"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, Georgiy Aleksandrovich; LYUBIMOV, Boris Georgiyevich; GEYMAN, M.A., nauchn. red.; SHVETSOVA, E.M., ved. red.; DEM'YANENKO, V.I., tekhn. red.

[Theory and design of axial multistage turbodrill turbines] Teoriia i raschet osevykh mnogostupenchatykh turbin turboburov. Leningrad, Gostoptekhizdat, 1963. 178 p. (MIRA 17:2)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

6

10(7)

AUTHOR: Lyubimov, G.A. SOV/55-58-5-6/34

TITLE: On the Influence of Viscosity and Thermal Conductivity on the Gas Flow Behind a Strongly Curved Shock Wave (O vliyanii vyazkosti i teploprovodnosti na techeniye gaza za sil'no iskrivlennoy udarnoy volnoy)

PERIODICAL: Vestnik Moskovskogo universiteta, Seriya matematiki, mekhaniki, astronomii, fiziki, khimii, 1958, Nr 5, pp 33 - 36 (USSR)

ABSTRACT: In [Ref 1] L.I. Sedov and others gave formulas for the relations of the braking temperatures and pressures in front of and behind a curved shock wave under consideration of viscosity and heat conduction of the gas, whereby plane and axial-symmetric waves were considered. The author generalizes these results to shock waves of arbitrary form.
There are 2 figures, and 1 Soviet reference.

ASSOCIATION: Kafedra gidromekhaniki (Chair of Hydromechanics)

SUBMITTED: May 28, 1958

Card 1/1

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LY[illegible]OV, G. [illegible], Cand Phy [illegible] Sci [illegible] "M [illegible] of the problems of [illegible] hydro [illegible] rd t [illegible] [illegible] [illegible] 6 pp (Mos State [illegible] [illegible] V. Lomonosov. Mechanical Math [illegible] Faculty), [illegible]

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

24 (1)

AUTHOR: Lyubimov, G. A. SOV/ 55-58-6-3/31

TITLE: On the Compression of a Gas Cylinder by Means of Current (O szhatii gazovogo tsilindra tokom)

PERIODICAL: Vestnik Moskovskogo universiteta. Seriya matematiki, mekhaniki, astronomii, fiziki, khimii, 1958, Nr 6, pp 13 - 17 (USSR)

ABSTRACT: In the present paper the solution of the problem mentioned in the title is carried out. In this investigation - in contrast to other papers (Refs 1,2) - the shock wave which forms due to a magnetic field is taken into account. This magnetic field forms due to the feeding of the gas cylinder with electric current. The solution is obtained in the form of a series, developed according to low powers of ε. In this connection ε denotes the ratio of the gas density before and behind the shock wave. For the solution first the system of equations (1)

$$\frac{\partial r^2}{\partial t^2} = - r\frac{\partial p}{\partial m},\ \frac{\partial r}{\partial m} = \frac{1}{\rho r},\ \frac{\partial}{\partial t}\left(\frac{p^{1/\gamma}}{\rho}\right) = 0$$

is set up ($r(t,m)$ - distance of the particles from the axis of the cylinder, ρ density, p - pressure) for the one-dimensional undisturbed motion of an ideal gas with a constant thermal capacity γ after the

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

introduction of the Lagrange variable m ($dm=\varrho_1^o(R)RdR$ R= distance of the particles from the cylinder axis at the time t=0 and $\varrho_1^o(R)$ - the initial distribution of density). The shock wave is taken into account by the following conditions: $\varrho_1^o/\varrho=\mathcal{E}$, $p=p_1^o+(1-\mathcal{E})\varrho_1^o\dot{r}^{*2}$, $i-i_1^o=\frac{1}{2}(1-\mathcal{E}^2)\dot{r}^{*2}$ (2) where ϱ_1^o, p_1^o, i_1^o denote the density, pressure and heat volume of the gas before the shock wave and ϱ, p, i the same behind the shock wave. $\dot{r}^*$ denotes the velocity of propagation of the shock wave. For the solution of the system of equations (1) the following series are set up in powers of $\mathcal{E}$ and inserted into (1) $\varrho=\varrho_o/\mathcal{E}+\varrho_1+\dots$, $p=p_o+\mathcal{E}p_1+\dots$, $r=r_o+\mathcal{E}r_1+\dots$,. Moreover, these expansions into series (3) and $r^*=r_o^*+\mathcal{E}r_1^*+\dots$ are introduced in the conditions for the shock wave (2). The series $r_c=r_{oc}+\mathcal{E}r_{1c}+\dots$ (c = cylinder) is set up for the motion of the external boundary of the cylinder and the pressure conditions are obtained (8). By means of the energy integral equation for the mentioned prob-

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

On the Compression of a Gas Cylinder by Means of Current SOV/55-58-6-3/31

lem with the mentioned conditions, equations for the determination $r_0(t)$ and $r_{0c}(t)$ (9) and (11) and for $r^*(t)$ (10) may be obtained by an expansion into a series according to powers of ε. Further, a comparison is made of the results with those from reference 2. An agreement was found between the results of the compression periods of the cylinder and also with the experimental results. The method described here permits also the computation of all parameters of motion behind the shock wave. The numerical computations were carried out by means of an electronic digital computer. There are 1 figure and 4 Soviet references.

ASSOCIATION: Kafedra gidromekhaniki (Chair of Hydromechanics)

SUBMITTED: June 25, 1958

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

SOV/179-59-1-32/36

AUTHOR: Lyubimov, G. A. (Moscow)

TITLE: Flow of Non-ideal Gas with a Great Supersonic Speed Around a Body (Obtekaniye tel potokom neideal'nogo gaza s bol'shimi sverkhzvukovymi skorostyami)

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Mekhanika i mashinostroyeniye, 1959, Nr 1, pp 173-176 (USSR)

ABSTRACT: A method is described in Ref.1 which is applied in this work to the case of supersonic flow round either a rotating body or a flat contour with an arbitrary relationship of pressure and temperature. The fundamental equations and their solutions are based on a system of coordinates as shown in Fig.1. When the function of the current ψ is denoted as:

$$d\psi = \rho u r^{\nu-1} dy - \rho v r^{\nu-1}\left(1 + \frac{y}{R}\right) dx$$

then the equation of motion of gas in the system of coordinates

Card 1/5

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

Flow of Non-ideal Gas with a Great Supersonic Speed Around a Body

x, ψ will take the form of Eqs.(1) where u and v - components of velocity along x and y ; p , ρ , S - pressure, density, entropy of gas, R - radius of the contour of flow, ν - 1, 2 for a flat or rotating body respectively, r - distance from the axis of symmetry, α - angle between the tangent to the contour of the body and the direction of incoming flow. The solutions of the above equations in respect to the main shock wave are based on Eqs.(2), where p_1^0 , ρ_1^0 , U - parameters of gas in the incoming flow, i - heat content, $y^*(x)$ - surface equation of the shock wave, β - angle between tangent to the surface of the shock wave and the direction of incoming flow, ε - ratio of densities in flow and behind the shock wave which in the case of a curved wave becomes a function x . Generally, the solution of Eq.(1) can be obtained when the series:

$$p = p_0 + \varepsilon p_1 + \ldots, \quad u = u_0 + \varepsilon u_1 + \ldots, \quad \rho = \frac{\rho_0}{\varepsilon} + \rho_1 + \ldots,$$

$$v = \varepsilon v_0 + \ldots, \quad y = \varepsilon y_0 + \ldots,$$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

SOV/179-59-1-32/36

Flow of Non-ideal Gas with a Great Supersonic Speed Around a Body

with a step ε are introduced. Thus the Eqs.(3) are derived. The limiting conditions will be defined when $\psi = \psi^*(x)$ which is an equation of shock wave in the co-ordinates x , ψ . In this case:

$$\psi^*(x) = \frac{\rho_1{}^o U r^{*\nu}}{\nu} = \psi_o^* + \varepsilon\psi_1^* + \ldots = \frac{\rho_1{}^o U}{\nu} r^{o\nu}\left(1 + \nu\varepsilon y_o^* \frac{\cos\alpha}{r^o} + \ldots\right)$$

where $y_o^* = y_o(x\psi_o^*)$ and the conditions to satisfy the equation $\psi = \psi^*$ are shown in Eqs.(4). These conditions are derived from the first three equations of Eqs.(2). The fourth equation of Eqs.(2) can be found in an identical way and the last equation of Eq.(2) can be expressed as:

$$i\left(p_o, \frac{\rho_o}{\varepsilon}\right) - i(p_1{}^o, \rho_1{}^o) = \frac{1}{2} U^2 \sin^2\alpha \left(1 + \frac{2}{\nu}\varepsilon\right) .$$

From this expression the value of $\varepsilon(x)$ can be determined.

Card 3/5

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

Flow of Non-ideal Gas with a Great Supersonic Speed Around a Body

As an example, the problem of airflow around a cone is considered. In this case the flow of the shock wave is taken as linear and ε = const ($\nu = 2$). The solutions of Eqs.(3) and the limiting conditions of Eqs.(4) will take the form of the expressions to the left of Fig.4, p 175. The Figs.2 to 4 illustrate the results of the calculation when $\alpha = 25$, $T_1^{\,o} = 220$, $p_1^{\,o} = 0.1$ atm. The values of ε and T_o are determined from:

$$\frac{\rho_1^{\,o}}{\varepsilon} = \rho(T_o p_o), \quad i(T_o, p_o) - i(T_1^{\,o}, p_1^{\,o}) = \frac{1}{2}U^2 \sin^2\alpha(1 + \varepsilon) \quad .$$

($\rho(T, p)$ and $i(T, p)$ are taken from tables in Refs.4 and 6. The points in the figures marked with crosses denote the values when the characteristics of air at higher temperatures were considered. Fig.2 shows the relation of the density of the shock wave to the number M of the incoming flow. When M = 20 the temperature behind the shock wave rises to 3000°C, causing the dissociation of the air; the density of the shock wave increases more rapidly in comparison with that at lower temperatures. Fig.3 gives the relation of the angle of the

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

SOV/179-59-1-32/36

Flow of Non-ideal Gas with a Great Supersonic Speed Around a Body

shock wave β to the number M . Fig.4 gives the value of the coefficient of resistance as calculated from the formula at the bottom of p 175 (black dots represent the values taken from Ref.5). All the results were calculated from the theoretical formula and show a 1 to 1.5% accuracy in comparison with the same results obtained in the Laboratory of Physics of Fire in the Institute of Power, Academy of Sciences USSR, imeni G. M. Krzhizhanovskiy. There are 4 figures and 6 references, of which 2 are Soviet and 4 are English.

SUBMITTED: April 7, 1958.

Card 5/5

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

24 (3)

AUTHORS: Kulikovskiy, A. G., Lyubimov, G. A. (Moscow) SOV/179-59-4-16/40

TITLE: On the Possible Kinds of Crack With a Conductivity Jump

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye tekhnicheskikh nauk. Mekhanika i mashinostroyeniye, 1959, Nr 4, pp 130-131 (USSR)

ABSTRACT: If in a flow of gas there is a surface with a jump-like change of its parameters, the mass-, momentum- and energy-conservation laws must be observed in the passing through this surface. Under certain assumptions made here, these laws are indicated in the form of formulas (1) (Ref 1). At given parameters of the approaching flow as well as of the electromagnetic field in front of the discontinuity surface, the formulas (1) determine the flow- and field parameters behind the discontinuity. It is shown that the presence of a single steady surface at given parameters of the approaching flow does not yet make it possible to solve only an unsteady problem with cracks of similar kind (e. g. the problem of the motion of a flat piston). The structure of the discontinuity surface with a conductivity jump is investigated. The procedure is similar to that described in the papers (Refs 2,3). The curve ABC shown in the figure is

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

On the Possible Kinds of Crack With a Conductivity Jump SOV/179-59-4-16/40

obtained. It expresses the connection between the volume v and the magnetic field strength H. It is shown that - if the structure of the discontinuity surface is investigated at $\sigma = \sigma(T)$, the conductivity σ being equal to zero, for T-values smaller than a certain T - there is only one point on the ABC-curve which depends on T^* and the initial values of the parameters, and from which the motion can be continued until ∞. This points to a certain connection between H_1 and H_2, which is not a consequence of the conservation laws, formula (1). This additional relationship, together with the conservation laws in unsteady problems, determines the intensity of the electromagnetic wave emitted, and makes the solution of such problems a unique one. There are 1 figure and 3 Soviet references.

SUBMITTED: February 19, 1959

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

67585

24.2720 SOV/179-59-5-3/41

AUTHOR: Lyubimov, G.A. (Moscow)

TITLE: Investigation of Stationary Surfaces of Discontinuity with a Conductivity Step of a Gas in an Electromagnetic Field

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Mekhanika i mashinostroyeniye, 1959, Nr 5, pp 9-15 (USSR)

ABSTRACT: Surfaces of discontinuity in ordinary gas dynamics are well known, including their structure and stability. In magnetic gas dynamics surfaces of discontinuity have been studied in an infinitely conducting medium (eg Syrovatskiy, S.I. "On the Stability of Shock Waves in Magneto-Hydrodynamics", Zh ETF, 1958, Nr 6). The present work considers stationary surfaces of discontinuity wherein, apart from the thermodynamic quantities of flow and velocity, the conductivity of the gas also suffers a discontinuity. First, the effect of an electromagnetic field on discontinuities is considered generally and it is found that surfaces of discontinuity may appear in addition to those arising from ordinary gas dynamic laws. For example, a discontinuity combining a pressure rise and a drop in density is possible. The specific effect of changes in conductivity is then analysed. It is concluded

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

67585

SOV/179-59-5-3/41

Investigation of Stationary Surfaces of Discontinuity with a Conductivity Step of a Gas in an Electromagnetic Field

that not all surfaces of discontinuity which satisfy the laws of conservation can be considered as the limits of continuous flows with varying conductivity. Surfaces of discontinuity with a conductivity step which can be considered as limits of continuous flows are either density increases with a rise in the magnetic field or density reductions with a diminishing magnetic field. Taking into account the viscosity and heat conductivity of the gas, shows that stationary flows are only possible at certain initial values of the parameters. Thus, in the flow of an ideal gas containing a surface of discontinuity with a conductivity step, an electromagnetic wave will propagate ahead of the step which changes the initial parameters of the field. Finally, discontinuity surfaces with a conductivity step are considered on whose fronts energy is released. In the ordinary gas dynamics it is not possible to achieve detonation conditions wherein the velocity of the gas behind the detonation wave is larger than the velocity of sound unless energy is absorbed at the detonation front. If, however,

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

67585
SOV/179-59-5-3/41

Investigation of Stationary Surfaces of Discontinuity with a Conductivity Step of a Gas in an Electromagnetic Field

the detonation proceeds in an electromagnetic field and the conductivity of the medium has a step at the detonation wave front, such conditions are possible at certain values of the initial parameters. Examples of such detonation waves were given by the author's earlier work ("Effect of Electromagnetic Fields on the Conditions of Detonation", DAN SSSR, 1959, Vol 126, Nr 3). There are 8 figures and 8 Soviet references.

SUBMITTED: March 13, 1959

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

KULIKOVSKIY, A.G.; LYUBIMOV, G.A.

In connection with V.A.Belokon's article "Permanent structure of shock waves with Joule dissipation." Zhur.eksp.i teor.fiz. 37 no.4:1173-1174 O '59. (MIRA 13:5)
(Shock waves) (Belokon, V.A.)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

10(6), 21(7)
AUTHOR: Lyubimov, G. A. SOV/20-126-2-18/64

TITLE: A Shock Wave With a Discontinuity of the Conductivity of Gas in an Electromagnetic Field (Udarnaya volna so skachkom provodimosti gaza v elektromagnitnom pole)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 2, pp 291-294 (USSR)

ABSTRACT: A gas current passing through a strong shock wave is heated up to such temperatures at which the gas is dissociated and ionized. Under these conditions and in the presence of an external electromagnetic field, the gas current behind the shock wave must on no account be assumed to be non-conductive. Therefore, it is also of interest to investigate a shock wave with a discontinuity of gas conductivity on the front of this wave. The author here investigates a steady shock wave against which the current of a nonconductive gas (conductivity $\sigma_1 = 0$) flows. Behind the shock wave the conductivity of the gas is assumed to be infinitely great ($\sigma_2 = \infty$).

On the basis of these assumptions the relations on the shock wave (law of conservation for mass, momentum, energy, and for the tangential component of the electric field have the form

Card 1/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

A Shock Wave With a Discontinuity of the Conductivity of Gas in an Electromagnetic Field SOV/20-126-2-18/64

$$\rho_1 v_1 = \rho_2 v_2; \quad p_1 + \rho_1 v_1^2 + \frac{1}{8\pi} H_1^2 = p_2 + \rho_2 v_2^2 + \frac{1}{8\pi} H_2^2;$$

$$\rho_1 v_1 \left(\frac{v_1^2}{2} + i_1\right) - \frac{c}{4\pi} E_1 H_1 = \rho_2 v_2 \left(\frac{v_2^2}{2} + i_2\right) - \frac{c}{4\pi} E_2 H_2; \quad E_1 = E_2 = -\frac{1}{c} v_2 H_2$$

Here i denotes the heat content of the unit of mass of the gas, c - the velocity of light, and the remaining denotations are generally known. The given shock wave may also be determined as the limiting case of a certain constant steady solution of the equations of magnetic hydrodynamics with variable conductivity (if magnetic field strength increases during passage through the shock wave). If there is no electric field in front of the shock wave, the magnetic field also does not penetrate into the domain behind the shock wave. In this case a current of the density $\vec{I} = \frac{c}{4\pi}[\vec{n}\,\vec{H}_1]$ flows on the surface of the shock wave. In the case $E_1 = -(v_1/c)H_1 k$ (where $k = \rho_1/\rho_2$ holds in the ordinary gas dynamic shock wave with the same parameters of the oncoming flow), it follows that $H_1 = H_2$, i. e. there is no discontinuity of the magnetic field in such a

Card 2/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

wave, and the other quantities vary in the same manner as in an ordinary shock wave. The Hugoniot adiabatic of the shock wave under investigation has the equation

$$\varepsilon_2-\varepsilon_1+\frac{p_2+p_1}{2}(V_2-V_1)-\frac{1}{16\pi}(H_2^2-H_1^2)(V_2-V_1)-\frac{1}{4\pi}H_2V_2(H_1-H_2)=0$$

where ε denotes the internal energy of the unit of mass of the gas and V - the specific volume. With $H_1=H_2$ this adiabatic goes over into the ordinary Hugoniot-adiabatic, and with $E_1=0$ it has the form $\varepsilon_2-\varepsilon_1+\frac{p_2-p_1}{2}(V_2-V_1)+\frac{H_1^2}{16\pi}(V_1+V_2)=0$. Small disturbances with an infinite discontinuity of conductivity are impossible. Not only expansion discontinuities, but also compression discontinuities with a slight increase of pressure are forbidden. In the case of the permitted compression discontinuities higher degrees of compression are possible than in ordinary shock waves. With increasing pressure density behind these discontinuities decreases. As an example, the author investigates the steady flow of a gas current round plane contours, which takes place with supersonic velocity in an external

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

A Shock Wave With a Discontinuity of the Conductivity of Gas in an Electromagnetic Field SOV/20-126-2-18/64

electromagnetic field. In this case the conductivity of the gas behind the frontal shock wave becomes high at a very high velocity of the oncoming current, and within this range the equations of magnetic hydrodynamics must be applied. The problem of steadiness is not investigated. There are 2 figures.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

PRESENTED: February 11, 1959 by L. I. Sedov, Academician

SUBMITTED: February 5, 1959

Card 4/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

10 (7)

SOV/20-126-3-20/69

AUTHOR: Lyubimov, G. A.

TITLE: The Influence of an Electromagnetic Field on the Development of a Detonation (Vliyaniye elektromagnitnogo polya na rezhim detonatsii)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 3, pp 532-533 (USSR)

ABSTRACT: When solving the problem of the propagation of detonation waves of gases in electromagnetic fields, the fact must be taken into account that after the passage of the detonation wave the gas becomes electrically conductive. In the introduction to the present paper a steady detonation wave is investigated, and it is assumed that before the detonation wave the conductivity of the gas is equal to zero, and behind it, it is infinitely great. By basing on these assumptions, the conditions prevailing in the detonation wave are described by the system of equations (1), and for the adiabatic the equation (2) is given. In the first part of the paper a steady detonation wave without a field is first dealt with, and it is shown that in this case the aforementioned formula for the adiabatic goes over into that of the ordinary adiabatic. Next, the

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

The Influence of an Electromagnetic Field on the Development of a Detonation SOV/20-126-3-20/69

process in the case of the existence of a field is investigated, and a formula is given for the propagation rate of minor disturbances behind the wave, from which it follows that their propagation rate behind the wave is higher, so that a decrease of density and pressure takes place. In the second part a cylindrical detonation wave propagating in a medium of constant density is investigated, and $\vec{E}_1 = -\frac{1}{c}\left[\vec{v}\,\vec{H}_1\right]$ is assumed to hold. The system of equations (3) then describes the motion; as is shown by an analysis of this system, a decrease of pressure and density occurs, and it is impossible in ordinary cases to bring about this sort of detonation without loss of energy. There are 2 Soviet references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

PRESENTED: February 11, 1959, by L. I. Sedov, Academician

SUBMITTED: February 5, 1959

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

10(4) SOV/20-126-4-12/62

AUTHOR: Lyubimov, G. A.

TITLE: The Steady Flow Round a Corner of the Current of an Infinitely Conductive Gas (Statsionarnoye obtekaniye ugla potokom beskonechno provodyashchego gaza)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 4, pp 733 - 735 (USSR)

ABSTRACT: By means of the system of equations (1), the system of equations of magnetic hydrodynamics in the case of an infinitely great conductivity of the medium is represented in polar coordinates, and in the first part, the solutions of (1) are given for a progressive stream and a rotational wave according to Prandtl-Mayer. For the flow round an infinitely conductive angle there are solutions which depend only on the coordinate φ; the external magnetic field must be parallel to the surface of the angle. These solutions are developed and written down with the system of equations (6). For determination of the function $\varrho(\varphi)$ the ordinary differential equation (7) is integrated and then $\varrho(\varphi)$ is substituted into (6). Finally, the flow round of a non-conductive angle is dealt with. For the solution of this problem, the general system of equ.tions (1) must be calculated and with equation (8) the integral of this system is written

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

The Steady Flow Round a Corner of the Current of an Infinitely Conductive Gas SOV/20-126-4-12/62

down. The results obtained show that, if an infinitely conductive gas flows round an angle, the velocity v is equal to the velocity of sound, similar to what is the case in ordinary gas dynamics .There are 1 figure and 2 Soviet references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

PRESENTED: February 21, 1959, by L. I. Sedov, Academician

SUBMITTED: December 3, 1958

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

66467

~~24(7)~~ 10.2000(A) SOV/20-129-1-13/64

AUTHORS: Kulikovskiy, A. G., Lyubimov, G. A.

TITLE: Magnetohydrodynamic Gas-ionizing Shock Waves

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 129, Nr 1, pp 52-55 (USSR)

ABSTRACT: An electromagnetic wave may move in front of a shock wave in unsteady problems, in which shock waves ionize the gas, present in an electromagnetic field. For known velocity of the gas behind the shock wave, the boundary conditions in the shock wave (expressing the continuity of the tangential component of the electric field as well as the fluxes of matter, momentum, and energy) are not sufficient to determine simultaneously the intensities of the shock wave and of the emitted electromagnetic wave. An additional relation between quantities before and behind the shock wave is furnished by the investigation of the structure of the shock waves of the above type. This relation and, in consequence, the alteration of all quantities in the shock wave depends essentially on the amount of the relations between the dissipation coefficients (viscosity, thermal conductivity, and magnetic viscosity) in the transition zone.

Card 1/4

4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

66467

Magnetohydrodynamic Gas-Ionizing Shock Waves SOV/20-129-[illegible]

The electrical conductivity of the gases is considered as a function of temperature in the present paper: σ=σ(T). It is assumed that σ=0 if T < T* and σ > 0 for T > T*. The structure of a hydrodynamic shock wave, which moves in a gas at a temperature $T_1 < T^*$ was investigated by the authors. For simplicity only the cases are treated, in which only 2 dissipation coefficients, that are magnetic viscosity and molecular viscosity (or magnetic viscosity and thermal conductivity) are not equal to 0. The electric and the magnetic field are assumed to be perpendicular to each other and in parallel to the plane of the wave front. The rather extensive equations of the magnetohydrodynamics are written down for both cases and shortly explained. These differential equations fix the family of integral curves in the plane H, v (where it holds that σ > 0, $\nu_m \neq \infty$), H= const in the range T < T*. The shock wave may be represented by solutions of a [illegible] kind, which pass over into a progressive flow if x=±∞. For these solutions all derivations converge towards as x approaches ±∞. First, a gas, which moves from x=-∞, is subject to [illegible] [illegible] mechanical compression and at T > T* the gas starts to [illegible]

Card 2/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

with the magnetic field. The change of the magnetic field in the wave $H_2 - H_1$ is determined by the point of intersection of the integral curve and the line T_1T^*. This point of intersection depends on the characteristics of the incoming flow as well as on the ratio of the dissipation coefficients within the transition zone. The relation $H_1 = H_1(E_1, Q_1, T_1, v_1, y_1)$ ... an additional boundary condition on the substitution of a shock wave for a steady flow. If one of the dissipation coefficients is considerably greater than the others, this additional boundary condition may be ascertained in explicit form. The width of the shock waves is defined by the greatest ... of the dissipation coefficients. There are 1 figure and ... references, 3 of which are Soviet.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova Akademii nauk SSSR (Mathematical Institute imeni V. A. Steklov of the Academy of Sciences, USSR)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

66467

Magnetohydrodynamic Gas-Ionizing Shock Waves SOV/20-129-1-12/64

PRESENTED: June 30, 1959, by L. I. Sedov, Academician

SUBMITTED: June 20, 1959

Card 4/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

~~21 (7), 24 (3)~~ 24.2120, 10.2000(A) 66448

SOV/20-129-3-14/70

AUTHORS: Kulikovskiy, A. G., Lyubimov, G. A.

TITLE: The Simplest Problems Concerning a Gas-ionizing Shock Wave in an Electromagnetic Field

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 129, Nr 3, pp 525-528 (USSR)

ABSTRACT: If the conductivity of the gas before the shock wave vanishes and is finite behind the shock wave, the theorems of conservation read: $\rho_1 v_1 = \rho_2 v_2$, $p_1 + \rho_1 v_1^2 + (1/8\pi)H_1^2 =$

$$= p_2 + \rho_2 v_2^2 + (1/8\pi)H_2^2, \quad \rho_1 v_1\left(\frac{v_1^2}{2} + i_1\right) + (c/4\pi)E_1 H_1 =$$

$$= \rho_2 v_2\left(\frac{v_2^2}{2} + i_2\right) + (c/4\pi)E_2 H_2, \quad E_1 = E_2 = \frac{v_2}{c} H_2.$$

The electric and the magnetic field strength are, for the purpose of simplifying matters, assumed to be parallel to the wave front and perpendicular to each other. The shock waves ionizing a gas may be considered to be the limit of a certain continuous motion of a viscous heat-conducting gas, the conductivity σ of which is considered to be a known

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

66448

SOV/20-129-3-14/70

The Simplest Problems Concerning a Gas-ionizing Shock Wave in an Electromagnetic Field

function of the temperature T ($T < T^*$, $\sigma > 0$ at $T > T^*$). This as well as other facts mentioned here indicate the following: The solution of problems concerning ionizing shock waves will differ from the solutions of the corresponding problems in gasdynamics and magnetogasdynamics. This difference exists not only in the electromagnetic wave, but also in the variation of the gas-dynamical parameters of the motion. In gas-ionizing shock waves compression is not higher than in gas-dynamic shock waves and not less than in magnetogasdynamic shock waves which have the same parameters of the incoming flow and the same magnetic field strength before the discontinuity. Also the other quantities behind the gas-ionizing shock wave attain values which are between the corresponding values behind the gas-dynamic shock wave and a magnetogasdynamic shock wave. In the first part of the present paper the problem of the motion of a plane piston is dealt with. In this case the presence of an electromagnetic field increases the velocity of the shock wave and reduces the compression in it compared to the gasdynamic solution at the same piston velocity. The second part deals with the flow

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

The Simplest Problems Concerning a Gas-ionizing Shock Wave in an Electromagnetic Field

66448
SOV/20-129-3-14/70

round a wedge. The velocity component which is tangential with respect to the shock wave remains conserved during passage through the shock wave, and the variations of normal velocity and of the other quantities may be dealt with in the same manner as in the first part. A surface charge must exist on the shock wave. There are 2 figures and 3 Soviet references.

PRESENTED: July 14, 1959, by L. I. Sedov, Academician

SUBMITTED: July 7, 1959

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

KULIKOVSKIY, A.G. and LYUBIMOV, G.A.

"On Gas-Ionizing Magnetohydrodynamic Shock Waves."

report presented at the Intl Symposium on Magneto-Fluid Dynamics, 17-24 Jan 1960, Wash., Comments - P 3,151,585, 24 Feb 60.

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G.A.; LYU CHAN'-SHEN' [Liu Ch'an- shên]

Testing the elastic materials of a turbodrill shoe under static and dynamic load conditions. Izv. vys. ucheb. zav.; neft' i gaz 3 no.11:25-32 '60. (MIRA 14:1)

1. Moskovskiy institut neftkhimicheskoy i gazovoy promyshlennosti imeni akademika I.M. Gubkina i Vsesoyuznyy nauchno-issledovatel'skiy institut burovoy tekhniki.
(Turbodrills—Testing)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394
S/040/61/025/001/013/022
B125/B204

10.8000
21.2311

AUTHORS: Kulikovskiy, A. G., Lyubimov, G. A. (Moscow)

TITLE: The structure of an inclined magnetohydrodynamic shock wave

PERIODICAL: Prikladnaya matematika i mekhanika, v. 25, no. 1, 1961, 125-131

TEXT: The present paper investigates the flow within the zone of the shock wave when the dissipation of energy in the wave is caused by magnetic viscosity and by the second kinematic viscosity. In the problem of the structure of a magnetohydrodynamic shock wave, the solutions of the equations of the magnetohydrodynamics of a non-perfect gas are to be determined, whose values with $x = \pm\infty$ satisfy the known laws of conservation. If only the magnetic viscosity and the second viscosity are non-vanishing, the equations of the steady onedimensional flows of a perfect gas read

$$\nu_m \frac{dH}{dx} = uH - vH_n + cE, \quad \mu \frac{du}{dx} = p + \rho u^2 + \frac{1}{8\pi} H^2 - J_1$$

$$\rho uv - \frac{1}{4\pi} H_n H = J_2, \quad \rho u = M, \quad H_n = \text{const} \qquad (1)$$

$$\rho u \left[\frac{\gamma}{\gamma - 1} \frac{p}{\rho} + \frac{1}{2}(u^2 + v^2)\right] - \frac{cEH}{4\pi} = U \quad .$$

Card 1/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394

S/040/61/025/001/013/022
B125/B204

The structure of an inclined...

They refer to a system of coordinates, in which the flow is plane. H_n, H, u, v are the components of the magnetic field and of the velocity along the x- and y-axis, E - the z-component of the electric field, c - velocity of light; J_1, J_2 - the fluxes of the x- and y-components of the momentum, U - the energy flux, M - the mass flux. With the dimensionless variables $u = u_0\tau$, $v = u_0 q$, $p = \varrho_0 u_0^2 \theta$, $H = \sqrt{4\pi\varrho_0 u_0^2}\, h$ (2) one obtains

$$\frac{\nu_m}{u_0}\frac{dh}{dx} = h(\tau - h_n^2) - e, \qquad \frac{\mu}{\rho_0 u_0}\frac{d\tau}{dx} = \theta + \tau + \frac{1}{2}h^2 - P$$

$$q - h_n h = 0, \qquad k\theta\tau + \frac{1}{2}\tau^2 + \frac{1}{2}h_n^2 h^2 + eh = \varepsilon \qquad (3).$$

$$\left(k = \frac{\gamma}{\gamma - 1},\ h_n = \frac{H_n}{\sqrt{4\pi\rho_0 u_0^2}},\ e = -\frac{cE}{\sqrt{4\pi\rho_0 u_0^2}};\ P = \frac{J_1}{\rho_0 u_0^2},\ \varepsilon = \frac{U}{\rho_0 u_0^3}\right).$$

Furthermore, $e = h_0(1 - h_n^2)$, $P = 1 + \theta_0 + \frac{1}{2}h_0^2$, $\varepsilon = k\theta_0 + \frac{1}{2} + h_0^2(1 - \frac{1}{2}h_n^2)$ holds. Besides, everywhere $e > 0$ is assumed. For reasons of simplicity, here $\gamma < 2$ is assumed. The real points of the isoclinal line $d\tau/dx = 0$

Card 2/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394

S/040/61/025/001/013/022
B125/B204

The structure of an inclined...

are on both sides of the hyperbola $h = e/(k\tau - h_n^2)$. The maxima and minima of the isoclinal line are on this hyperbola on such points τ, where the discriminant of $h^2(k\tau - h_n^2) - 2eh + (2k-1)\tau^2 - 2kP\tau + 2\varepsilon = 0$ (6) is equal to zero. The isoclinal line $d\tau/dx = 0$ has the asymptote $\tau = h_n^2/k$. With increasing α the roots of $D(\tau) = 2\alpha(P-1)\left[(1-kh_n^2)+k(h_n^2+k-2)\tau\right]-(k\tau-h_n^2)\left[(2k-1)\tau^2 - 2kP\tau + 2k(P-1)+1\right]$ change monotonically. In the plane of the variables $P - 1 = \frac{1}{2}h_o^2 + \theta_o$ and h_n^2, there is a curve which separates the domain of existence of the three roots of the discriminant from that of a single root with $\theta_o = 0$ ($\alpha = 1$) (see Fig.1, curve ABCD). The curve ECF illustrating the equation $\tau = \tau_*$ touches the curve ABCD at the point C. To the left of ABCF, the discriminant has three roots with small α, and with large α it has one root. For the remaining points of the variable $P-1, h_n^2$, the discriminant, with small and large α, has three roots, but with intermediary values of α, it has one single root. Case a): In the

Card 3/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394

S/040/61/025/001/013/022
B125/B204

The structure of an inclined...

case of points lying simultaneously below the straight line $\tau_1 = h_2^2/k$ and $h_n^2/k = 1$, two roots of the discriminant are greater than h_n^2/k, and one is smaller than h_n^2/k. Case b): In all other cases with three roots, one root is greater than h_n^2/k, and the two others are smaller. These properties permit the construction of the isoclinal line. For points above the straight line $\tau = h_n^2$, the velocity is greater than Alfvèn velocity $a_A = H_n/\sqrt{4\pi\varrho_0}$, and for points below this straight line it is smaller than Alfvèn velocity. To the states before and behind the shock wave there correspond the points of intersection of the isoclinal lines (6) and (8). To the solution of the problem of the structure of the shock wave, there corresponds the integral curve of the Eq. (9)

$$\frac{d\tau}{dh} = \frac{h^2(k\tau - h_n^2) - 2eh + (2k-1)\tau^2 - 2kP\tau + 2\varepsilon}{2k\tau\left[h(\tau - h_n^2) - e\right]}$$

, which connects the singular

Card 4/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394

S/040/61/025/001/013/022
B125/B204

points lying in the region $\tau > 0$. With continually decreasing velocity, the following singular points are possible: 1) Nodes, 2) saddle, 3) saddle, 4) nodes, into which the integral curves lead. If the curves (6) $h^2(k\tau - h_n^2) - 2eh + (2k-1)\tau^2 - 2kP\tau + 2\varepsilon = 0$ have the shape indicated in Figs.2 and 4, then all singular points lie on the same branch of the curve (6). In Figs. 5 and 7 $\mu/\varrho_0\nu_m$ is either small or large, respectively. In Fig.6, the single value of $\mu/\varrho_0\nu_m$, at which the integral curve emerging from point 2 runs into point 3, corresponds to the value of $(\mu/\varrho_0\nu_m)_*$. The fast and the slow waves thus have a structure with an arbitrary ratio of dissipative coefficients. In four singular points the structure may also have intermediary shock waves. The transition 2⟶3 is possible only in the case of $\frac{\mu}{\varrho_0\nu_m} = \left(\frac{\mu}{\varrho_0\nu_m}\right)_*$, the transitions 1⟶3 and 2⟶4 exist and are unique with $\frac{\mu}{\varrho_0\nu_m} > \left(\frac{\mu}{\varrho_0\nu_m}\right)_*$, $\frac{\mu}{\varrho_0\nu_m} > \left(\frac{\mu}{\varrho_0\nu_m}\right)_*$, and the transition 1⟶4 is possible with

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

89394

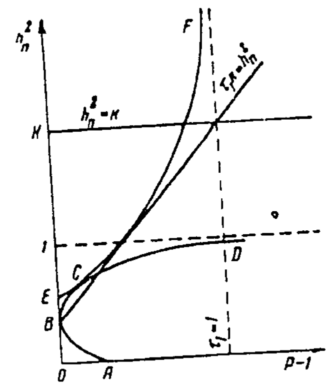
S/040/61/025/001/013/022
B125/B204

The structure of an inclined...

and may also occur on an infinite number of integral curves. The structure of the "evolution" shock waves (in the sense of A. I. Akhiyezer et al.) differs from the structure of the non-evolution shock waves by the fact that only they have a structure at any ratio between the dissipative coefficients. A. N. Voynov is mentioned. There are 7 figures and 4 references: 2 Soviet-bloc and 3 non-Soviet-bloc.

SUBMITTED: July 16, 1960

Fig. 1



Фиг. 1

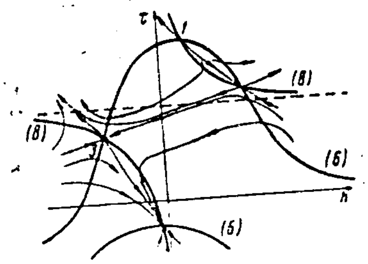
Card 6/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

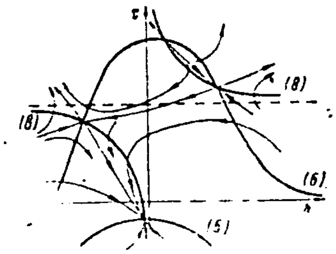
S/040/61/025/001/013/022
B125/B204

The structure of an inclined...



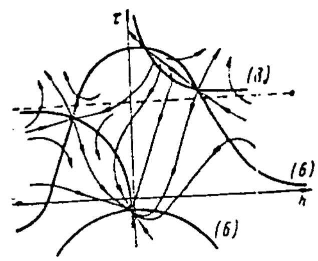
Фиг. 5

Fig. 5



Фиг. 6

Fig. 6



Фиг. 7

Fig. 7

Card 7/7

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

10.2000
26.1410
24.2120

S/040/61/025/002/0[illegible]1/022
D201/D302

AUTHOR: Lyubimov, G.A. (Moscow)

TITLE: The structure of magneto fluid dynamic shock waves in a gas with anisotropic conductivity

PERIODICAL: Prikladnaya matematika i mekhanika, v. 25, no. 2, 1961, 179 - 186

TEXT: For a gas with anisotropic conductivity flowing in a magnetic field which must be wide enough to allow for a [illegible] movement of electrons the following will apply:

$$\omega\tau \quad 1 \qquad \left(\omega = \frac{eH}{m_e c}\right) \qquad (1)$$

where ω - Larmor's frequency; τ - time between collisions of electrons and ions. If Eq. (1) is to hold true for the ionization of gas, Ohm's law must be satisfied according to T. Kautling (Ref. 1: Magnitnaya gidrodinamika, Izd. inostr. lit., 1959).

Card 1/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

20492
S/040/61/025/002/001/022
D201/D302

The structure of magneto ...

$$\sigma(E + \frac{1}{c} v \cdot H + \frac{1}{ne} \text{grad } p_e) = j + \frac{\omega\tau}{H} j \cdot H \qquad (2)$$

where σ - conductivity in the absence of magnetic field; p_e - press of electrons; n - number of electrons in unit volume; e - electrons charge. Hence one can assume hydrodynamic conditions within the gas. To investigate the structure of the shock wave one assumes that it occupies a narrow zone in the current field. In this zone, the parameters of the current change slowly. As the wave dies away the current becomes steady. It is assumed that in the core of the wave, only dissipation energy of electric current is of any importance. The x-axis is taken at right angles to the normal of a wave's surface and the y and z lie in the wave's plane. Then, for the core of the wave (Maxwell's equations being satisfied) the dimensionless condition

$$u = u_o u^*, \quad v = u_o v^*, \quad w = u_o w^*, \quad RT = \theta u_o^2, \quad u^* p = \rho_o u_o^2 \theta \qquad (5)$$

$$H_i = \sqrt{8\pi\rho_o u_o^2 h_i} \quad (i = x, y, z)$$

Card 2/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

S/040/61/025/002/001/022
D201/D302

holds, where θ - temperature, h_i - the dimensionless component of the vector of magnetic field intensity, u*, v*, w* - dimensionless components of velocity [Abstractor's note: Other symbols not defined]. Before the shock-wave

$$w_0 = H_{z0} = J_3 = 0 \qquad (6)$$

holds. [Abstractor's note: J = J_1, J_2, J_3, not defined]. Simplifying and eliminating gives

$$\tfrac{1}{2}(\gamma + 1)u^{*2} + \gamma u^*(h_y^2 + h_z^2) - 2(\gamma - 1)h_x^2(h_y^2 + h_z^2) - \qquad (10)$$

$$-\gamma J_1^* - 2(\gamma - 1)J_2^* h_x h_y - \tfrac{1}{2}(\gamma \text{ [illegible] } 1) \text{ [illegible] } (\gamma - 1)\varepsilon^* = 0$$

where asterisks denote dimensionless coordinates, and the vectors U and H are known to be parallel before and after the wave. Eq. (10) determines the structure of the shock wave. If h_z = 0, (10) gives the curve for the structure of a magneto-hydrodynamic shock-

Card 3/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

S/040/61/025/002/001/022
D201/D302

wave in an isotropic gas. If only one dissipation coefficient σ is given then

$$\frac{1}{2}(\gamma + 1)u^{*2} + \gamma u^* h_y^2 + 2(\gamma - 1)h_x^2 h_z^2 - \gamma J_1^* u^* - 2(\gamma - 1) J_2^* h_x h_y - \frac{1}{2}(\gamma - 1) J_2^{*2} - (\gamma - 1)\varepsilon^* = 0 \quad (11)$$

The surface expressed by Eq. (10) is found along the perpendicular axis u* whose center lie on the hypertola

$$h_y = \frac{(\gamma - 1) J_2^*}{\gamma u^* - 2(\gamma - 1) h_x^2}. \quad (12)$$

In the case $x = \pm \infty$,

$$(u^* - 2h_x^2)(\alpha^* h_x h_y + h_z) - \alpha^* h_x^2 J_2^* = 0 \quad (13)$$

$$(u^* - 2h_x^2)(h_y - \alpha^* h_x h_z) - h_x J_2^* = 0 \quad (14)$$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

From the above statements one may determine that in the vicinity of u^*, h_y, h_z, corresponding to conditions before and after the wave, must lie intersections of the surface expressed in (10) and hyperbolic cylinders Eq. (13) and Eq. (14). Also Eqs. (13) and (14) lie on the hyperbola

$$(u^* - 2h_x^2)\, h_y - h_x J_2^* = 0 \qquad (15)$$

which lies in the plane $h_z = 0$. Therefore it is seen that a point after and before the wave lies in the plane $h_z = 0$ and occurs at the points of intersection of the curves (11) and (15). The intersections of curves (11) and (15) depend on parameters before and after the shockwave. Investigating local properties of intersection points of the curves (11) and (15) one assumes that $u^* = 1$, $h_y = h_{yo}$, $h_z = 0$. This may be obtained by scaling down coordinates of the axis. Individual points of intersection may be distinguished by considering the discriminant D,

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

23492
S/040/61/025/002/001/022
D201/D302

The structure of magneto ...

$$D = \left[-\frac{h_{y0}^2}{1-\gamma\theta_0} + (1-2h_x^2) \right]^2 + (1-2h_x^2) \left[\frac{2h_{y0}^2}{1-\gamma\theta_0} - (1-2h_x^2) \right] \times$$
$$\times (1+\alpha^{*2}h_x^2) = \frac{h_{y0}^4}{(1-\gamma\theta_0)^2} + \alpha^{*2}h_x^2(1-2h_x^2)h_{y0}\left[\frac{2h_{y0}}{1-\gamma\theta_0} - \frac{1-2h_x^2}{h_{y0}} \right] \qquad (23)$$

If $D > 0$, then the point is a node if

$$\frac{2h_{yo}}{1-\gamma\theta_o} > \frac{1-2h_x^2}{h_{yo}} \qquad (21)$$

is satisfied, and a saddle-point if

$$\frac{2h_{yo}}{1-\gamma\theta_o} < \frac{1-2h_x^2}{h_{yo}}. \qquad (20)$$

If $D < 0$ the point is a focus. In the case of rapid waves all nodes and foci are initial, and in the case of slow waves the inte-

Card 6/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

28492
S/040/61/025/002/001/022
D201/D302

The structure of magneto ...

gral curves always pass through nodes and foci. The author concludes that the current in the internal zone depends primarily on the spiral flow of electrons and on the wave i... elf (fast or slow). Inside the wave, vectors of intensity of a magnetic field may change over if there is a large spiral flow of electrons. This movement does not follow the rotation of vector H around one x-axis. If the spiral flow of electrons tends to zero ($\alpha^* \to 0$) then the shock wave changes to an ordinary magneto-fluid dynamic shock-wave. Beyond the amplitude of the shockwave, if it is strong, there may exist a region where magnetic field is the same as in the front of the shock wave. If this is so, with $\omega\tau \sim 1$, becomes

$$l \sim \frac{c^2}{4\pi\sigma u_0}(1 + \alpha^2 H_x^2) \sim \frac{c}{4\pi\sigma u_0}(1 + \omega^2\tau^2)$$

or with $\omega\tau \gg 1$

$$l \sim \frac{c^2}{4\pi\sigma u_0}\frac{1 + \alpha^2 H_x^2}{\alpha H_x} \sim \frac{c^2}{4\pi\sigma u_0}\omega\tau$$

Card 7/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

Hence the amplitude of the magneto-fluid-dynamic shockwave in an isotropic gas is greater than an ordinary magneto-fluid-dynamic wave, and, therefore, for large spiral flow of electrons ($\omega\tau$ 1), the amplitude of the shockwave in an isotropic gas conforms with Larmor's radius for ions

$$l \sim \frac{c^2}{4\pi\sigma u_0}\omega\tau = \frac{cH}{4\pi u_0 nl} \sim \frac{cH^2 u_0 m_i}{4\pi\rho u_0^2 lH} \sim R_i$$

In this case energy of the magnetic field is equal to the mean vinematic energy ($H^2/8\pi \sim u_0^2$). Projecting Eq. (2) on the x-axis gives

$$-\frac{\omega\tau}{H}\frac{d}{dx}(H_y^2 + H_z^2) = \frac{\sigma}{c}(vH_z - wH_y) + \frac{1}{ne}\frac{dp_e}{dx} + \sigma E_x \qquad (24)$$

This equality can be used in determining $E_x(x)$ when p_e is known. If the random velocities of ions and electrons are of the same order and are expressed in whole numbers, then $2\,p_e = p$ ($p_1 = p_e$).

Card 8/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

28492
S/040/61/025/002/001/022
D201/D302

The structure of magneto ...

With $E_x(x)$ known, equality $dE_x/dx = 4\pi p_e$ determines the density of charge inside the wave as a function of x. There are 4 figures and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc.

SUBMITTED: July 16, 1960

Card 9/9

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26734
S/040/61/025/003/011/026
D208/D304

1327
2207
24.2120

AUTHORS: Baranov, V.B., and Lyubimov, G.A. (Moscow)

TITLE: Generalized Ohm's law in a completely ionized gas

PERIODICAL: Akademiya nauk SSR. Otdeleniye tekhnicheskikh nauk. Prikladnaya matematika i mekhanika, v. 25, no. 3, 1961, 468 - 472

TEXT: In deriving equations of motion of fully ionized gas and relations connecting current density with other parameters, the concept of a binary (electron-ion) mixture is used. Here the problem considered is that of the influence of viscosity of the components on the equation for the curr t density of generalized Ohm's law and the dimensionless criteria are given which influence the final form of the generalized Ohm's law for a completely ionized gas. The gas is assumed to consist of the electrons and singly charged ions and their number per unit volume to be n. The equations of motion for each component are

Card 1/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

$$m_e n \frac{d_e \mathbf{v}_e}{dt} = -\nabla p_e - \operatorname{div} \pi_e - en\left(\mathbf{E} + \frac{1}{c}[\mathbf{v}_e \times \mathbf{H}]\right) + \mathbf{R}_e \qquad (1)$$

$$m_i n \frac{d_i \mathbf{v}_i}{dt} = -\nabla p_i - \operatorname{div} \pi_i + en\left(\mathbf{E} + \frac{1}{c}[\mathbf{v}_i \times \mathbf{H}]\right) + \mathbf{R}_i \qquad (2)$$

$$\frac{d_e}{dt} = \frac{\partial}{\partial t} + \mathbf{v}_e\nabla, \quad \frac{d_i}{dt} = \frac{\partial}{\partial t} + \mathbf{v}_i\nabla$$

where m_e, m_i = mass of the electron and iron respectively ($m_e \ll m_i$) v_e, v_i = macroscopic velocities; p_e, p_i = partial pressures; π_e, π_i = tensors of viscous stresses for the electron and ion gas respectively, e = electron charge, E and H = intensities of electric and magnetic fields, and $R_e = - R_i$. If also $m_e v_{ex}^2 \ll m_i v_{ix}^2$, $p_e \approx p_i = 1/2$ p, then

$$en\left(-\frac{d_e \mathbf{v}_e}{dt} + \frac{d_i \mathbf{v}_i}{dt}\right) = \frac{e}{m_e}\nabla p_e + \operatorname{div}\left(\frac{e}{m_e}\pi_e - \frac{e}{m_i}\pi_i\right) + \frac{e^2 n}{m_e}\left(\mathbf{E} + \frac{1}{c}[\mathbf{v} \times \mathbf{H}]\right) - \frac{e}{m_e c}[\mathbf{j} \times \mathbf{H}] - \frac{e^2 n}{m_e}\frac{1}{\sigma}\mathbf{j} \quad (m_e \ll m_i) \qquad (3)$$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26734
S/040/61/025/003/011/026
D208/D304

$$\sigma = \frac{ne^2\tau_e}{m_e}, \qquad j = -en(v_e - v_i) \tag{3}$$

where σ = conductivity of the gas in the absence of magnetic field. j = current density, τ_e - time between two electron-ion collisions. If in addition $m_i v_i \gg m_e v_e$ and $v \sim v_i$, $v_e \sim v - \frac{1}{en} j$, then together with the continuing $\frac{dn}{dt} + n \operatorname{div} v = 0$

$$\frac{dj}{dt} + j \operatorname{div} v + (j\nabla)v - (j\nabla)\frac{j}{en} = \frac{e^2n}{m_e}\frac{1}{\sigma} j + \frac{e^2n}{m_e}\left(E + \frac{1}{c} v \times H\right) - \tag{4}$$

$$- \frac{e}{m_e c} j \times H + \frac{e}{m_e} \nabla p_e + \operatorname{div}\left(\frac{e}{m_e}\pi_e - \frac{e}{m_i}\pi_i\right)$$

is obtained. It is assumed that characteristic time $t \gg \max\{\tau_e,$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

τ_i). When the electromagnetic field influences the motion and viscous forces are present,

$$\rho V^2 \sim \frac{1}{c} jHL, \text{ or } j \sim \frac{nm_i V^2 c}{HL} \quad (\rho = n(m_e + m_i) = nm_i) \qquad (5)$$

and

$$\eta \frac{V}{L} \sim V^2 \text{ or } \eta \sim nm_i VL \quad (\eta = 0.96 nT\tau_i) \qquad (6)$$

where V, L = characteristic velocity and length associated with the problem. T = temperature. From Eqs. (5), (6) the following expressions are obtained for the terms of (4).

$$A_1 = j \operatorname{div} v \sim (j\nabla) v \sim \frac{enm_i V^2 cV}{eHL^2} = enV \frac{\Omega^2}{\omega_i}$$

$$A_2 = (j\nabla) \frac{j}{en} \sim \frac{nm_i V^2 c\, nm_i V^2 c}{HL\, enL\, HL} = enV \frac{\Omega^3}{\omega_i^2}$$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26734
S/040/61/025/003/011/026
D208/D304

Generalized Ohm's law in a ...

$$A_3 = \frac{e^2 n}{m_e}\frac{1}{\sigma}\mathbf{j} = \frac{\mathbf{j}}{\tau_e} \sim \frac{n m_i V^2}{H L \tau_e} \sim enV\frac{\Omega}{\omega_i \tau_e}$$

$$A_4 = \frac{e^2 n}{m_e}\mathbf{E} \gtrsim \frac{e^2 n}{m_e c}[\mathbf{v} \times \mathbf{H}] \sim enV\omega_e$$

$$A_5 = \frac{e}{m_e}\nabla p_e \lessgtr \frac{e}{m_e c}\mathbf{j} \times \mathbf{H} \sim \frac{e}{m_e c}\frac{n m_i V^2 c}{HL} H = enV\frac{m_i}{m_e}\Omega$$

$$A_6 = \frac{\partial}{\partial x}\left[0.96\, enT\frac{\tau_e}{m_e}\frac{\partial w}{\partial z}\right] \sim 0.96\, nT\tau_i\frac{e}{m_e}\frac{\tau_e}{\tau_i}\frac{V}{L^2} =$$

$$= \eta\frac{e}{m_e}\frac{V}{L^2}\sqrt{\frac{m_e}{m_i}} \sim enV\sqrt{\frac{m_i}{m_e}}\Omega$$

$$A_7 = \frac{\partial}{\partial x}\left[0.96\, enT\frac{\tau_e}{m_e}\frac{\partial}{\partial z}\frac{j_z}{en}\right] \sim 0.96\, nT\tau_i\frac{\tau_e}{\tau_i}\frac{n m_i e V^2 c}{H L e n m_e L^2} =$$

$$= \eta\frac{\tau_e}{\tau_i}\frac{m_i}{m_e}\frac{eV^2 c}{eHL^3} \sim enV\sqrt{\frac{m_i}{m_e}}\frac{\Omega^2}{\omega_i}$$

$$\left(\Omega = \frac{V}{L} = \frac{1}{t},\ \frac{\Omega}{\omega_i} \sim \frac{v_e - v_i}{V}\right)$$

Card 5/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26734
S/040/61/025/003/011/026
D208/D304

Generalized Ohm's law in a ...

where Ω = characteristic frequency and all the terms of Eq. (4) are expressed in dimensionless parameters Ω/ω_i and $\omega_e\tau_e$. The final form of Ohm's law will depend on those parameters, and the following cases are considered: 1) $\Omega/\omega_i \ll 1$, $\omega_e\tau_e \ll 1$; 2) $\Omega/\omega_i \ll 1$, $\omega_e\tau_e \simeq 1$; 3) $\Omega/\omega_i \ll 1$, $\omega_e\tau_e \gg 1$; 4) $\Omega/\omega_i \simeq 1$, $\omega_e\tau_e \ll 1$; 5) $\Omega/\omega_i \simeq 1$; $\omega_e\tau_e \simeq 1$; 6) $\Omega/\omega_i \simeq 1$, $\omega_e\tau_e \gg 1$; 7) $\Omega/\omega_i \gg 1$, $\omega_e\tau_e \ll 1$; 8) $\Omega/\omega_i \gg 1$, $\omega_e\tau_e \simeq 1$; 9) $\Omega/\omega_i \gg 1$, $\omega_e\tau_e \gg 1$. The result shows that in deriving Ohm's law for a binary model of a completely ionized gas, the viscosity terms can be neglected. There are 3 Soviet-bloc references.

SUBMITTED: March 4, 1961

Card 6/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26124

S/040/61/025/004/003/021
D274/D306

26.2311

AUTHOR: Lyubimov, G.A. (Moscow)

TITLE: On the form of Ohm's law in magneto-hydrodynamics

PERIODICAL: Prikladnaya matematika i mekhanika, v. 25, no. 4, 1961, 611-622

TEXT: A generalized form of Ohm's law is derived for a quasi-neutral medium consisting of electrons, ions and neutral atoms, in the presence of a space charge ρ_e. The limits of applicability of the obtained relationships are discussed, as well as the possible use (in concrete cases) of various forms of Ohm's law. Basic equations of the motion of the medium are then discussed, consisting of electrons, ions and neutral atoms. A very simple model is considered, in which the electrons, ions and neutral atoms are ideal gases. The degree of ionization is defined as $\alpha = n / (n + n_\alpha)$ (1.1) n is the number of ions and n_α that of neutral atoms. Formulas are given for the pressure p, the momentum J, velocity v, and for the motion of electron- and ion gases respectively. The equation of

Card 1/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26174

S/040/61/025/004/003/021
D274/D306

On the form of Ohm's law...

motion of the gas mixture is

$$m_i(n + n_a)\frac{dv}{dt} = - \text{grad } p - n'eE - \frac{e}{c}[nV_e + n'(v + v_i)] \times H \quad (1.8)$$

where m_i is the ion mass, $n + n'$ is the number of electrons; formula

$$j = \sum_k n_k e_k v_k = -(n + n')e(v + v_i + v_e) + + ne(v + v_i) = -nev_e - n'e(v + v_i)$$

was used which defines the current density, and $n' \ll n$. The derivation of the generalized Ohm law is then looked at. A number of assumptions are made

$$T \gg \max\{\tau, \tau_e, \tau_i\} \quad v_i \ll v_{ix}, \; |v_i + v_e| \ll v_{ex}, \quad |v - v_a| < v_{ax} \quad (2.1)$$

where T is the characteristic time, related to the characteristic dimension (length) L and the characteristic velocity U, by $U = L/T$; v_{ix}, v_{ex}, v_{ax} are the random velocities of ions, electrons, and neutral atoms, respectively; τ, τ_e, τ_i are the collision times between electrons and ions, electrons and atoms, and ions and atoms, respectively. The notations are introduced:

Card 2/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26124
S/040/61/025/004/003/021
D274/D306

$$j = -nev_e - n'e(v + v_i), \quad j_i = nev_i$$

$$\varkappa \equiv \frac{1}{\omega_e \tau} = \frac{cm_e}{eH}\tau^{-1}, \quad \varkappa_e \equiv \frac{1}{\omega_e \tau_e} = \frac{cm_e}{eH}\tau_e^{-1}, \quad \varkappa_i \equiv \frac{1}{\omega_i \tau_i} = \frac{1}{2}\frac{cm_i}{eH}\tau_i^{-1} \qquad (2.3)$$

where ω_e and ω_i are the Larmor frequencies of electrons and ions. Finally the generalized Ohm law is obtained:

$$\begin{aligned} &-[\operatorname{grad} p_e + \beta(\alpha \operatorname{grad} p - \operatorname{grad}(p_i + p_e))] - ne\left(E + \frac{1}{c} v \times H\right) + \\ &+ \left[1 - 2(1-\alpha)\beta - \alpha \frac{\varkappa_i}{\varkappa_e + \varkappa_i}\frac{m_e}{m_i}\right]\frac{1}{c} j \times H + \beta\alpha n'eE - \\ &- \frac{1-\alpha}{c}\left(\beta + \frac{\alpha}{1-\alpha}\frac{m_e}{m_i}\frac{\varkappa_i}{\varkappa_e + \varkappa_i}\right)en'v \times H + \left[\varkappa + (1-\beta)\varkappa_e - \right. \\ &\left. - \beta\frac{\alpha}{1-\alpha}\frac{m_e}{m_i}\varkappa_i\right]\frac{H}{c}(j + n'ev) - \frac{1-\alpha}{H(\varkappa_e + \varkappa_i)}\left\{[\alpha \operatorname{grad} p - \right. \\ &\left. - \operatorname{grad}(p_e + p_i)] \times H + \frac{1-\alpha}{c} j \times H \times H - (1-\alpha)n'eE \times H\right\} = \\ &= -\varkappa\frac{n'}{n}\frac{1-\alpha}{\varkappa_e + \varkappa_i}\left[\alpha \operatorname{grad} p - \operatorname{grad}(p_e + p_i) - (1-\alpha)n'eE + \right. \\ &\left. + (j + n'ev)\frac{H}{c}\left(\varkappa_e + \frac{\alpha}{1-\alpha}\frac{m_e}{m_i}\varkappa_i\right) + \frac{1-\alpha}{c} j \times H\right] \\ &\left(\beta = \frac{\varkappa_e}{\varkappa_i + \varkappa_e}\right) \end{aligned} \qquad (2.8)$$

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26124
S/040/61/025/004/003/021
D274/D306

On the form of Ohm's law...

(for partially-ionized gases). Simplifying assumptions are made which lead to simpler forms of the law. For not highly rarefied gases and moderate temperatures:

$$- \text{grad}\, p_e - ne\left(E + \frac{1}{c} v \times H\right) + \frac{1}{c} j \times H + \frac{\varkappa + \varkappa_e}{c} H (j - \rho_e v) -$$

$$- \frac{(1-\alpha)^2}{H \varkappa_i} \left\{ - \frac{\alpha}{\alpha + 1} \text{grad}\, p \times H + \frac{1}{c} j \times H \times H + \rho_e E \times H \right\} = 0 \qquad (2.12)$$

For a completely ionized gas:

$$- \text{grad}\, p_e - ne\left(E + \frac{1}{c} v \times H\right) + \frac{1}{c} j \times H + \frac{\varkappa}{c} H (j - \rho_e v) = 0 \qquad (2.13)$$

In concrete problems, it may turn out that some of the terms in Eq. (2.12) are negligibly small, hence simpler forms of the generalized law can be used. The relative magnitude of the terms entering Eq. (2.12) is evaluated. It is found that the relative magnitude of these terms is determined by the value of the following dimensionless parameters:

$$\omega_e \tau^*, \; \frac{1}{\alpha} \frac{\Omega}{\omega_i}, \; \frac{(1-\alpha)^2}{\varkappa_i}, \; \frac{2(1-\alpha)T_i}{\alpha T}, \; \frac{1}{\alpha} \frac{\Omega}{\omega_i} (\omega_e \tau^*)^{-1} \qquad (3.19)$$

Card 4/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26124
S/040/61/025/004/003/021
D274/D306

On the form of Ohm's law...

which are related to the physical properties of the medium and to the specific conditions of the problem; Ω is the characteristic frequency; τ^* is defined by $\frac{1}{\tau^*} = \frac{1}{\tau} + \frac{1}{\tau_e}$ (3.11)

The values of each of these parameters are discussed for various conditions of pressure, temperature, strength of magnetic field, etc; this leads to conclusions regarding the value of the various terms of Eq. (2.12) and their possible neglecting. Thus e.g. the parameter $[2(1 - \alpha)/\alpha]\tau_i/T$ which determines the relative magnitude of the terms $(\sigma/c)\, v \times H$ and $c^{-1}\, j \times H \times H$, can (by virtue of Eq. (2.1) be comparable to unity in case of a very small degree of ionization only; σ is the conductivity. It is noted that the above evaluation was carried out for quantities L, U and T which are the same for all mechanical and electromagnetic magnitudes; hence these estimates cannot be used for all problems, but other, analogous, estimates can be made. There are 9 references: 5 Soviet-bloc and 4 non-Soviet-bloc. The references to the English-language publications read as follows: T. Kihara, Macroscopic Foundation of Plasma Dynamics. J.

Card 5/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

26124

On the form of Ohm's law... S/040/61/025/004/003/021
D274/D306

Phys. Soc. of Japan, 1958, v. 13, no. 5; L. Steg and G.W. Sutton, The prospects of MHD power generation. Astronautics, 1960, v. 5, no. 8.

SUBMITTED: April 7, 1961

Card 6/6

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G. A

PHASE I BOOK EXPLOITATION SOV/6191

Kulikovskiy, Andrey Gennadiyevich, and Grigoriy Aleksandrovich Lyubimov

Magnitnaya gidrodinamika (Magnetohydrodynamics) Moscow, Fizmatgiz, 1962. 246 p. 7500 copies printed.

Ed.: V. P. Korobeynikov; Tech. Ed.: K. F. Brudno.

PURPOSE: This book is intended for persons working in the field of magnetohydrodynamics.

COVERAGE: The book contains systematized basic principles of magnetohydrodynamics, presents relationships resulting from interaction of a conducting medium with an electromagnetic field, and investigates the possibility of obtaining exact solutions for magnetohydrodynamic equations. The author thanks M. N. Kogan and V. P. Korobeynikov for their advice. There are 134 references, about two-thirds of them Soviet.

Card 1/4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

38092

S/040/62/026/003/015/020
D407/D301

26.2331

AUTHOR: Lyubimov, G.A. (Moscow)

TITLE: On solving magnetohydrodynamic problems with anisotropic conductivity

PERIODICAL: Prikladnaya matematika i mekhanika, v. 26, no. 3, 1962, 530 - 541

TEXT: Proceeding from the generalized Ohm's law, the author obtains a single vector equation for the magnetic field, viz.

$$\Delta H - \alpha[(H\nabla)\mathrm{rot}\,H - (\mathrm{rot}\,H\,\nabla)H] = \frac{1}{\nu_m}\cdot\frac{\partial H}{\partial t}. \quad (1.4)$$

This equation is analogous to the induction equation of magnetohydrodynamics. For stationary problems, Eq. (1.4) reduces to

$$\Delta H - \alpha[(H\nabla)\mathrm{rot}\,H - (\mathrm{rot}\,H\,\nabla)H] = 0. \quad (2.1)$$

In view of applying the results to problems of flow in tubes and channels under the effect of an external electromagnetic field, solutions to Eq. (2.1) are sought, which do not depend on the x-coor-

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

S/040/62/026/003/015/020
D407/D301

On solving magnetohydrodynamic problems..

dinate. The boundary conditions are set up. Several particular solutions of the system of equations are considered. These solutions have the property that the density of the current and that of the electromagnetic force in the direction of the x-axis are proportional to the magnetic field-strength in that direction. As an application of these solutions, the flow of current from a flat electrode is discussed. Further, the influence of anisotropic conductivity on gas flow in a rectangular channel, is considered. Two sides of the rectangle are electrodes, and the other two are dielectrics. The electric- and magnetic fields are crossed. In order to ascertain the effect of anisotropic conductivity on the electromagnetic force, the author determines first the magnetic field and the current field in the channel. On the assumption of weak currents, the solution is sought in the form of series in the small parameter $\lambda = 4\pi I/cH$ (I being the total current). In the first approximation, one obtains

$$j_{x1} = -\omega\tau \frac{\partial H_x}{\partial z} = - I_1 \omega\tau, \qquad (4.11)$$

where j is the current density along the x-axis. In the second appro-

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

S/040/62/026/003/015/020
On solving magnetohydrodynamic problems.. D407/D301

ximation, one obtains a mixed problem for the Laplace equation. The dependence of I on the voltage, applied at the electrodes, is analyzed. Further, gas flow in a cylindrical channel is considered (also by the method of expansion in series). In the first approximation, the space-charge density differs from zero, whereas in the case of the rectangular channel, it was zero in the first approximation. As a more complicated example, flow in a rectangular channel is considered, with "point"-electrodes which are located at the points z = 0 y = ± δ. In this case, too, the space charge differs from zero in the first approximation already. There are 4 figures.

ASSOCIATION: NII mekhaniki MGU (Scientific Research Institute of Mechanics of Moscow State University)

SUBMITTED: January 25, 1962

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

40116

S/040/62/026/004/0?2/0?3
D409/D301

24.2120
26.1410

AUTHORS: Kulikovskiy, A.G., and Lyubimov, G.A. (Moscow)

TITLE: On magnetohydrodynamic shock-wave structure in a gas with anisotropic conductivity

PERIODICAL: Prikladnaya matematika i mekhanika, v. 26, no. 4, 1962 791 - 792

TEXT: In the references (A.G. Kulikovskiy, O strukture udarnykh voln, PMM, this issue) it is shown that the width (thickness) of a shock-wave in a non-ideal medium may not vanish when all the dissipation coefficients tend to zero. Below, such a shock wave is constructed. Ohm's generalized law is used in the following form:

$$cE + v \times H + \frac{c}{ne} \operatorname{grad} p_e = \frac{c}{\sigma} j + \frac{c}{\sigma} \frac{\omega\tau}{H} j \times H.$$

The equations for one-dimensional steady flow are set up. The matrix of the dissipation coefficients ν_m^* and $\varkappa\nu_m^*$ is denoted by L_{ij}. One obtains for the width of the shock wave

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

$$1 \sim \nu_m^* (1 + \varkappa^2) U^{-1},$$

where U is a characteristic velocity. This expression shows that if the dissipation coefficients [illegible] zero, [illegible] wave behaves as follows

$$1 \rightarrow 0, \text{ if } \nu_m^* \varkappa^2 \rightarrow 0; \; 1 \not\rightarrow 0, \text{ if } \nu_m^* \varkappa^2 \not\rightarrow 0.$$

The latter case occurs only if $\omega\tau \rightarrow \infty$. With large $\omega\tau$, the solution of the shock-structure problem is peri[illegible] the width [illegible] period is of the order of $U \varkappa \nu_m^*$, and approaches zero if the [illegible]tion coefficients approach zero. A formula is given for the [illegible] of increase of the entropy dP/dx. If $\nu_m^* \rightarrow 0$, and $\nu_m^* \varkappa$ remains finite, then $dP/dx \rightarrow 0$, and $1 \rightarrow \infty$. Thereby, the solution approaches [illegible] periodic solution on any finite interval $[x_1, x_2]$, and [illegible] does not increase on this interval. Such a solution can [illegible]red as a macroscopic analogue of the correspon[illegible] solution [illegible] plasma in the absence of dissi[illegible]tion.

[illegible]: May 16, 1962

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

41505
S/040/62/026/005/002/016
D234/D308

17

26 2231

AUTHOR: Lyubimov, G. A. (Moscow)

TITLE: Formulation of the problem of magnetohydrodynamic boundary layer

PERIODICAL: Prikladnaya matematika i mekhanika, v. 26, no. 5, 1962, 811-820

TEXT: The author gives general considerations and relations which may be useful in formulating complicated problems. Only incompressible liquids are treated. It is found that one must include in the boundary layer equations the force

$$f = \frac{\sigma}{c} (E + \frac{v}{c} \times H) \times H \qquad (9)$$

and the additional equations

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

Formulation of the ...

S/040/62/026/005/002/016
D234/D308

$$\text{rot } E = 0, \quad \text{div } E = 4\pi\rho_e. \qquad (2)$$

The boundary layer problem must then be generally solved together with the external problem. The author introduces some simplifications into Eq. (2) and formulates the boundary conditions for the external problem in such a way that the boundary layer problem may be solved independently. Systems of equations for the boundary layer are deduced for the case when the magnetic Reynolds number $|R_{mL}|$ is smaller or approximately equal to 1. The equations of the external problem are formulated separately for the cases $R_{mL} \ll 1$ and $R_{mL} \sim 1$. A simple example is given. Two references to V. N. Zhigulev.

ASSOCIATION: MGU

SUBMITTED: June 22, 1962

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

S/040/62/026/006/005/015
D234/D308

AUTHOR: Lyubimov, G.A. (Moscow)

TITLE: Magnetohydrodynamic boundary layer in a medium having anisotropic conductivity for small magnetic Reynolds's numbers

PERIODICAL: Prikladnaya matematika i mekhanika, v. 26, no. 6, 1962, 1077 - 1086

TEXT: General formulation of the problem is given and applied to the boundary layer on a semi-infinite plate, assuming that

$$mL = \frac{H_0^2 \sigma L}{c^2 \rho U(1 + \omega^2 \tau^2)} \ll 1 \qquad (2.4)$$

and that the magnetic field is homogeneous and perpendicular to the plate. The final system of equations is

$$u_0 \frac{\partial u_1}{\partial x} + u_1 \frac{\partial u_0}{\partial x} + v_0 \frac{\partial u_1}{\partial y} + v_1 \frac{\partial u_0}{\partial y} - \frac{1}{R} \frac{\partial^2 u_1}{\partial y^2} = 1 - u_0 \qquad (2.10)$$

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

$$\frac{\partial u_1}{\partial x} + \frac{\partial v_1}{\partial y} = 0, \quad u_0 \frac{\partial w_1}{\partial x} + v_0 \frac{\partial w_1}{\partial y} - \frac{1}{R} \frac{\partial^2 w_1}{\partial y^2} = \omega\tau u_0. \quad ([illegible])$$

The last equation in it is reduced to an ordinary differential [illegible] tion by putting $\eta = y\sqrt{(R/x)}$ and

$$w_1 = \omega\tau x \, \Psi(\eta) \quad ([illegible])$$

Ψ was found by numerical integration. The deceleration of flow along the x axis decreases with increasing $\omega\tau$. The transverse velocity has a maximum at $\omega\tau = 1$ and tends to 0 for $\omega\tau \to \infty$. The coefficients of longitudinal and transversal friction are computed up to terms of the first order in mL. There are 3 figures.

SUBMITTED: June 28, 1962

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 15772-63 EWT(1)/BDS/ES(w)-2 AFFTC/ASD/AFWL/SSD Pab-4/Pi-4/Po-4
ACCESSION NR: AP3006126 S/0207/63/000/004/0078/0082

AUTHOR: Lyubimov, G. A. (Moscow)

67

TITLE: Boundary conditions on contact surface of ionized gas-solid body

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 4, 1963, 78-82

TOPIC TAGS: interface boundary condition, contact potential difference, conductive gas flow, MHD generator

ABSTRACT: It is shown that the boundary conditions for an electrode can be formulated when the physical properties of the electrode material are taken into account and that an exact formulation depends on the distribution of electrical values in the electrode layer, whose thickness is smaller than the length of the free path of the electron. The formulation is based on several assumptions with regard to the mechanism of electronic emission and the character of the near-electrode layer. The correspondence of the accepted assumptions to the nature of the investigated problem is proved for each concrete case. For example, the problem of the flow of a conductive viscous gas in a plane channel is studied

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 15772-63
ACCESSION NR: AP3006126

under conditions of the application (perpendicular to the plane of flow) of an external and constant magnetic field. The volt-ampere characteristics of the channel are calculated for different temperatures of the electrode and rough assumptions made with regard to flow and physical properties of the electrode material. It is shown that at weak currents a negatively charged layer is formed near the electrode, apparently as the result of high emission by the electrode. In the case of strong currents the near-electrode layer is charged positively, and a fraction of the voltage generated in the flow cancels on it. Orig. art. has: 2 figures and 8 formulas.

ASSOCIATION: none

SUBMITTED: 25Apr63 DATE ACQ: 11Sep63 ENCL: 00

SUB CODE: PH NO REF SOV: 002 OTHER: 005

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP3014917 S/0207/63/000/005/0024/0034

AUTHOR: Lyubimov, G. A. (Moscow)

TITLE: Electric potential changes near the walls of a channel during the motion of ionized gas in a magnetic field

SOURCE: Zhurnal prikl. mekhaniki i tekhn. fiziki, no. 5, 1963, 24-34

TOPIC TAGS: ionized gas electric potential, moving gas electric potential, electric potential near wall, magnetic field, ionized gas, ionized gas in magnetic field, moving ionized gas

ABSTRACT: The flow of a conducting viscous fluid in a plane channel is considered with constant velocity U and transverse, constant magnetic field H. For cold walls the conductivity is assumed to be a function of temperature across the channel and the magnitude of the wall potentials φ is derived for small currents, in a boundary layer with a straight line velocity profile, using Ohm's law and assuming $R_m \ll 1$. The channel walls are then assumed to be hot electrodes, and the magnitude of each electron sheath is studied under an electric field E, including the

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP3014917

Schottky effect on thermionic emission greater or less than the random electron plasma currents. Next, an external load of finite resistivity is applied, and expressions for the current densities at each electrode derived. The potential drop across the channel is then determined from

$$(R+r)j = \mathscr{E} - \varphi_{+}(j, T_{+}) + \varphi_{-}(j, T_{-}) + \Phi_{+} - \Phi_{-}$$

where Φ indicates work functions of each electrode and φ, the sheath potentials. The first term on the right represents the induced field. This equation shows that in order to evaluate the current-voltage characteristics one should determine the sheath potentials in terms of the various plasma parameters. Orig. art. has: 29 formulas and 11 figures.

ASSOCIATION: none

SUBMITTED: 08Jun63 DATE ACQ: 27Nov63 ENCL: 00

SUB CODE: PH NO REF SOV: 005 OTHER: 004

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G. A. (Moskva)

Near-the-electrode layers of changes in the potential when a weak current is sent through an ionized gas. PMTF no. 6: 146-148 N-D '63. (MIRA 17:7)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP3003245 S/0040/63/027/003/0509/0522

AUTHOR: Baranov, V. B. (Moscow); Lyubimov, G. A. (Moscow); Hu Yu-yin (Moscow)

TITLE: Calculation of the boundary layer on a dielectric plate in a flow of an incompressible, anisotropically conducting fluid in the presence of a homogeneous, transverse magnetic field

SOURCE: Prikladnaya matematika i mekhanika, v. 27, no. 3, 1963, 509-522

TOPIC TAGS: boundary layer, flow over flat plate, electrically conducting fluid flow, transverse magnetic field, flow in magnetic field, magneto-aerodynamic effect

ABSTRACT: The results of the authors' previous works (Baranov, V. B. Prikl. mat. i mekh., v. 26, no. 6, 1962; Lyubimov, G. A. Prikl. mat. i mekh., v. 26, nos. 5 and 6, 1962) are applied to the solution of the boundary layer problem in weakly and fully ionized media. Under certain assumptions

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP3003245

the problem is reduced to the solution of a system of differential equations:

$$u\frac{\partial u}{\partial x}+w\frac{\partial u}{\partial z}-\frac{1}{R}\frac{\partial^2 u}{\partial z^2}=-\frac{\partial p}{\partial x}+mL(-u+\omega\tau v+\omega\tau E_x^{\,o})+\frac{\omega^2\tau^2}{1+\omega^2\tau^2}\frac{\partial p_e}{\partial x}$$

$$u\frac{\partial v}{\partial x}+w\frac{\partial v}{\partial z}-\frac{1}{R}\frac{\partial^2 v}{\partial z^2}=-mL(\omega\tau u+v+E_x^{\,o})-\frac{\omega\tau}{1+\omega^2\tau^2}\frac{\partial p_e}{\partial x}$$

$$\frac{\partial u}{\partial x}+\frac{\partial w}{\partial z}=0.$$

Four different regimes of external flow are considered, and solutions are sought by linearization with respect to a certain parameter. The cyclotron frequency of ion rotation is assumed to be small in comparison to the ion collision frequency. The Thompson, Ettinghausen, and Leduc-Riggi effects are taken into account in the derivation of energy equations. Studies of the

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

1

ACCESSION NR: AP3003245

thermal boundary layer are presented, and graphs of the velocity and temperature profiles are given for various values of different parameters (ω, τ, m*x, and Prandtl numbers from 0.1 to 0.01). Numerical calculations were made on the "Strela" computer at the MGU computing center. "The authors consider it their duty to thank M. N. Kogan and A. G. Kulikovskiy for their discussion of the results and useful critical comments and staff members G. S. Roslyakov and Ye. N. Starova of the MGU computing center for help in calculation." Orig. art. has: 12 figures and 49 formulas.

ASSOCIATION: none

SUBMITTED: 21Jan63 DATE ACQ: 23Jul63 ENCL: 00

SUB CODE: 00 NO REF SOV: 006 OTHER: 001

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G. A.

"Electrical Potential Variation Layers Near Electrodes."

report submitted for Intl Symp on Magnetohydrodynamics Electrical Power Generation, Paris, 6-11 Jul 64.

Inst of Mechanics, Moscow State Univ.

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G.A. (Moscow)

"Magnetohydrodymanic boundary layers".

report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow, 29 Jan - 5 Feb 64.

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP4018433 S/0179/64/000/001/0141/0142

AUTHOR: Baranov, V. B. (Moscow); Kulikovskiy, A. G. (Moscow); Lyubimov, G. A. (Moscow)

TITLE: The boundary layer on a flat plate in anisotropic magnetohydrodynamics

SOURCE: AN SSSR. Izv. Otd. tekh. nauk. Mekhanika i mashinostroyeniye, no. 1, 1964, 141-142

TOPIC TAGS: flat plate, boundary layer, boundary layer condition, thermal boundary layer, Ettingshausen effect, aerodynamics

ABSTRACT: Expanding the subject of a previous report (Baranov, V. B., Izv, AN SSSR, OTN, Mekhanika i mashinostroyeniye, 1962, No. 6), the authors consider disturbances to an external flow caused by a boundary layer to show that temperature at the latter's boundary can be considered fixed despite the presence of the Ettingshausen effect. Further, it is shown that the inequality $M \lesssim R$ (where M is Hartman's number, R is Reynold's number, as related to the characteristic length l along the plate) can be diminished and the form $M \lesssim R$ can be used for the existence of the Blasius velocity profile. The thermal boundary layer is

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP4018433

calculated with consideration of Ettingshausen's effect (see Fig. 1 in the Enclosure). "In conclusion, the authors express gratitude to M. N. Kogan for calling their attention to the problem and participating in evaluation of possible solutions". Orig. art. has: 1 figure and 10 formulas.

ASSOCIATION: none

SUBMITTED: 24Sep63 ATD PRESS: 3046 ENCL: 01

SUB CODE: ME NO REF SOV: 003 OTHER: 000

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP4018433

ENCLOSURE: 01

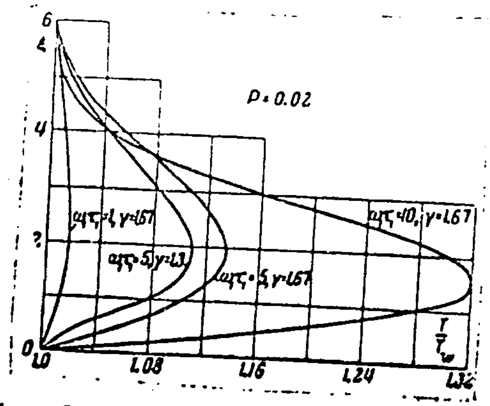


Fig. 1. Results of calculations

3/3

Card

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP4044714

S/0207/64/000/004/0010/0015

AUTHOR: Lyubimov, G. A. (Moscow)

TITLE: Some problems in theory of potential change through sheath

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 4, 1964, 10-15

TOPIC TAGS: plasma sheath, electron ion plasma, seeded plasma, thermionic emission, debye length

ABSTRACT: The author attempted to refine his previous theory on electric sheath formation (Prielektrodny*ye sloi izmeneniya potentsiala pri propouskanii slabogo toka cherez ionizovanny*y gaz. PMTF, 1963, No. 6) by including in his analysis such effects as collision ionization of atoms by electrons and acceleration of electrons in sheath layers. The model consists of a thermionically emitting surface, a Debye length much smaller than the electron mean free path, and a linear potential drop $E = \phi/d$. The current balance equation between emitted electrons $j_э$, plasma electrons j_e, plasma ions j_i, and collision ionized atoms j_i^* is given by

$$j_э \exp\left\{\frac{4.39}{T}\sqrt{E}\right\} + j_i + j_i^* - j_e \exp\left\{-\frac{e\varphi_+}{kT}\right\} = j$$

Card 1/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

For a potential change in the sheath greater than the ionization potential U_k of the seed material added to the gas, the value of j_i^* can be given by

$$j_i^* = eN\left\{\frac{n_k Q_k}{n_k Q_k + n_a Q_a} C_k(\varphi_+ - U_k) + \frac{n_a Q_a}{n_k Q_k + n_a Q_a} C_a(\varphi_+ - U_a)\right\}$$

$$C_k = 0 \quad \text{at} \quad \varphi_+ < U_k, \qquad C_a = 0 \quad \text{at} \quad \varphi_+ < U_a$$

Q- electron-atom collision cross section. To this is added the current due to secondary electron emission by ions bombarding the cathode surface, given by $\Upsilon = j_e^0/j_i^0$, leading to the final expression for j given by

$$j = j_s \exp\left\{\frac{4.30}{T}\sqrt{E}\right\} + (j_i + j_{ik}^*) + (1 + \gamma_a) j_{ia}^* - j_e \exp\left\{-\frac{11600}{T}\varphi_+\right\}.$$

Comparison of above theory with experimental data collected in argon at T = 2200K and one atm pressure with additions of potassium seed indicated a considerably better agreement with experimental data than for analysis done without considering collisional ionization. Orig. art. has: 16 formulas and 1 figure.

ASSOCIATION: none

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACCESSION NR: AP4044714

SUBMITTED: 19Apr64

ENCL: 00

SUB CODE: ME,GP

NO REF SOV: 005

OTHER: 003

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G.A. (Moskva)

Viscous boundary layer on an electrode in a medium of varying electroconductivity. Prikl. mat. i mekh. 28 no.5:846-851 S-O '64. (MIRA 17:11)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 14235-66 EWT(1)/EWP(m)/T-2 IJP(c)
ACC NR: AP5024894 UR/0382/65/000/003/0003/0020

11
B

AUTHOR: Lyubimov, G.A.

ORG: None

44,55

TITLE: Magnetohydrodynamic boundary layer

SOURCE: Magnitnaya gidrodinamika, no. 3, 1965, 3-20

TOPIC TAGS: magnetohydrodynamic theory, magnetohydrodynamic boundary layer

ABSTRACT: A review of selected published work on the theory of the laminar magnetohydrodynamic boundary layer is presented for the cases where the magnetic Reynold's number, R_m, is less than unity, and the Reynold's number, R, is much larger than unity: $R \gg 1 \gg R_m$. These cases are of interest in many theoretical and experimental problems. Attention is directed to the mathematical and physical fundamentals of the problems, with emphasis upon qualitative considerations. A list of some 54 references serves as a source of quantitative data and as a reference board for several quantitative discussions of the author. Consideration starts with a review of the physical and mathematical consequences of imposing suitable limiting conditions on the problem parameters. Estimates of the boundary layer thickness and of magnetic field changes across the boundary layer lead to certain clarifications; for instance, to a recognition of conditions for external problem dominance via its influence upon magnetic field in the boundary layer (internal problem) equations. These general considera-

UDC: 538.4

Card 1/3

2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 14235-66

ACC NR: AP5024894

0

tions lead to a system of equations for the viscous magnetohydrodynamic boundary layer in the case where $R_m \leqslant 1$. In the simplest case, that of an isotropically conducting weakly ionized fluid, the equations (with detailed notations available in the cited literature) are:

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}-\nu\frac{\partial^2 u}{\partial y^2}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\frac{\sigma}{\rho}(\mathbf{E}^0+\mathbf{v}_\tau\times\mathbf{B})\times\mathbf{B}|_x;$$

$$u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}-\nu\frac{\partial^2 w}{\partial y^2}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+\frac{\sigma}{\rho}(\mathbf{E}^0+\mathbf{v}_\tau\times\mathbf{B})\times\mathbf{B}|_z; \quad (1)$$

$$\frac{\partial\rho u}{\partial x}+\frac{\partial\rho v}{\partial y}+\frac{\partial\rho w}{\partial z}=0;$$

$$\rho c_p\left(u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}+w\frac{\partial T}{\partial z}\right)=u\frac{\partial p}{\partial x}+w\frac{\partial p}{\partial z}+\frac{\partial}{\partial y}\left(\lambda\frac{\partial T}{\partial y}\right)+$$

$$+\eta\left[\left(\frac{\partial u}{\partial y}\right)^2+\left(\frac{\partial w}{\partial y}\right)^2\right]-\frac{2}{3}\eta(\operatorname{div}\mathbf{v})^2+\mathbf{j}^0(\mathbf{E}^0+\mathbf{v}_\tau\times\mathbf{B});$$

$$p=p(x,z);\quad \mathbf{B}=\mathbf{B}(x,z);\quad \mathbf{E}_\tau^0=\mathbf{E}_\tau^0(x,z);$$

$$E_n^0=-\mathbf{v}_\tau\times\mathbf{B}+\frac{j_n^0}{\sigma},\quad j_n^0=j_n^0(x,z).$$

Card 2/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 14235-66

ACC NR: AP5024894

O

The arbitrary functions in the equations (1) of the internal problem (p; B; E and j), are determined by the solution of the external problem. Equations for an environment with an anisotropy of electrical conductivity, and equations for the case of strong ionization are available in the cited literature. The imposition of further parameter restrictions (e.g.: E= 0, or B = const. everywhere) - lead to additional decisive simplification of the external problem. The corresponding internal problem, defined by the boundary layer equations, can then be considered as an efficient point of departure for a review of basic boundary layer problem solutions. The author's review starts from this basic point and includes many papers. Among his comments are those on the discovery of a decrease in friction and in heat exchange with an increase in the magnetic field; and on the appearance of nonmonotonous velocity profiles. Research on the anisotropic and highly ionized cases is also reviewed. The author concludes that the existing studies of the magnetohydrodynamic viscous boundary layer refer, as a rule, to specific segregated problems and are aimed at quick qualitative answers. It is thus clear that the systematic investigation of the overall problem belongs still to the future. For instance, an approach to the magnetohydrodynamics of the boundary layer in the case of highly ionized environment and absence of plasma thermal equilibrium still needs the construction of a basic system of equations. Considerations for the advancement of magnetohydrodynamic boundary layer research are contributed. Orig. art. has 15 figs., 12 formulas.

SUB CODE: 20 SUBM DATE: 26Nov64/ ORIG REF: 024 OTH REF: 030

LB

Card 3/3

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 8485-66 EWT(1)/EWT(m)/ETC/EPF(n)-2/T IJP(c) AT
EWG(m)

ACC NR: AP5021903 SOURCE CODE: UR/0207/65/000/004/0045/0053

AUTHOR: Lyubimov, G. A. (Moscow)

ORG: none

TITLE: Near-electrode layers in "hot" electrodes

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 4, 1965, 45-53

TOPIC TAGS: ionized gas, electrode, boundary layer plasma

ABSTRACT: A semi-empirical theory of the properties of ionized gas near hot electrode surfaces is constructed. Several models are considered for which current density, particle velocity distribution and the Poisson equation yield the electric field near the electrodes, boundary layer thickness and current densities. The appropriate conditions are discussed under the assumption of equilibrium and the voltage-current curves are plotted. A variety of cases arises from the multitude of possible MHD concepts to which the developed theory is applied. It is shown that a choice of empirical constants is somewhat ambiguous; this leads to more than one solution, all within the experimental data. Other examples of comparison between the derived and measured voltage-current curves are given. Only a tentative comparison is made since not all parameters required by the theory were measured in all instances. Orig. art. has: 5 figures, 21 formulas.

SUB CODE: 20/ SUBM DATE: 20Jun65/ ORIG REF: 005/ OTH REF: 005

Card 1/1

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 16703-66 EWP(m)/EWT(1)/EWA(1) WW
ACC NR: AP6003209 SOURCE CODE: UR/0382/65/000/004/0080/0084

AUTHOR: Lyubimov, G. A.; Semenova, I. P. 85 83 B

ORG: none

TITLE: Formulation of the problem of a viscose boundary layer on a cold electrode

SOURCE: Magnitnaya gidrodinamika, no. 4, 1965, 80-84

TOPIC TAGS: temperature dependence, Maxwell equation, current density, electrode, conducting gas, boundary layer flow, electric field, fluid flow, electric conductivity, conductive fluid 21, 44, 55

ABSTRACT: The effect of the axial electric field in the core of a fluid stream characterized by temperature-dependent electrical conductivity is investigated. In contrast to the results of other authors, it was found that cold electrodes in contact with the conducting gas cause a significant decrease of conductivity in the outermost regions. This phenomenon leads to the development of potential differences with amplitudes comparable to those of the applied field across the stream. To account for this effect, Maxwell's and Ohm's equations are solved for the associated current densities. It is shown that the resulting currents induce Joule heating

UDC: 533.95 : 538.4

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 16703-66

ACC NR: AP6003209

2

which affects the flow. The characteristics of the flow are plotted for several ratios of the resistance of boundary layers to that of the inner layers. Heat transfer and friction are not considered, since the conventional approach is sufficient to estimate these effects. Orig. art. has: 3 figures, 7 formulas.

SUB CODE: 20/ SUBM DATE: 13Nov64/ ORIG REF: 001/ OTH REF: 001

Card 2/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

L 07017-67 EWT(1)/EWP(m)/EWT(m) IJP(c) DJ
ACC NR: AP7001061 SOURCE CODE: UR/0421/66/000/003/0003/0011

56
B

AUTHOR: Lyubimov, G. A. (Moscow

ORG: none

TITLE: Averaging of magnetohydrodynamic flows and the applicability of a hydraulic approximation for the calculation of magnetohydrodynamic flows through channels

SOURCE: AN SSSR. Izvestiya. Mekhanika zhidkosti i gaza, no. 3, 1966, 3-11

TOPIC TAGS: magnetohydrodynamics, nonuniform flow

ABSTRACT: As engineers are beginning to use the methods of hydraulic calculations for the design of definite magnetohydrodynamic devices (using the analysis of overall characteristics like the efficiency, power at the external load, etc., supplied by hydraulic calculations), it is becoming clear during investigations in gas dynamics of the same nonuniform flow that the results of hydraulic calculation may differ by as much as 10, depending on the method of averaging. Consequently, the author carries out a comprehensive investigation of the problem of averaging of magnetodynamic flows and shows, for selected examples,

Card 1/2

0924 0081

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

ACC NR: AP7001061

that the nonuniformity of magnetohydrodynamic flows is much stronger than in gas dynamic currents because of the nonuniformity of the force and thermal interactions of currents within the flows. These increased nonuniformities lead, in turn, to even larger fluctuations in the results of hydraulic calculations, and the author concludes that there is a definite need for the development of hydraulic calculational methods based on nonuniform (in the hydrodynamic and electrodynamic sense) canonical flows. Such an approach appears in many cases as the only one applicable for practical design of magnetohydrodynamic equipment. Orig. art. has: 3 figures and 2 formulas. [JPRS: 37,751]

SUB CODE: 20 / SUBM DATE: 10Feb65 / ORIG REF: 006 / OTH REF: 002

Card 2/2 vmb

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

124-57-1-1210

Translation from: Referativnyy zhurnal, Mekhanika, 1957, Nr 1, p 156 (USSR)

AUTHORS: Pochtovik, G. Ya., Lyubimov, G. D., Likverman, A. I.

TITLE: Investigation of the Strength, Rigidity, and Crack Resistance of Reinforced-concrete Structures Based on "Keramzit" Clayey Filler Gravel (Issledovaniye prochnosti, zhestkosti i treshchinoustoychivosti zhelezobetonnykh konstruktsiy na keramzitovom gravii)

PERIODICAL: Tr. Mosk. avtomob.-dor. in-ta, 1956, Nr 18, pp 231-240

ABSTRACT: Bibliographic entry

1. Box beams--Stresses--Test results 2. Box beams--Vibration --Mathematical analysis

Card 1/1

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G.D. (Moskva)

Designing eccentrically loaded rigid beams for elastic supports. Stroi. mekh. i rasch. soor. 3 no.3:18-24 '61.
(MIRA 14:6)

(Girders)

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"

"APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5

LYUBIMOV, G P

56-6-12/47

AUTHORS: Lyubimov, G. P., Khokhlov, R. V.

TITLE: On the Polarization of a Molecular Beam by an Alternating Field With Changing Amplitude and Phase (O polyarizatsii molekulyarnogo puchka peremennym polem s izmenyayushchimisya amplitudoy i fazoy)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1957, Vol. 33, Nr 6, pp. 1396 - 1402 (USSR)

ABSTRACT: The principle upon which the operation of a molecular generator is based consists in the fact that the molecule flying through the resonator enters into interaction with its electric field. On this occasion the excited molecule will pass its excess energy on to the resonator. For the analysis of all possible, stable, steady oscillations it is necessary to determine the polarization of the beam if this beam is subjected to the action of an alternating field with changing amplitude and phase.
The paper contains the following chapters:
1.) Derivation of the initial equation
2.) Discussion of the case in which the phase of the acting field is constant
3.) Discussion of the case in which the amplitude and frequency of

Card 1/2

APPROVED FOR RELEASE: 08/31/2001 CIA-RDP86-00513R001031210008-5"