הכינוס
הישראלי ה-25
להנדסת מכונות

תכניה

25-26 במאי 1994
קרית הטכניון, חיפה

THE 25th
ISRAEL CONFERENCE
ON
MECHANICAL ENGINEERING

PROGRAM

25-26 MAY 1994
TECHNION – HAIFA

C9.2 *MECSIP - Mechanical Equipment and Subsystems Integrity Program*
J. Bortman, Y. Elazar - Israeli Air Force

C9.3 *Tailoring a Dynamic Environment Spectrum for Combat Vehicles*
E. De-Medonsa, G. Reina, Y. Alfassa - Ordinance Corps, IDF

Session C10 **DESIGN & OPTIMIZATION**
Chairperson: **D. Wolf**, Technion

C10.1 *A New Field Single Wheel Tester*
D. Ronai, I. Shmulevich, D. Wolf - Technion

C10.2 *Models of Optimal Design of Ribbed Cylindrical Shells Subjected to Stochastic Loads*
Y. Pochtman - Dniepropetrovsk State University, UKRAINE, **I. Karnovsky** - Tel-Hai Regional College, **G.M. Fridman** - Marine Technical University of St. Petersburg, RUSSIA

C10.3 *Accuracy and Strength of a Joint Loaded by Suddenly Applied Torque*
I.M. Lopatukhin - Technion

Session C11 **MULTIPHASE FLOW**
Chairperson: **Y. Taitel**, Tel Aviv University

C11.1 *A Two Phase Model of Fractional Recovery and Grain-Size Composition of the Hydrocyclone Suspension Classification Products*
G. Kosoy - UPS

C11.2 *Amplification of Pressure Waves in Vapour-Liquid Bubble Medium*
B.G. Pokusarev, N.A. Pribaturin, E.S. Vasserman - Institute of Thermophysics, Novosibirsk, RUSSIA

C11.3 *Direct Numerical Modeling of Two-Phase Turbulent Axially Symmetrical Jets*
I.S. Antonov, M.S. Angelov - Higher Institute of Food Technology, Plovdiv, BULGARIA

Session C12 **STABILITY OF STRUCTURES**
Chairperson: **I. Sheinman**, Technion

C12.1 *A Note on Convex Models of Uncertainty for Small Initial Imperfections of Non-Linear Structures*
Y. Ben-Haim - Technion

C12.2 *Divergence of a Cantilever Plate as a Nonconservative Problem of Elastic Stability*
W. Dmitriyuk - Israel Electric Corporation

C12.3 *Nonlinear Effects in the Behaviour of Cylindrical Shells Under Nonuniform Axial Compression - Experimental Results*
V. L. Krasovsky - Dniepropetrovsk Civil Engineering Institute, Dniepropetrovsk, UKRAINE

C12.4 *Dynamical Stability of Viscoelastic Bodies Interacting with Fluid or Gas*
P.A. Velmisov - Ulyanovsk Polytechnical Institute, RUSSIA

Session C13 **COMPUTATIONAL MECHANICS**
Chairperson: **I. Harari**, Tel-Aviv University

C13.1 *Substructuring of Composite Panels - Mixed Grids of Elements, Strips and Transient Strip Elements*
D. Marom, J. Avrashi - Technion

הכינוס הישראלי ה־25 להנדסת מכונות

THE 25th ISRAEL CONFERENCE ON MECHANICAL ENGINEERING

TECHNION CITY, HAIFA, 25 - 26 MAY, 1994

Sponsored by:

Technion-Israel Institute of Technology
Tel-Aviv University
Ben-Gurion University of the Negev
Israel Association of Engineers and Architects

17 June, 1994

Professor M.S. Angelov
Higher Institute of Food Technology
26, bul. "Maritza"
Plovdiv 4000
BULGARIA

Dear Professor Angelov

Re:Your article submitted to the 25th Israel Conference on Mechanical Engineering

Your article, under the title:"Direct Numerical Modeling of Two-PhaseTurbulent Axially Symmetrical Jets" is included in the Conference proceedings.

We were disappointed, though, that you did not come to the Conference to deliver your lecture. A program was sent to you, as well as a registration form, but you did not respond.

Should you wish to purchase the Confernce Proceedings, please send us a check for the sum of $40.- (payable to the Technion Institute of Research and Developement) for the book (including shipping costs).

Sincerely yours

DIRECT NUMERICAL MODELLING OF TWO-PHASE TURBULENT AXIALLY SYMMETRICAL JETS

I. Antonov [1] , M. Angelov[2*]
[1]Technical University of Sofia, Bulgaria
[2] Higher Institute of Food Technology, Plovdiv, Bulgaria
[*] Conference Lecture

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DIRECT NUMERICAL MODELLING OF TWO-PHASE TURBULENT AXIALLY SYMMETRICAL JETS

I. Antonov [1] , M. Angelov [2*]
[1]Technical University of Sofia, Bulgaria
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ABSTRACT

A two-phase turbulent axially symmetrical jet have been investigated. It has been assumed that the size of the admixture particles is bigger than the molecular-kinetic scales and smaller than the characteristic scale of change of the macroscopic parameters. The numerical solution was realised by a direct method of numerical investigation. The model is based on a two-velocity scheme of a two-phase flow. There has been described the procedure of equation averaging, output systems of equations for numerical study and numerical results. The changes of maximum values of the velocity's components and concentration of admixture are given.

INTRODUCTION

The main disadvantage of the existing models of turbulence, applied for closing of the equation system for moving of turbulent flow, close to the boundary layer is the necessity of averaging and using relations with the aim to obtain a system which could be integrate [1,2,3]. These disadvantages can be eliminated by using the direct methods for numerical modelling of the Navie-Stoks equations without a preliminary averaging. This approach of investigation of turbulent flows has several advantages that make it applicable for the investigation of complicated flows such as the two-phase flows. We can prove it's advantages, lake using a simpler turbulent model, reading of three dimensional effects, etc.

BASIS OF THE NUMERICAL MODEL

In this publication the continuum model of moving of heterogeneous admixture is described. The numerical solution was realised by a direct method of numerical investigation on the base of Shuman's procedure [4] for one phase flows. A two-phase turbulent jet has been investigated. It was assumed that the size of the admixture is bigger than molecular-kinetics scales and smaller than the characteristic scale of change of macroscopic parameters. Due to this assumption the requirements of continuity of the admixture phase are fulfilled and this phase is considered like a special fluid medium without own tension tensor [5].The continuum model of flow is worked out on the base of the equations of continuity and moving for the two phases:

$$\frac{d_g\rho_g}{dt}+\rho_g\Delta\vec{V}_g=0 \qquad (1)$$

$$\rho_g\frac{d_g\vec{V}_g}{dt}=-\vec{F}+\Delta P \qquad (2)$$

$$\frac{\partial\rho}{\partial t}+\Delta\left(\rho_p\vec{V}_p\right)=0 \qquad (3)$$

$$D\left(\rho_p V_p\right)/dt=\vec{F}+\rho_p\vec{g} \qquad (4)$$

$$\rho_p=\alpha_p\rho_p^0 \qquad (5)$$

where subscript "p" is for the phase of admixture and "g" for the carrying phase.- When we solve the problem we have to read the forces of phase-to-phase interaction as follows:

$$\vec{F}=\vec{F}+\vec{F}_m+\vec{F}_{sf} \qquad (6)$$

where $\vec{F}_a$ is the aerodynamic resistance, $\vec{F}_m$ - the Magnus' force, $\vec{F}_{sf}$ - the Saffman's force. Here we take into consideration a Saffman's force because the jet flows have a big transverse velocity gradient [7]. A scheme like in [2] has been used, in which the basic equations are averaged by cell's volume. The turbulent tensions are determined by averaging the field's velocities, using Businesk's hypothesis. The averaging is realised as follows:

$$^j\overline{u}_i'\overline{u}_j'=-{}^j\mu\overline{D}_{ij}+\frac{1}{3}\delta_{ij}{}^k\overline{u}_k\overline{u}_k \qquad (7)$$

were: $\overline{D}_{ij}=\delta_i{}^j\overline{u}_i+\delta_i{}^j\overline{u}_j$

According to the Kolmogorov-Prandtl's hypothesis $^j\mu$ is determined by the expression:

$$^j\mu=C_2\left({}^jF{}^j\overline{E}'\right)C_{ij} \qquad (8)$$

where ^jF is a typical length, obtained from the area of the calculated cell, $^j\overline{E}'$ is a part of the filtered out turbulent energy, active on the respective wall:

$^j\overline{E}'={}^jC_5{}^v\overline{E}'$, at a condition

$$^v\overline{E}'=\frac{1}{2}\left({}^vu_i-{}^v\overline{u}_i\right)^2 \qquad (9)$$

The coefficients C_2 and $^jC_5$ are determined at a condition of equality of generation and dissipation of the turbulent energy.

The force of phase-to-phase interaction (6) is treated as follows.

For the resistant force:

$$\vec{F}_a=\beta\left(1+b_1\,Re_p^{1/2}+b_2\,Re_p\right)\rho_p\vec{V}_r$$

were: $\beta=18\nu\rho_g^0/\left(\delta_p\rho_p^o\right)$

$$Re_p=\delta_p\left|\vec{V}_r\right|/v;\ \vec{V}_r=\vec{V}_g-\vec{V}_p$$

For coefficient C_r it was assumed non-linear law:

$$C_r = 24\left(1 + Re_p^{1/2} + b_2\ Re_p\right) / Re_p \tag{10}$$

For the averaged by volume resistance force, projected on axis X we obtain:

$$^{v}\overline{F}_{ax} = \gamma\left(^{v}\overline{\rho}_p\ ^{v}\overline{u}_r + ^{v}\overline{\rho}_p^{'}\overline{u}_r^{'} \right) + \gamma_o\left(^{v}\overline{\rho}_p\overline{u}_r\overline{u}_r^{'2} + \overline{u}_r^{2}\overline{\rho}_p\overline{u}_r \right)$$
$$+ ^{v}\overline{u}_r\ ^{v}\rho_p^{'}\overline{u}_r^{'2} + ^{v}\overline{\rho}_p\ ^{v}\overline{v}_r\overline{u}_r^{'}\overline{v}_r^{'} + ^{v}\overline{u}_r\ ^{v}\overline{v}_r\ ^{v}\overline{\rho}_p^{'}\overline{v}_r^{'} +$$
$$+ ^{v}\overline{v}_r\dot{\rho}_p^{'}\overline{u}_r^{'}\overline{v}_r^{'}) / v_r^2 \tag{11}$$

For the averaged Magnus' force follows:

$$\vec{F}_m = \lambda_m\rho_p\left(\vec{\Omega}_r x\vec{V}_r\right)$$

where.

$$\lambda = 6K_m\rho_g^o / \left(\pi\rho_p^o\right)$$
$$\vec{\Omega}_r = 0.5\text{rot}\vec{V}_g - 0.5\text{rot}\vec{V}_p$$

For the averaged by a cell's volume this force has follows type:

$$^{v}\vec{F}_m = \lambda_m\ ^{v}\overline{\rho}_p\left(^{v}\overline{\Omega}_r x\ ^{v}\vec{v}_r + ^{v}\overline{\Omega}_r x\overline{v}_r^{'} \right) + \lambda_m\left(^{v}\overline{\rho}_p^{0}\overline{\Omega}_p^{'} x\right.$$
$$\left. ^{v}\overline{v}_r + ^{v}\overline{\rho}_p^{'}\overline{\Omega}_r x\overline{v}_r + ^{v}\overline{\rho}_p^{'}\overline{\Omega}_r^{'} x\overline{v}_r^{'} \right) \tag{12}$$

As it was mentioned in the present paper, the Saffman,s force is taken into consideration and read as in previous publications, treating this problem [7]. For the averaged by cell's volum this force has the following form:

$$^{v}\overline{F}_{sf} = k_{ss}\left(\partial\overline{u}_g / \partial y\right)^{0.5}\left\{ ^{v}\overline{u}_r\overline{\rho}_p + \left(\overline{\rho}_p\overline{u}_r^{'}\partial\overline{u}_g^{'} / \partial y + \right.\right.$$
$$\left.\left. +0.5\ ^{v}\overline{u}_r\overline{\rho}_p^{'}\partial\overline{u}_g / \partial\overline{u}_g\partial y\right\}\right) \tag{13}$$

were:

$$k_{ss} = 6k_s v^{0.5}\rho_g^o / \left(\delta_p\rho_p^0\pi\right) \tag{14}$$

The method for averaging [4,7] of the others terms in equations 1÷5 won't be investigated here because of the limited space.

NUMERICAL RESULTS

It's been assumed that the most suitable for this case is the numerical scheme using the method of "streams" [8], adapted to the features of the modelled flow. The results of the numerical solution for some of the investigated parameters are shown on figures 1 and 2. The velocity distribution is non-dimensionalized with the initial velocities of the gas phase U_g and the admixtures U_p. The changes of the maximum values of the velocity's components and concentration of admixture are shown on figures 3÷5. From these figures we should analyse the influence of the initial concentration χ and the diameter of the admixture D_p over the respective parameters. Because of the limited space we will not display here the extremely interesting results, concerning the transverse velocity component distribution of the turbulent energy and the turbulent tensions.

The present investigation and research were performed regarding the possibility to use this type of flow for the intensification of thermal, hydraulic and chemical processes in heat and mass exchange apparatus.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support and encouragement of Scientific Research Fund at the Bulgarian Ministry of Education.

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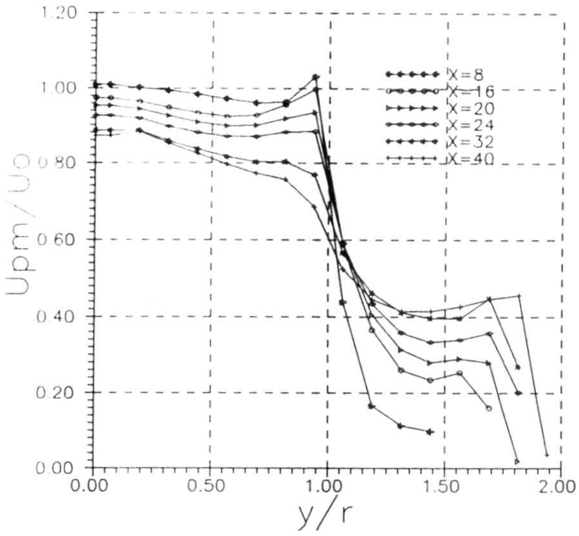

Fig. 1. Velocity distribution of admixture phase

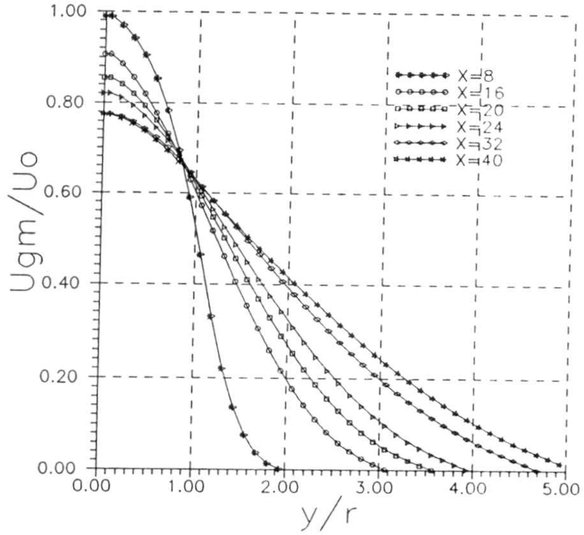

Fig.2. Velocity distribution of gas phase

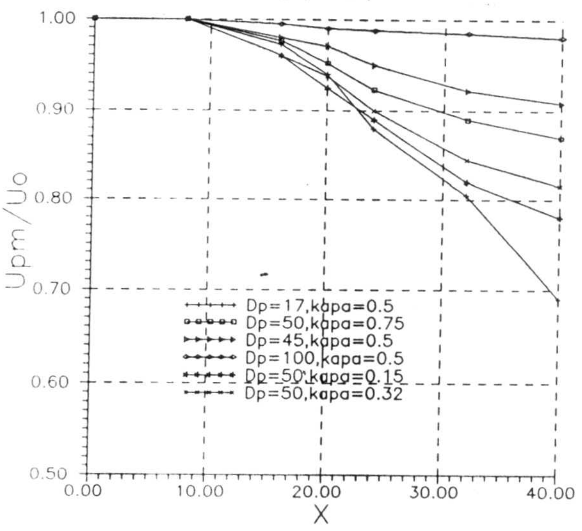

Fig. 4. Variation of the admicture velocity due to admixture particles size and initial concentration

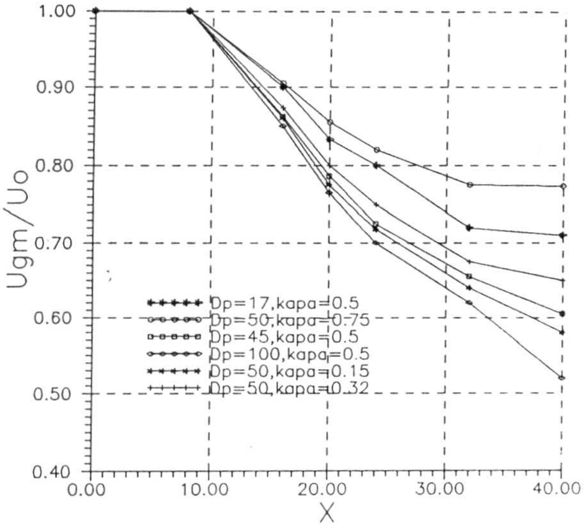

Fig. 3. Variation of the maximum gas velocity due to admicture particles size and initial concentration

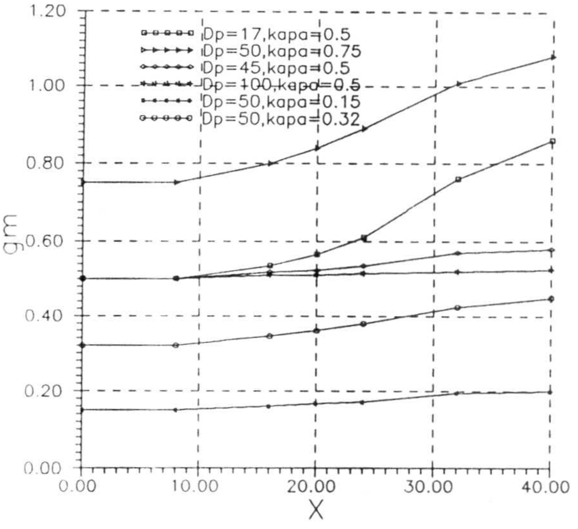

Fig. 5. Variation of the maximum concentration due to admixture size and initial concentration

THE 25th ISRAEL CONFERENCE ON MECHANICAL ENGINEERING
PROGRAM
Wednesday 25 May 1994

		1	2	3	4	5	6	7	8	9	10	11	12	13
	08:00 08:45	REGISTRATION Churchill												
	08:45 09:30	WELCOMING ADDRESSES AND AWARDS Churchill Auditorium												
	09:30 10:30	OPENING LECTURE: *Applications Of Laser Technology*, M. Oron - EL-OP Churchill Auditorium												
	10:30 11:00	BREAK												
A	11:00 11:30	Brittle Fracture Pineau (Rm. 250) A1.1	M. Kacz (Churchill) A2.1	Tribology (Rm. xxx) A3.1	Heat Transfer (Rm. xxx) A4.1	Robotics (Rm. xxx) A5.1	Dyn. Resp. of Solids (Rm. xxx) A6.1	Nonlinear Dynamics (Rm. xxx) A7.1	Composite Materials (Rm. xxx) A8.1	Metal Forming (Rm. xxx) A9.1	Design Optimiz. (Rm. xxx) A10.1	Multiphase Flow (Rm. xxx) A11.1	Transport Systems (Rm. xxx) A12.1	Ship Hydro-Dynamics (Rm. xxx) A13.1
A	11:30 12:00		D. BenNatan (Churchill) A2.2	A3.2	A4.2	A5.2	A6.2	A7.2	A8.2	A9.2	A10.2	A11.2	A12.2	A13.2
A	12:00 12:30	--		A3.3	A4.3	A5.3	A6.3		A8.3	A9.3	A10.3	A11.3	A12.3	A13.3
	12:30 14:00	LUNCH Student Center												
B	14:00 14:30	Control of Noise Pollution Rosenhouse (Rm. 250) B1.1	Coatings (Rm. xxx) B2.1	Tribology (Rm. xxx) B3.1	Heat Transfer (Rm. xxx) B4.1	Robotics (Rm. xxx) B5.1	Turbo-machinery (Rm. xxx) B6.1	Nonlinear Dynamics (Rm. xxx) B7.1	Composite Materials (Rm. xxx) B8.1	Metal Forming (Rm. xxx) B9.1	Design Optimiz. (Rm. xxx) B10.1	Multiphase Flow (Rm. xxx) B11.1	Transport Systems (Rm. xxx) B12.1	Comput. Mechanics (Rm. xxx) B13.1
B	14:30 15:00		B2.2	B3.2	B4.2	B5.2	B6.2	B7.2	B8.2	B9.2	B10.2	B11.2	B12.2	B13.2
B	15:00 15:30	Micro-machines Zmood B1.3	B2.3	B3.3	B4.3	B5.3	B6.3	B7.3	B8.3	B9.3	B10.3	B11.3	--	B13.3
B	15:30 16:00		B2.4	B3.4	--	B5.4	B6.4	--	B8.4	B9.4	B10.4	--	Stability (Rm. xxx) B12.4	B13.4
	16:00 16:30	BREAK												
C	16:30 17:00	Composites Hiel (Rm. 250) C1.1	Coatings (Rm. xxx) C2.1	Tribology (Rm. xxx) C3.1	Heat Transfer (Rm. xxx) C4.1	Robotics (Rm. xxx) C5.1	Turbo-machinery (Rm. xxx) C6.1	Aerosols (Rm. xxx) C7.1	Dyn. Resp. of Solids (Rm. xxx) C8.1	Industrial Projects (Rm. xxx) C9.1	Design Optimiz. (Rm. xxx) C10.1	Multiphase Flow (Rm. xxx) C11.1	Stability (Rm. xxx) C12.1	Comput. Mechanics (Rm. xxx) C13.1
C	17:00 17:30		C2.2	C3.2	C4.2	C5.2	C6.2	C7.2	C8.2	C9.2	C10.2	C11.2	C12.2	C13.2
C	17:30 18:00	Application of Fractals Stiassnie C1.3	C2.3	C3.3	C4.3	C5.3	C6.3	C7.3	C8.3	C9.3	C10.3	C11.3	C12.3	C13.3
C	18:00 18:30		C2.4	--	C4.4	--	C6.4	C7.4	--	--	--	--	C12.4	C13.4
	18:30 19:00	BREAK												
	19:00 20:00	BUFFET RECEPTION Student Center												
	20:00 21:00	EVENING LECTURE: *Can We Quantify Perception?*, D. Algom - Bar-Ilan University Student Center												

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Israel Association of Engineers and Architects

January 13, 1994

Prof. M.S. Angelov
Higher Institute of Food Technology
26 bul. "Maritza"
Plovdov
BULGARIA

Dear Prof. Angelov.

Thank you for your interest in submitting papers at the 25th conference.

The abstract of your papers arrived, titled:
1. Antonov I.S. & Angelov M.S. :"Direct numerical modeling of two-phase turbulent axially symmetrical jets."
2. Angelov M.S.:"Using of hydrodydamic cavitation for purification of water- alcohol solutions."

Printing information will be sent by mid- February of 1994.

Best wishes for a happy new year.

Sincerely Yours,
A. Orell
Alisa Orell
Conference Secretary

Technical Information
Conference Chairman
Prof. Miles B. Rubin
Faculty of Mechanical Engineering
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-293-188

Editorial Information
Editorial Chairman
Prof. Eli Altus
Faculty of Mechanical Engineering
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-293-157

Administrative Information
Conference Secretariat
Division of Continuing Education
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-294-464, 4-225-150
Fax. 972-4-294-466
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10 April 1994

Prof M. S. Angelov
Plovdiv, Bulgaria

Dear Lecturer

RE: <u>Your lecture at The 25th Israel Conference On Mechanical Engineering</u>

Enclosed please find the detailed program of the above mentioned conference, the registration form, and Hotel & Tour form. Please fill out these forms and return them to us as soon as possible.

☑ Your paper has arrived and will be included in the Conference proceedings.

☐ We have not yet received your paper and it will not appear in the proceedings unless it is received by 17 April 1994.

Just to remind you, your lecture is allotted 20 minutes, with an additional 5 minutes for questions. Slides and transparencies for all lectures will be in English.

Your lecture is scheduled for

Wednesday, 25 May 1994 at 17^{30} Lecture No C II.3

☑ At your request, your lecture hall will be provided with:

- ☑ An Overhead Projector
- ☐ A Slide Projector
- ☐ A Video System

☐ We did not receive your Lecturer's Form. Therefore, your lecture hall will only have an overhead projector.

We look forward to seeing you here in Haifa and wish you a rewarding and pleasant stay.

Sincerely

Miles B. Rubin
Conference Chairman

Technical Information
Conference Chairman
Prof. Miles B. Rubin
Faculty of Mechanical Engineering
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-293-188

Editorial Information
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Tel: 972-4-293-157

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Plovdiv, Bulgaria

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Sincerely

Miles B. Rubin
Conference Chairman

Technical Information
Conference Chairman
Prof. Miles B. Rubin
Faculty of Mechanical Engineering
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-293-188

Editorial Information
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Prof. Eli Altus
Faculty of Mechanical Engineering
Technion-Israel Institute of Technology
Haifa, 32000 Israel
Tel: 972-4-293-157

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ДИРЕКТНО ЧИСЛЕНО МОДЕЛИРАНЕ НА ДВУФАЗНИ ТУРБУЛЕНТНИ ОСОСИМЕТРИЧНИ СТРУИ

доц М. Ангелов - ВИХВП, Пловдив, България

Съществен недостатък на съвременните модели, прилагани за затваряне на системата уравнения за движение при турбулентните течения в приближение на граничен слой, се явява необходимостта от осредняване и прилагане на определени връзки и отношения, с цел да се достигне една интегрируема система. Дори и при решения, направени на основата на К-ε модел на турбулентност, /1/ /2/ /3/, тези противоречия не са преодолени.

При директните методи на числено моделиране на уравненията на Навие-Стокс, изградени на непосредственото им, без предварително осредняване, интегриране, тези недостатъци упоменати по-горе, са преодолими. Освен това, могат да се посочат възможностите им за отчитане тримерни ефекти, прилагане на опростени модели на турбулентност и др. В настоящата работа решението за двуфазни турбулентни струи е изградено на основата на разработената от Шуман /4/ процедура за еднофазни течения.

Използва се континуално приближение на двуфазното течение /5/ /6/. Двете фази се разглеждат като два взаимнопроникващи континуума, при което във всяка точка от течението те се характеризират с различни скорост и плътност. Едно подобно разглежане позволява доближаване до физическата картина на течението, като се отчитат силите на межуфазово взаимодействие. По този начин фактически се използва т.н. двускоростна схема на двуфазното течение, формулирана от Нигматулин /5/.

Разглежда се движение на газ с носени в него дисперсни частици примеси. Прието е, че размерът на частиците е много по-голям от молекулярно-кинетичните мащаби и много по-малък в сравнение с характерния мащаб на изменение на макроскопичните параметри. С това приемане се цели изпълнение на условието за непрекъснатост на фазата на примесите и разглеждането ѝ като особена флуидна среда, без собствен тензор на напрежение.

Континуалния модел на течението е изграден на базата на уравненията за непрекъснатост и движение за двете фази.

1

2

3

4

5

, където индексите „р“ се отнасят за фазата на примесите и“ г“ за носещата фаза.

При решаване на задачата се отчитат силите на междуфазово взаимоействие F, както следва:

(6) $$\vec{F} = \vec{F}_a + \vec{F}_m + \vec{F}_{sf}$$

където: F_a е аеродинамично съпротивление, F_m - Магнусова сила, $F_{яо}$ - сила на Saffman. За разлика от решенията в /2/ се въвежда отчитане на Саменовата сила, тъй като струйните течения имат много голям напречен градиент на скоростта.

Осредняването се извършва по обема V на изчислителната клетка или по направление на някоя от страните ѝ, съвпадаща със съответната координатна ос.

Турбулентните напрежения се определят чрез осреднените скорости на полето, при използване на хипотезата на Бусинеск. Осредняването им се реализира, както следва:

(7) Съгласно хипотезата на Колмогоров-Прандтъл $^{j}\mu$ се определя с израза:

(8) $${}^{i}\mu = C_2[FE]C_{ij} \, ,$$

където F е характерна дължина получена от площта на изчислителната клетка, jE е частта от отфилтрираната турбулентна енергия, действаща на съответната стена:

(9)

Коефициентите C_2 и C_5 се определят при равенството на генерация и дисипация на турбулентната енергия.

Силите на междуфазово взаимодействие (6) се обработват по следния начин. За коефициента на съпротивление /2/ се приема нелинейния закон:

(10)

при

За осреднената по обема V съпротивителна сила, проектирана по ос X, се получава:

(11)

За осреднената сила на Магнус следва:

(12)

където:

Както бе споменато в настоящата работа се въвежда отчитане на силата на Saffman. Това е упоменато и в някои от предишните ни разработки по въпроса /7/.

Осреднена по обема на клетката V, тази сила има следния вид:

(13)

,където

(14)

Методиката на осредняване /4/ /7/ за останалите членове в уравненията 1 ÷ 5, поради липса на обем няма да бъде обект на настоящето изследване.

Числената схема, на основата на която е разработена програмната реализация, е изградена по метода на потоците.

Резултатите от численото решение (при режим с $x_0 =, \Delta_p = \mu m, n_{p_0} = m/s, n_{g_0} = m/s, \rho_p = kg/m^3, \rho_g = kg/m^3$ са показани на фиг. 1, където са дадени разпределенията на скоростите, обезразмерени спрямо началната на газовата фаза U и на примесите U,

Изменението на максималните стойности на скоростните компоненти и на концентрацията на примеси е показано на фиг. 2 - 5. От фигурите се вижда влиянието на началната концентрация χ и диаметъра на частиците Δ_p върху съответния параметър. Нарастването на χ (фиг. 5) показва наличието на шнуроване /2/ в двуфазното течение - повишаване на концентрацията на примеси към оста му.

Поради малкия обем на работата тук не могат да се покажат много интересните резултати за разпределението на напречната скоростна компонента, турбулентните напрежения и турбулентната енергия.

Изследването е направено във връзка с възможностите за използване на този вид течения за интезифициране на топлообменните, хидравлични и химични процеси в топлообменните и масообменните апарати.

ЛИТЕРАТУРА

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ABSTRACT

Разглежда се движение на газ с носени в него дисперсни частици примеси , които образуват двуфазна турбулентна ососиметрична струя. Двете фази се разглеждат като два взаимнопроникващи континиума, при което във всяка точка от течението те се характеризират с различни скорост и плътност. В работата е описана изходящата система уравнения за числено моделиране , процедурата за осредняване по обем и резултати от числения експеримент. Моделът се основава на д~~ф~~вускоростна схема на двуфазно течение. Показано е влиянието на началната концентрация и размера на частиците върху изменението на основните параметри на течението. Направената съпоставка с опитни данни показва добро съвпадение на резултатите.