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INFLUENCE OF REAL GAS EFFECTS ON THE HYPERSONIC RAREFIED FLOW NEAR THE SHARP LEADING EDGE OF A THIN PLATE

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Аннотация—В работе представлены результаты исследования распределения индуцированного давления на тонкой пластине с острой передней кромкой, обтекаемой гиперзвуковым разреженным потоком.

Исследования проводились в аэродинамической трубе низкой плотности при следующих условиях в набегающем потоке: $5{,}7 < M_\infty < 14$, $30 < Re_{\infty/mm} < 600$.

Полученные результаты показывают, чго по мере приближения к передней кромке теория сильного взаимодействия перестает соответствовать экспериментальным результатам и с увеличением $\bar{\varkappa} = [(\mu^3_\infty \sqrt{C_\infty})/\sqrt{Re_{x\infty}}]$ индуцированное давление на пластине приближается к некоторой постоянной величине, начиная с некоторого $\bar{\varkappa} > \varkappa_{n\ \text{рег}}$, где $\bar{\varkappa}_{n\ \text{рег}}$ является функцией числа Маха.

Наиболее характерным является отклонение индуцированного давления от теории взаимодействия с увеличением разреженности—резкое уменьшение $\Delta\bar{P}/\bar{\varkappa}P_\infty$ при $[(M_\infty \sqrt{C_\infty})/Re_{x\infty}] > 0{,}2$.

NOMENCLATURE

M,	Mach number;
P,	pressure on the plate surface;
P'_0,	Pitot pressure;
P_0,	pressure in adiabatically stagnated flow;
P_∞,	static pressure in undisturbed flow;
Re,	Reynolds number;
a_∞,	sound velocity in undisturbed flow;
ρ,	gas density;
μ,	gas viscosity coefficient;
γ,	index of an adiabatic line;
$\overline{\Delta P}$	$= (P - P_\infty/P_\infty)$;
x,	distance from a leading edge of a plate;
x_1,	distance from a plane of nozzle exit;
T,	temperature;
λ,	mean free path of molecules;
$\varkappa$,	interaction parameter;
$\frac{M_\infty\sqrt{C_\infty}}{\sqrt{Re_{x\infty}}}$,	rarefaction number;
C_∞,	$= \left(\frac{\mu_w}{\mu_\infty}\right)\left(\frac{T_\infty}{T_w}\right)$.

Subscripts

∞,	parameters in undisturbed flow;
0,	parameters in adiabatically stagnated flow;
w,	parameters at the plate wall;
ex,	parameters at nozzle exit;
v,	parameters in vacuum chamber.

THE INVESTIGATION of a thin plate with a sharp leading edge in a hypersonic rarefied flow is important for solving a number of applied and theoretical problems of high-altitude flight.

The present paper is devoted to a study of the flow near a plate with a sharp leading edge placed in a hypersonic air stream. The most significant processes which determine the physical and chemical parameters of the air near a plate surface are the dissipation processes associated with the interaction between the wall and the flow, and also the chemical processes leading to considerable changes in the gas composition.

In the flow regions corresponding to the conditions of large relaxation times it is necessary to take into account the effect of kinetics of elementary processes. To solve the kinetics equations it is necessary to know the fields of gas dynamic parameters which depend upon the rarefaction of the medium. This paper contains the results of the experimental investigation of the flow near a plate placed in a hypersonic low density air stream and which makes it possible to show the influence of rarefication upon a pressure field.

In Fig. 1 is presented a pattern of hypersonic flow past a plate with a sharp leading edge (see [1]), and the flow regions corresponding to different flow regimes are marked. Best studied are the flow regions (*d–e*) at a distance of $x/\lambda_\infty \geqslant 10^2$ from the leading edge where a pressure distribution is determined by the theories of weak and strong interactions [2]. In these regions the induced pressure at a plate surface is according to theoretical and experimental investigations, a linear function of the hypersonic interaction parameter

$$\varkappa = \frac{M_\infty^3\sqrt{C_\infty}}{\sqrt{Re_{x\infty}}}$$

to a first approximation.

In the flow regions (*a*, *b*, *c*) near the leading edge the effect of the rarefaction of the medium is noticeable and the value of the induced pressure becomes different from the values calculated from the theory of weak and strong interactions. The theoretical study of the flow in the region (*c*) near the leading edge [3], using the model of "viscous layer" between the body surface and the rectilinear thin shock wave without allowing for slip, made it possible to obtain the limiting solutions of the boundary-layer equations determining the flow of viscous gas above the plate.

The solutions have shown that in the region distant from the leading edge by several scores of lengths of the mean free path of molecules in the undisturbed flow, the pressure is constant (in the diagram for the induced pressure as a function of $\varkappa$ there is a "plateau") and is approximately determined by the formula

$$\frac{P_{\max}}{P_\infty} \simeq \frac{\gamma - 1}{2} G\left(\frac{T_w}{T_0}\right) M_\infty^2 \qquad (1)$$

where $G(T_w/T_0)$ is the function of the temperature ratio T_w/T_0 which varies from 0·3 to 0·8 if $0{\cdot}1 \leqslant T_w/T_0 \leqslant 1$. In the region downstream of and adjacent to that of the strong interaction, the value of the induced pressure depends linearly upon $\varkappa$, but the proportionality factor is smaller than that obtained from the strong interaction theory. In this region the pressure distribution is approximately described by the

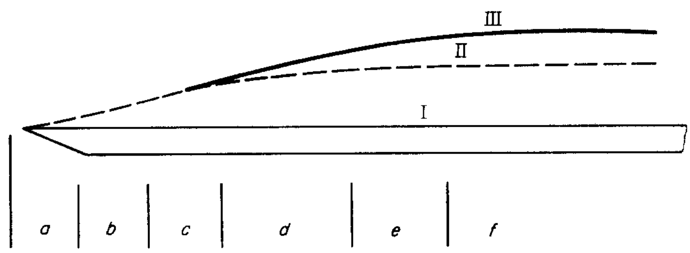

FIG. 1. Pattern of flow above the plate with a sharp leading edge: I. viscous layer; II. non-viscous layer; III. shock wave; (*a*) free molecular regime; (*b*) regime similar to a free molecular one; (*c*) flow of "viscous layer"; (*d*) strong interaction region; (*e*) transient region; (*f*) weak interaction region.

formula

$$\frac{P}{P_\infty} \simeq \tfrac{3}{4}(\gamma - 1)\left(\frac{\gamma}{\gamma + 1}\right)^{\frac{1}{2}} I\kappa \qquad (2)$$

where $\tau(T_w/T_0)$ is the function of the temperature ratio $T_w/T_0 = 0{\cdot}490$ for $T_w/T_0 \doteq 0{\cdot}1$; I.

Allowances made for slip velocity and temperature jump [4] (for the same model of flow) lead to the theoretical results which confirmed the existence of a "plateau" and revealed the influence of the induced pressure at the plate on the rarefaction parameter $M_\infty/\sqrt{Re_{x\infty}}$.

The theoretical analysis [5] of the flow for the region (*b*) which lies closer still to the leading edge (at $x/\lambda_\infty = 1 + 3$) shows, from the kinetic theory that in this region the pressure should reach some constant value dependent on the relationship between the wall temperature, the adiabatic stagnation temperature and the Mach number for the incoming flow. The results of the experimental investigation of hypersonic rarefied flow past a plate [1] confirm substantial deviation (decrease) of the induced pressure from the predetermined values obtained on the basis of the strong interaction theory. However, with an increase in $\varkappa$ the induced pressure on a plate does not tend to a definite limiting value. On the other hand, for flows in weak rarefied gases, corresponding to the slip conditions, it was found in [6] that near the leading edge of the plate there exists a flow region, for which the induced pressure along the plate surface is essentially lower than the values predicted by the theory of the interaction of the continuum regime and that it approaches some constant value which is satisfactorily described by formula (1).

The aim of the present paper is to study the hypersonic rarefied gas flow past a plate with a sharp leading edge, in order to determine the effect of the rarefaction upon the value and distribution of the induced pressure on a plate over a wide range of the Knudsen numbers and to establish the relations characterizing the pressure distribution near the leading edge at $10 \leqslant x/\lambda_\infty \leqslant 300$.

1. APPARATUS AND METHODS

The vacuum wind tunnel, whose construction and parameters have been described in [7, 8] was used in the experiments. The power of the pump system allowed steady hypersonic rarefied gas flows in the working section of the wind tunnel at $5{\cdot}7 \leqslant M_\infty \leqslant 14$ and static pressures $100 \leqslant P_\infty \leqslant 0{\cdot}28$ μHg when a uniform field has cross-section dimensions 10–20 mm.

During the operation of the installation dried air entered the mixing chamber through a flow regulator where it was heated up to T_0, to ensure the absence of gas condensation in the adiabatic air expansion in the nozzle and jet in the vacuum chamber of the low-density wind tunnel. The choice of T_0 corresponded to the experimental data on air condensation in the supersonic flow at low densities of [9]. The axisymmetric nozzles operating in slightly underexpanded exit pressure condition were used for obtaining the supersonic flow in a vacuum chamber. Tables 1 and 2 give the geometric dimensions of the nozzle used, the static pressures at the nozzle exit and in the vacuum chamber, and the gas dynamic parameters of flow in the working section of a jet and at the nozzle inlet.

To measure pressures over the range of 10^{-3} mm Hg $\leqslant P \leqslant 6{\cdot}10^{-1}$ mm Hg we used manometric lamps T-2 with a device BT-2 after a preliminary calibration of the lamps using compressor manometers and also a manometer BP-3 [16]. Higher pressures $P >$ 0·5 mm Hg were measured by a set of oil U-tube manometers.

To calculate the flow parameters and to determine the structure of the jet the total pressure distribution was measured at several positions along the flow and along the jet axis by means of cylindrical Pitot probes of various diameters. The probe diameter was chosen so that the number $Re_d/M \geqslant 40$, which allowed neglect of the effect of viscosity and rarefaction upon the probe indications within the accuracy of the experiment, in accordance with the data of [7]. The Mach number at the nozzle exit was calculated by the Rayleigh formula on the basis

Table 1. Geometric sizes of conic nozzles

No.	d_{cr} Diameter of nozzle throat (mm)	d_{ex} Diameter of nozzle exit (mm)	l Length of supersonic nozzle part (mm)	S_{ex}/S_{cr} Nozzle expansion
1	1·3	30	75	535
2	1·5	40	75	710
3	1·75	50	75	795
4	2·0	50	65	625
5	1·4	49·5	75	1250
6	1·45	58	75	1600
7	1·59	63	80	158
8	1·52	4·2	14·2	7·6

of the measured values of the total and static pressures. When calculating the free-path length of molecules in the undisturbed flow (by formula $\lambda_\infty = (\mu_\infty/\rho_\infty a_\infty)(\pi\gamma/2)^{\frac{1}{2}}$ [10]) and the Reynolds number $[Re_{x\infty} = (\rho_\infty U_\infty X)/(\mu_\infty C_\infty)]$, the air viscosity employed was determined from the Sutherland relation.

The operating conditions were chosen after a preliminary study was made of the air flow from the nozzle according to the methods of [8, 11]. The region of the isentropic flow at the nozzle exit was determined for the nozzles used. The Mach numbers were calculated by the relation of the Pitot pressure to that in the adiabatically stagnated flow and by the relation of the measured static pressure on a nozzle wall to that of the Pitot pressure; the close agreement between the values of the Mach numbers calculated by different ways allowed the operating conditions of the installation to be chosen. The uniform flow region was studied by the Pitot pressure probes in detail. Fig. 2 gives the results of measurement of a Pitot pressure distribution in the plane of the nozzle exit which indicate the presence of uniform flow with a breadth of 8 mm $\leqslant \Delta y \leqslant$ 18 mm for all the operating conditions and the nozzles used.

The flow parameters in the isentropic jet core behind a nozzle exit are calculated from the indications of the Pitot pressure probes and from the initial values of pressure and temperature in the adiabatically stagnated flow.

The study of the flow parameters by means of the Pitot pressure probes near the nozzle exit with $5{\cdot}7 \leqslant M_{ex} \leqslant 9$ has shown that the flow along the jet axis at a distance of $0 \leqslant x_1 \leqslant 10$ mm from the nozzle exit is characterized by a slight non-uniformity (the change in P does not exceed 15 per cent and that in the Mach number, 2 per cent). The working sections of the flow with the hypersonic Mach numbers ($M_\infty \simeq 14$) corresponded to the jet region at a considerable distance from the conic nozzle exit of small dimension, operating at large ratios P_{ex}/P_v (see Table 2). At distances of $x_1 > 50\ r_{ex}$ from the nozzle exit the flow field was sufficiently uniform to allow its use as a working section. The position of the breakdown shock wave in a free jet was preliminarily determined on the basis of the calculations and results of [12, 13]. The model under investigation was placed in front of the breakdown shock wave, and the distance of the end of the model from the breakdown shock wave was equal to several sizes of the model. The model of the plate was made of thin steel rolled plate, the leading edge was 0·01-mm thick and the plate was 18-mm wide and 36-mm long. A thin hollow wedge was stuck from below to the plate to remove air through a connecting pipe to the manometric lamp. The wedge was at a distance of 2 mm from the leading edge. A thermal insulating glass washer, 4-mm thick, was stuck between the wedge and the connecting pipe. To measure pressure the

Table 2. Flow parameters in the working section of low density wind tunnel in a mixing chamber

	x_1	T	P_0	P_v	P_{ex}	M_∞	$Re_{\infty/mm}$	P_∞	$\lambda_{\infty/mm}$	T	T_w/T_0
Number regimes	Distance from nozzle exit	Temperature in adiabatically stagnated flow (°K)	Pressure in adiabatically stagnated flow (mm Hg)	Pressure in vacuum chamber (μHg)	Static pressure at nozzle exit (μHg)	Mach number in working section	Reynolds number in working section	Static pressure in working section (μHg)	Free path of molecules in undisturbed flow	Static temperature of stream in working section (°K)	Ratio of plate temperature T_w to that in adiabatically stagnated flow
1	−3	400	515	30	103	7·22	589	102·4	0·018	35	0·87
2	0	400	300	15·5	37	7·88	298	35·7	0·039	29·8	0·87
3	0	400	190	12·5	20·5	7·89	180	21·3	0·065	29·8	0·87
4	0	400	65	6	9·8	7·66	67	9·25	0·17	31·4	0·87
5	0	400	250	9·5	16·5	8·75	192	14·85	0·068	24·5	0·87
6	0	400	160	6	9·5	8·71	124	9·4	0·104	24·7	0·87
7	10	293	9	6·5	12·1	5·67	30·4	8·3	0·28	39	0·98
8	70	523	90	10		13·54	16·91	0·28	1·19	13·9	0·87

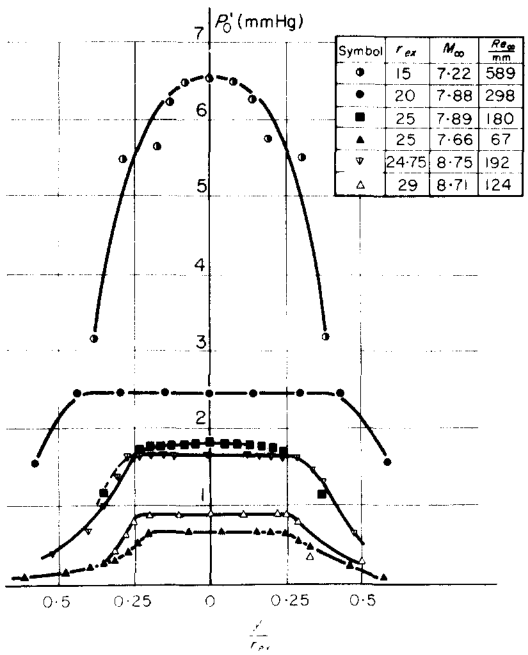

FIG. 2. Pitot pressure distribution in a plane of nozzle exit.

model was drained at different distances from the leading edge: the distance of pressure orifices from the leading edge varied from 3 to 15 mm; the diameter of these orifices was so chosen that the conduction of the orifice should have no effect on the value of the pressure to be measured (in the experiments the orifice diameter was 0·8–0·7 mm). The non-uniformity of the undisturbed flow by the value of static pressure along the plate at a distance corresponding to a pressure orifice far removed from the leading edge, did not exceed 12 per cent, i.e. it was within the error of the experiment. The internal diameter of the connecting pipe (12-mm long) between the model and the measuring lamp was 0·8 cm. To determine the effect of conduction of the system model-connecting pipe-manometric lamp, the system was preliminarily calibrated in a vacuum chamber at pressure of 0·5 μHg $\leqslant P_v \leqslant 10^2$ μHg.

The calibration showed that at pressures of $P \geqslant 15$ μHg (corresponding to the experimental conditions of the Mach number range for the undisturbed flow from 5·7 to 8·9) the error of measurement of pressure due to conduction and degassing of a drainage system did not exceed 5 per cent. At pressures of $1 \leqslant P \leqslant 10$ μHg the error could reach 30–40 per cent, which corresponded to the conditions of the study of a surface pressure in flows at $M_\infty \simeq 14$.

When studying a plate in a hypersonic rarefied gas flow over a range of the Mach numbers ($5{\cdot}7 \leqslant M_\infty \leqslant 8{\cdot}9$) the leading edge of the model was placed at the nozzle exit.

When measuring pressures on the plate at $M \simeq 14$ the model of the plate was located in the flow at a distance of 70 mm from the exit; the distance from the section to the breakdown shock wave was 120–130 mm, i.e. the model under study was in the isentropic flow. The plate temperature was measured by a chromel-coppel thermocouple. To achieve adiabatic conditions on the plate, the lowest possible stagnation temperature was set, its choice being limited, however, by the necessity of preventing condensation of air during expansion in the nozzle and jet. In the experiments carried out the wall temperature was similar to that of stagnation ($T_w/T_0 \simeq 0{\cdot}87$).

2. RESULTS ON INVESTIGATION OF PRESSURE DISTRIBUTION ON A FLAT PLATE WITH A SHARP LEADING EDGE

As a result of the experiments carried out, data has been obtained on the pressure distribution along a plate at different values of the Mach numbers and density in the undisturbed flow (see Table 3) for wall conditions similar to adiabatic.

The results of the treatment of the experimental data given in Fig. 3 allowed the determination of the dependence of the value of the induced pressure on a plate surface with a sharp leading edge on the hypersonic parameter of the interaction $\varkappa$.

For comparison, in Fig. 3 the linear dependence is shown of the induced pressure upon $\varkappa$, as obtained from the theory of strong interaction

Table 3. Plate surface pressure

Number of regime	Pressure, Hg at different distances of x from leading edge					
	$x = 3$ mm	$x = 5{\cdot}2$ mm	$x = 6$ mm	$x = 7{\cdot}8$ mm	$x = 10$ mm	$x = 20$ mm
1	447	407	372	310		
2	242	225	202	195		
3	139	135	125	112		
4	66	64	61	55	50	
5	133	128	118	103	93	
6	78	78	76	67	60	
7	41	44·5	39·6	38·6		
8	10	8·7	4·8		6·7	4·8
9	12		8·7			7·0

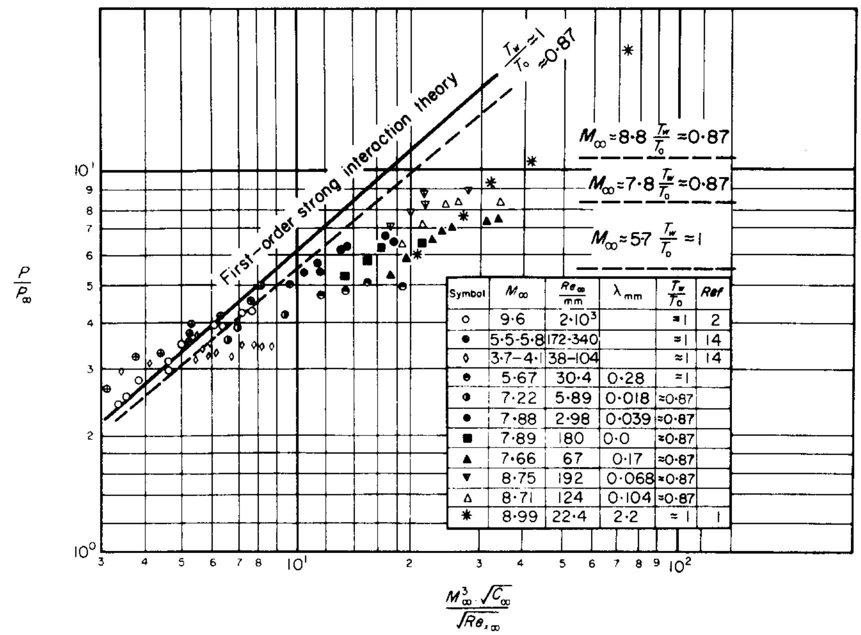

FIG. 3. Dependence of the induced pressure on a plate with a sharp leading edge upon the hypersonic interaction parameter at different Mach and Reynolds numbers of the incident flow. The limiting values of induced pressure for fixed values of the Mach numbers according to the theory [3] are given by dashed lines.

of the first order, together with the experimental data of other authors [1, 2, 14].

For hypersonic parameters of the interaction $\varkappa \geqslant 7{\cdot}5$ and the rarefaction criterion $(M_\infty/\sqrt{Re_{x\infty}} \leqslant 0{\cdot}2$ the results obtained from the measurement of the induced pressure well agree with those in [2, 14]. For the hypersonic interaction parameters $\varkappa > 25$ and the rarefaction criterion $[M_\infty/\sqrt{Re_{x\infty}}] \geqslant 0{\cdot}5$ there is some discrepancy with the results of [1]. The published results show smaller values of pressure at $\varkappa > 25$, which fact agrees with theory [3] more than do the results of [1], the character of the change in pressure with an increase in $\varkappa$

corresponding to the presence of the pressure "plateau".

From the comparison of the experimental data for pressure distribution on a plate at the same Mach numbers but at different densities of the incident flow, it is seen that for lower flow density $[M_\infty/\sqrt{Re_{x\infty}}] \geqslant 0{\cdot}2$ the pressure distribution on the plate is not described by the theories of strong and weak interaction of the continuum.

For the region of the flow under consideration for the Mach numbers of the undisturbed flow $5{\cdot}7 \leqslant M_\infty \leqslant 8{\cdot}8$ and at the Reynolds numbers of the undisturbed flow $30 \leqslant Re_{\infty/\mathrm{mm}} \leqslant 590$ with an increase of $\varkappa$ for the fixed Mach numbers, starting with some value of $\varkappa_{\lim} = f(M_\infty)$, (corresponding to the distance of x from the leading edge of a plate which is smaller than 30λ), the value of the induced pressure tends to a certain limiting constant value, which qualitatively agrees with the theoretical results of [3, 4, 5]. In Fig. 3 are shown the limiting values of pressure calculated by formula (1) and the experimental data obtained which allow the determination of the limiting values of the interaction parameters, at which the value of the induced pressure (at $\varkappa > \varkappa_{\lim}$) slightly depends upon $\varkappa$. For example, for the velocities of the incident flow $M_\infty = 5{\cdot}7$ over the range $10 \leqslant \varkappa \leqslant 20$ the pressure is almost constant for $0{\cdot}1 > \lambda_\infty/x > 0{\cdot}03$.

The analysis of the results shows that for the values of the interaction parameters $\varkappa < \varkappa_{\lim}$, the induced pressure over a certain range of $\varkappa$ is a linear function of the hypersonic interaction parameter, and that the slope angle of the linear portion of the dependence $P/P_\infty = f(\varkappa)$ decreases with an increase in the free path of molecules in the undisturbed flow. Fig. 4 shows the relation of the tangent of the slope angle of the linear part of this relation plotted against the Knudsen parameter ($Kn_\infty = \lambda_\infty/L$) where $L = 10$ mm for the undisturbed flow. With the rise of density of the incident flow ($Kn_\infty \leqslant 10^{-3}$) the slope angle of the linear part of the relation $P/P_\infty = f(\varkappa)$ tends to the value determined by the strong interaction theory: the slope angle of the linear part decreases with the decrease of density of the undisturbed flow. To estimate the effect of rarefaction upon the value of the induced pressure on the plate the criterion $(M_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}$ is used which is the basis for the relation $\overline{\Delta P}/\varkappa$ characterizing the deviation of the induced pressure at the plate from the calculated values corresponding to the continuum theory.

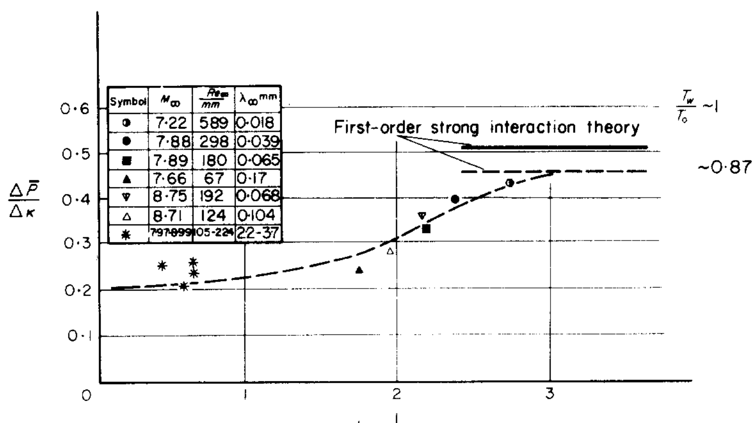

FIG. 4. Tangent of the slope angle of the rectilinear part of relation $P/P_\infty = f(\varkappa)$ for different values of the Knudsen parameters in the incident flow.

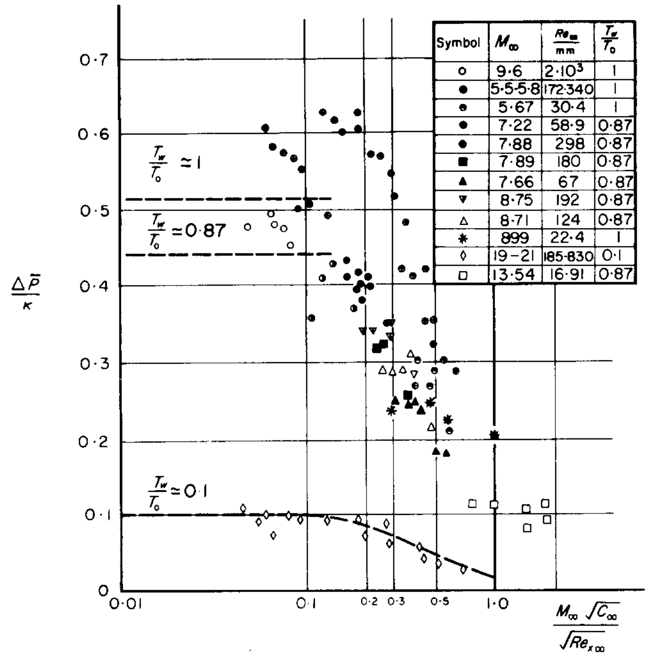

FIG. 5. Dependence of the induced pressure on the plate upon the rarefication parameter $[(M_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}]$.

The experimental data presented and also the results of other authors [14, 15] show that the effect of the rarefaction becomes noticeable at $[(M_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}] > 0{\cdot}15$. The deviation of $\Delta\bar{P}/\varkappa$ from the constant values (in Fig. 5 dotted lines correspond to the strong interaction theory at different T_w/T_0) does not depend upon the temperature ratio T_w/T_0.

CONCLUSIONS

The experimental material determining the value of the induced pressure at the plate with a sharp leading edge in the hypersonic air flow over the range $3{\cdot}7 \leqslant M_\infty \leqslant 14$ and $20 \leqslant Re_{\infty/\mathrm{mm}} \leqslant 600$ for the undisturbed flow, leads to the following conclusions on the effect of the rarefaction of the medium upon the value of the induced pressure on the plate:

1. The rarefaction of the undisturbed flow leads to a considerable decrease of the induced pressure on the plate, as compared with the values predicted by the strong interaction theory at $Kn_\infty > 10^{-3}$;

2. The induced pressure on the plate for rarefied and weakly rarefied flows depends not only upon the hypersonic interaction parameters but also upon the density of the undisturbed flow determined by $(M_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}$. At $[(M_\infty\sqrt{C_\infty})/Re_{x\infty}] > 0{\cdot}15$ the deviation from the strong interaction theory is observed.

3. For fixed Mach numbers with an increase in the hypersonic interaction parameter at $[(M_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}] \geqslant 0{\cdot}5$ the induced pressure on the plate tends to a certain limiting value which is approximately determined by formula (1) from [3], i.e. a region exists near the leading edge in which the variation of the induced pressure is small.

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Abstract—In this paper are presented the results of an investigation of the induced pressure distribution on a thin plate with a sharp leading edge placed in supersonic rarefaction flow. The research was carried out in the low-density wind tunnel under the following conditions in the incident flow $5{\cdot}7 \leqslant M \leqslant 14$, $30 \leqslant Re_{\infty/mm} \leqslant 600$. The results obtained show that as one approaches sufficiently closely to the leading edge, the strong interaction theory no longer agrees with the experimental data and as $\bar{\varkappa} = [(\mu_\infty^3\sqrt{C_\infty})/\sqrt{Re_{x\infty}}]$ increases, the induced pressure on the plate approaches a constant value starting with $\bar{\varkappa} > \bar{\varkappa}_{\lim}$, where $\bar{\varkappa}_{\lim}$ depends upon the Mach number. For example, $\bar{\varkappa}_{\lim}$ is similar to 8 at the Mach number 5·7. The most characteristic of the induced pressure distribution is the deviation of the induced pressure from the strong interaction theory as rarefaction increases. There is a strong decrease in $\Delta\bar{P}/\bar{\varkappa}P_\infty$ for $[(\mu_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}] > 0{\cdot}2$.

Résumé—On présente ici les résultats d'une recherche sur la distribution de pression induite d'une plaque mince avec un bord d'attaque aigu placée dans un écoulement supersonique de gaz rarefié. La recherche a été conduite dans une soufflerie à gaz rarefié sous les conditions suivantes d'écoulement incident: $5{,}7 \leqslant M \leqslant 14$ et $30 \leqslant Re_{\infty/mm} \leqslant 600$. Les résultats obtenus montrent que lorsqu'on s'approche suffisamment près du bord d'attaque, la théorie de l'interaction forte n'est plus en accord avec les données expérimentales et lorsque $\bar{\kappa} = [(\mu_\infty^3\sqrt{C_\infty})/\sqrt{Re_{x\infty}}]$ croît, la pression induite sur la plaque commence à tendre vers une valeur constante, lorsque $\bar{\kappa} > \bar{\kappa}_{\lim}$, où $\bar{\kappa}_{\lim}$ dépend du nombre de Mach. Par exemple, $\bar{\kappa}_{\lim}$ est voisin de 8 au nombre de Mach de 5,7. Ce qui estleplus caractéristique de la distribution de pression induite est la déviation de celle-ci de la théorie de l'intéraction forte lorsque la raréfaction augmente. Il y a une diminution importante de $\Delta\bar{P}/\bar{\kappa}P_\infty$ pour $[(\mu_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}] > 0{,}2$.

Zusammenfassung—In dieser Arbeit werden Ergebnisse gebracht für Versuche an einer dünnen Platte mit scharfer Anströmkante in einer Überschallströmung mit verdünntem Medium bei aufgeprägter Druckverteilung. Die Untersuchung wurde in einem Windkanal für folgende Anströmbedingungen durchgeführt: $5{,}7 \leqslant M \leqslant 14$ und $30 \leqslant Re_{\infty/mm} \leqslant 600$. Die Ergebnisse zeigen, dass bei hinreichend grosser Annäherung an die Anströmkante, die Theorie der starken Wechselwirkung nicht mehr mit den Versuchsdaten übereinstimmt und dass bei einer Zunahme von $\bar{\kappa} = [(\mu_\infty^3\sqrt{C_\infty})/\sqrt{Re_{x\infty}}]$, ausgehend von $\bar{\kappa} > \bar{\kappa}_{\lim}$ sich der aufgeprägte Druck einem konstanten Wert nähert; dabei hängt $\bar{\kappa}_{\lim}$ von der Machzahl ab. So ist zum Beispiel $\bar{\kappa}_{\lim}$ etwa 8 für die Machzahl 5,7. Besonders charakteristisch für die aufgeprägte Druckverteilung ist die mit zunehmender Verdünnung erkennbare Abweichung des aufgeprägten Druckes von der Theorie der starken Wechselwirkung. Für $[(\mu_\infty\sqrt{C_\infty})/\sqrt{Re_{x\infty}}] > 0{,}2$ ergibt sich ein starker Abfall von $\Delta\bar{P}/\kappa P_\infty$.