ ĩ»íáõÛ: ²Ýë»ÕÛ»Éç Ñ»Õáõĩç ááĩ»Ýóç³É ß³ñÅÛ³Ý Å³Û³Ý³ĩ φ ýáõÝĩóç³Ý ρωί³ñ³ñáõÛ ħ É³áÉ³ëç

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2} = 0 \quad 6.16$$

η) $\int \rho \frac{dV}{dt} = \rho \frac{d}{dt} \left(\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} \right) = c$, $\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} = c$, $\frac{V^2}{2} + gz + \frac{P}{\rho} = c$

$$\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} = c \quad 6.17$$

(6.17)-Á $\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} = c$, (6.17)-Ç $\frac{V^2}{2} + gz + \frac{P}{\rho} = c$

$$\frac{V^2}{2} + gz + \frac{P}{\rho} = c \quad 6.18$$

$\frac{V^2}{2} + gz + \frac{P}{\rho} = c$, $\frac{V^2}{2} + \Pi + \int \frac{dP}{\rho} = c$