News Magazine of The Institution of Engineers(India), Kerala State Centre

Voice of Kerala Engineers

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CHAIRMAN SPEAKS

Er. K.K Gopalakrishnan Nair FIE

A one day seminar on "Plastic Waste Utilisation - and process" will be held in association with Sarabhai Institute of Science and Technology, Vellanadu, Thiruvananthapuram on 12th March 2020 at the college auditorium.

We are planning for a one day seminar on "Contribution of Biomedical Engineering for Humanity" in association with IEEE on 21st March 2020 at the IEI hall at Thiruvananthapuram. The next meeting of the council will be held on 27th, 28th and 29th March at Nagpur.

We have requested to the Headquarters to allot the National Convention of Electronics and Telecommunication Division for 2020 to be conducted at Thiruvananthapuram during October 2020.

President and SDG have again requested for membership drive to be conducted during the centenary year. I request all the members to get at least one more member enrolled to the institution.

SPECIAL MEMBERSHIP DRIVE

IEI plan to increase the membership by 10% in this Centenary year. All Corporate Members are requested to contribute to this effort by bringing in new members. The application forms can be downloaded from the website ***www.ieindia.org*** or obtained from Kerala State Centre or respective Local Centres.

23RD Er.C.S.PADMANABHA IYER MEMORIAL LECTURE

12.02.2020 23rd Er.C.S.Padmanabha Iyer Memorial Lecture on "Some tips for efficient use of energy and conservation" by Er.K.G.Chandrasekharan, Former Member (Civil), Kerala State Electricity Board & Past Chairman, IEI Kerala State Centre.

HONORARY SECRETARY'S DESK

Er. Asok Kumar K FIE

04-03-2020:World Engineering Day Celebrations. Talk on 'Maradu Flats Demolition- A review' by Dr. Anil Joseph, Managing Director, Geo Structurals, Kochi.

11-03-2020 : Talk on 'Technological Strategies for Safety Management in Steel Industry' by Er.P.Balakrishnan Nair, HSE Trainer & Consultant.

12-03-2020 : One Day Seminar on **'Technological advancement in Plastic Waste Utilsation and Processes (STAPWUP-2020)'** Organised by The Institution of Engineers (India) Kerala State Centre in association with Sarabhai Institute of Science & Technology Vellanad, Thiruvananthapuram.

Venue: APJ Abdul Kalam Memorial Seminar Hall, Sarabhai Institute of Science & Technology.

18-03-2020 : Talk on 'Some Decision Problems in Uncertainty ' by Dr.N.Narayana Pillai, Professor Emeritus, Amrita School of Engineering, Coimbatore.

21-03-2020 : One Day Seminar on **'Contribution of Biomedical Engineering for humanity'.** Organised by The Institution of Engineers (India) Kerala State Centre in association with Engineering in medicine and Biology Society (EMBS) of IEEE Kerala Section.

Venue: Institution of Engineers Hall, Visvesvaraya Bhavan, IEI, Kerala state Centre.

An exhibition of medical equipments and services also arranged.

Participation by registration.

25-03-2020 : World Water Day Celebrations on **'Water and Climate change'.**

IEI YOUNG ENGINEER AWARD 2020-21

With a view to promote the pursuit of excellence in the field of Engineering, IEI has instituted "IEI Young Engineers Award". The award consists of a plaque and certificate. The purpose of award is to recognize outstanding achievements/ contributions made by young engineers in engineering research, technology development, technologies transfer etc. Any engineer, citizen of India not more than 35 years of age as on 31/03/2020 can apply.

Visit ***https://www.ieindia.org*** for application and filled up forms be sent to ***award@ieindia.org*** by 31/03/2020.

100 years of relentless journey towards engineering advancement for national building

PALGHAT LOCAL CENTRE

On 13-02-2020 conducted a Technical Session on **"Bioenergy Options for Climate Change Mitigation"** by Dr. Shaji James P Professor of Farm Power, Machinery and Energy Dept., Kerala Agricultural University, Mannuthy.

KOZHIKODE LOCAL CENTRE

The inauguration of Centenary Celebrations is planned to be held on 7th March 2020. The Hon'ble Governor of Kerala **Sri. Arif Mohammed Khan** will be the Chief Guest.

Function at **4.30 p.m. at Tripenta Hotel** (Opposite Sarovaram Bio Park)

TRYST WITH TUNNELS

Dr. Deependran B, Wind Tunnel Group, Vikram Sarabhai Space Centre, Thiruvananthapuram

Paper presented during Seminar on 'Thermal Aspects of Space craft Systems' on 23.11.2019

Background : Forces and moments exerted on bodies during their motion through air, depending on the pressure, temperature and density are the prime concern in aerodynamics that results from a net exchange of mass, momentum and energy in the flow under the interference of the body **(Fig.1.).**

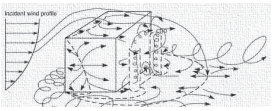


Fig.1. **Three dimensional flow over a body**

There are several fundamental physical processes to be understood for a flow over a body such as the onset of turbulence, flow separation, re-attachment, stability of flow, inertial effects, and molecular elasticity and in high speed flow the shock structure, molecular DOF, non-equilibrium effects, chemical reactions and so on. These non-linear interactions are independently being modelled, but, there are limitations of physical model and as a result, experiments are essential. A wind tunnel is the prime tool for simulating a flow over a body in ground be it low speed or high speed and for deriving the aerodynamic data.

Introduction to Wind Tunnels : Wind tunnels are device that generate a controlled, uniform, steady flow of air to test models of rocket or spacecraft for the generation of aerodynamic data. Obviously, it is not economical to simulate all types of flow in single tunnel and hence multiple tunnels are in existence based on the need. Tunnels can be classified based on their speed limits, and can be listed as;

Low speed wind tunnel – up to 100 m/s (Incompressible flows).

Transonic tunnel – $0.8 < M < 1.4$

Supersonic tunnel – $1.5 < M < 5.0$

Hypersonic tunnel – $5.0 < M < 12$

Trisonic WindTunnel – $0.1 < M < 4.0$

Polysonic Wind Tunnel – $0.2 < M < 5.0$

High enthalpy facilities (Shock Tunnel, Ludwieg tube, Free piston Shock Tunnel/Stalker tube)

Ballistic Range

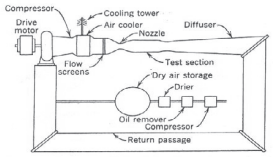
Arc heaters

Rarefied wind tunnel

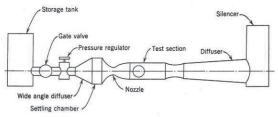
Flight Testing

Conventional wind tunnels are of three broad categories such as continuous wind tunnels,

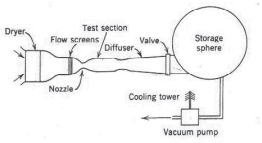
intermittent blowdown tunnels and indraft tunnel **(figure.2.a,b,c).**



a. Continuous circuit wind tunnels



b. Intermittent blowdown tunnels



c. Indraft type tunnel

Figure.2. a, b, c. Types of Wind Tunnels

A closed circuit or continuous wind tunnel uses a compressor drive system and circulate the air after proper conditioning before the test section. Hence a significant part of the energy expended in driving the air is regained and this also allows for long test durations. However, in the blow down type, air is compressed offline and stored in pressure vessels before the test run when the entire air used for blow down is expelled to the atmosphere. The blow down tunnels have short run times, typically of the order 20 to 50 seconds. The indraft tunnel start at atmospheric pressure and hence have low Reynolds number and also excellent flow quality in the test section.

The fundamental question in wind tunnel testing is the consideration of the non-dimensional number to be simulated. Not possible to obtain equality of all non-dimensional groups and scaling requirements might be relaxed. Judgement based on experience and understanding of mechanics of the phenomena is essential.

In incompressible flows, the important parameter for simulation is the Reynolds number. In compressible flow, the important parameter to simulate is the Mach number and the Reynolds number. There are tunnels, such as the shock tunnel where the Stanton number need to be simulated and the rarefied wind tunnel where the Knudsen number is important to be simulated.

Principles for model design : It is obvious that only a model will be tested in a wind tunnel and hence a model scale has to be arrived. Towards this, the important similarities with the actual flight scale need to be maintained.

1. Geometric Similarity, where the model is the same shape as the application, usually scaled.
2. Dynamic similarity, where the ratios of all forces acting on corresponding fluid particles and boundary surfaces in the two systems are constant.
3. Kinematic similarity, where the fluid flow of both the model and real application must undergo similar time rates of change motions (i.e. fluid streamlines are similar).

The model scale has to be selected considering the blockage of the model in the test section is minimum and is about 1% in transonic regime and less than 5% in supersonic regime. Wall interference is a severe problem for transonic wind tunnels as flow can "choke" due to shock wave across the tunnel test section and due to this there are porous walls or movable adaptive walls for the transonic test section. However, the model has to be designed and fabricated to withstand the starting and stoppage loads which are significantly larger than the loads during test and is a function of the blowing pressure.

Important guidelines for model design

Scale down the model as dictated by the test section of the tunnel. In general the model should have a blockage of 0.5% to 1.0% for Transonic, and about 2% to 3 % for supersonic to have interference free data Design the model to suit the existing instrument

Load are estimated through design methods or start / stop loads dictated by the facility. All the Joints should have a minimum FS of above.

Model should be of highly modular in nature. Mandatory to assemble or disassemble

Principle of Wind Tunnel : The working fluid, normally air, is sourced from the pressure vessel (or compressor drive, in case of a continuous tunnel). The pressure regulating valve regulates the pressure of the air to the desired steady pressure in the settling chamber. In the settling chamber the flow undergoes conditioning by passing through a honey comb for straightening and a series of meshes for reducing the flow turbulence. The conditioned air enter the nozzle to accelerate to the desired Mach number in the test section, in case of a supersonic tunnel. The flow at the desired Mach number flows through the test section where the model is positioned using a model incidence mechanism. However, in case of subsonic flow, the flow velocity is controlled by the variable diffuser located downstream of the test section. Aft of the test section, the flow kinetic energy is recovered using the diffuser system. An ejector system for the tunnel will enable to operate the tunnel at lower starting pressures and simulate larger range of Reynolds numbers.

What to worry in a wind tunnel flow: The important factors of a tunnel blow down are the starting of the started, adequate supply of dryair for the required run time, free stream turbulence, condensation, liquefaction, the flow quality in the test section such as spatial uniformity, velocity fluctuations, flow angularity, wall interference effect from test section, the transonic Mach number control, test rigs such as twin roll model system/damping rig/ captive trajectory rig and the associated instrument capable of rapid measurement.

Wind Tunnel Testing to derive Aero data : The major tests that are undertaken in a wind tunnel are:

Force measurements, using strain gauge balances.

Pressure Measurement such as surface steady & unsteady pressure measurements

Special tests for strap-on separation studies, component load measurements (on strapon, nozzle, etc.), pitch /yaw /roll damping measurements, angle of attack measurement and flow visualization using tuft, oil flow (separation, attachment), Shlieren shadowgraph/ interoferometry (shock, expansion waves, shear layer), hot wire, LDA

Flow Visualization in Wind Tunnels

QUALITATIVE

- Smoke flow
- Fog
- Optical methods
- Evaporating suspensions
- Dye visualization

QUANTITATIVE

- Particle Image Velocimetry
- Infrared Thermography
- Optical methods
- Electron beam fluorescence
- Planar laser induced flouresce
- Surface sensitive paints

Advanced techniques such as Nitric Oxide Planer Laser Induced Fluorescence (NO PLIF), DualPump Coherent Anti-Stokes Raman Spectroscopy (DP-CARS), and Virtual Diagnostics Interface are being developed world wide.

Dynamic stability tests: Stability derivatives arising due to angular velocity components, and the rate of change of linear velocity are known as dynamic stability derivatives and is an important part of wind tunnel testing. The conventional force measurement balance cannot be used for this and requires special purpose rig. The basic principle is to create relative motion between the model and the uniform stream of flow in the desired degree of freedom and measure the reaction or the motion of the model of above. There are two measurement technique namely the free or forced oscillation. Here, typically, the model is held at its centre of gravity and allowed to perform rotational motion under aerodynamic forces. The record of its motion using rotary encoder accelerometers, gyros is used to derive the damping coefficients.

In view of the important of wind tunnels, ISRO is also developing a 1.2m trisonic wind tunnel. The tunnel is an intermittent blowdown type wind tunnel in the Mach range: 0.2 to 4. The dimensions of test section is 1.2m × 1.2 m. The tunnel will have a air storage system of storage pressure of 20 bar and of total storage volume of 4550 m3. The pressure vessels have a length of 50 m, Diameter: 4.5m; and number of vessels are 6nos. The high pressure system comprise of two chains of 4-stage centrifugal compressor and the air dryer. **Figure.3.** show the layout of ISRO 1.2m trisonic wind tunnel.

Figure.3. Layout of ISRO 1.2m Trisonic wind tunnel.

Conclusions : Modern industrial class wind tunnels are massive engineering systems using which accurate aerodynamic characterization of launch vehicle/spacecraft can be obtained with confidence. Wind tunnel testing techniques must grow hand in hand. Model realization remains one of the critical chain in tunnel testing. With the advent of 3D printing, it has become possible to simulate small components during wind tunnel testing to a great extent of accuracy.

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I, Er.N.Rajkumar, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Sd/-
Er.N.Rajkumar
Signature of Publisher

01-03-2020

Kerala State Centre- WEDNESDAY TALKS - Glimpses

05.02.2020 Talk on "Rocket Science at Microscopic Scale ~ The Self Propelled Colloids ~" by Dr Akhil Varma, PhD, Laboratory of Hydrodynamics (LadHyX), Ecole Polytechnique, Paris, France.

19.02.2020 Talk on 'Dynamics of two-phase flow - Modeling challenges and road forward' by Dr.Pradeep Kumar, Associate Professor, Department of Aerospace Engineering, IIST.

26.02.2020 Talk on 'Precision farming' by Dr.Abdul Hakkim.V.M., Professor-Soil & Water Conservation Engineering, College of Agriculture, Kasaragod.

PROPOSED GUIDANCE CLASSES AT IEI KERALA STATE CENTRES

Summer Vacation Class for High School Students

Admission starts from March 2020 and classes starts from 6th April for 1 month duration.

Training programme includes both theory and practicals. Theory classes on Science Education, Energy Management, Sustainable Development and various safety practices are handled by eminent faculty from schools, colleges and Government Departments.

Practical class include assembly and testing of an electronic device, which can be taken home after the course.

GATE 2020 (Graduate Aptitude Test in Engineering)

Admission starts from April 2020 and classes starts from May 2020 for following branches.

Course duration: 8 months (Saturdays & Sunday Batch)

- Civil
- Mechanical
- Electrical & Electronics
- Electronics & Communication

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