# GANESH BORDE

**MS in AEROSPACE ENGINEER| UNIVERSITY OF TEXAS AT AUSTIN**

**BS in AERONAUTICAL ENGINEER| VELTECH UNIVERSITY**

ganeshyng789@gmail.com

+1 737-326-0702

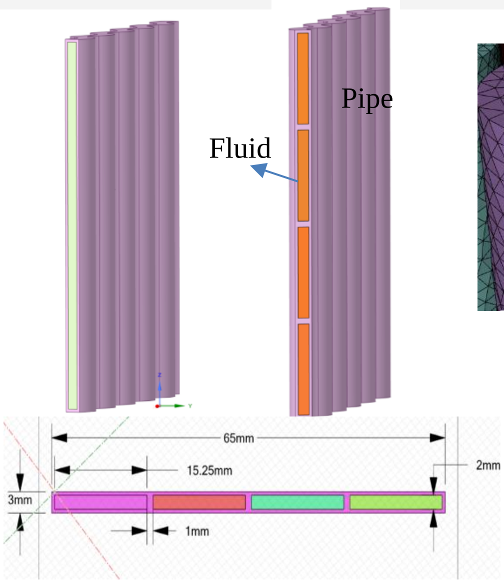
Austin, TX, USA

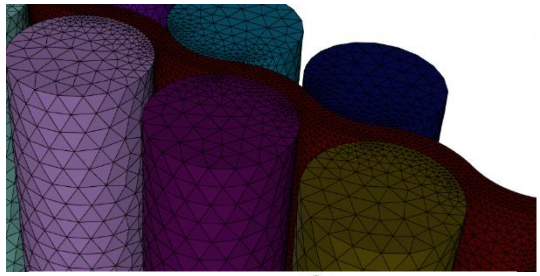
linkedin.com/in/ganesh-borde-928701217

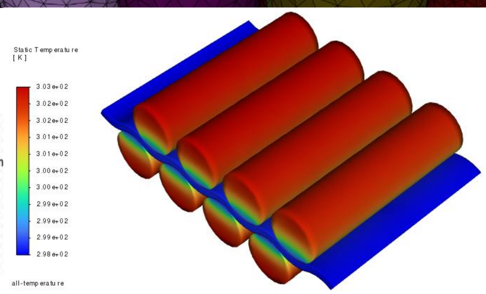
ganesh-borde.github.io/

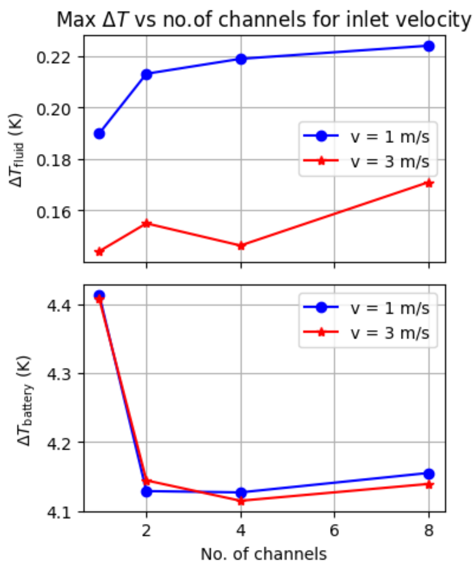
github.com/Ganesh-Borde


## 18650 Battery Pack Cooling Using Serpentine Pipe








### What?

- EV Battery pack cooling using serpentine pipe –used in Tesla
- Heat released @ 4C =74163 $W/m^3$
- Study effect of single channel and multi channel 2,4, and **8**

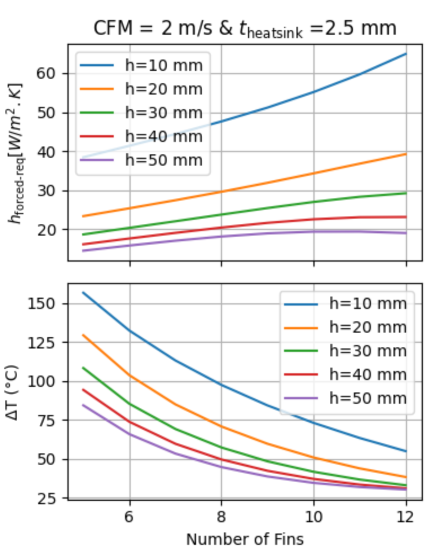
### How?

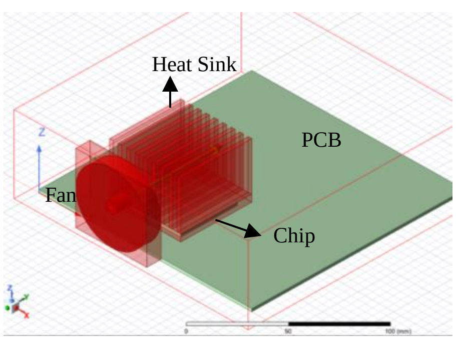
- ANSYS water tight geometry meshing
- Ansys Fluent- Steady state, Conjugate heat transfer, and Multi zone
- Flow is laminar and solving energy
- Multiple Iteration

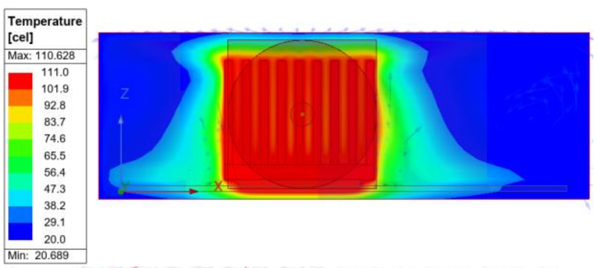
### Results

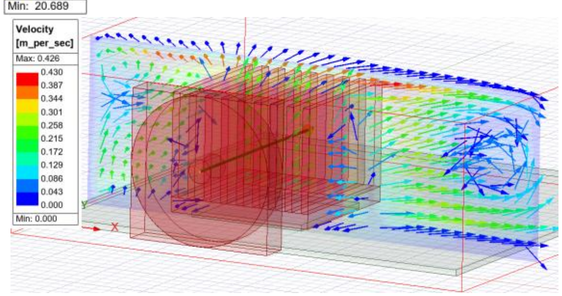
- Using multiple channels decreased MTD (Maximum temperature diff)
- But in the cost of increasing fluid temperature
- Adding more channels reduces overall fluid mass rate, so no change in MTD

## Analytical & CFD-FEA Study of Chip Cooling with Optimized Heatsink Design.




### What?

- Analytical Thermal Resistance Model (RM) for a chip-heatsink-fan system by using DOE
- $Q_{chip} = 30W, T_{amb} = 20$℃.
- DOE varying thickness and no.of fins to maintain $T_{jun} = 85$℃

### How?

- Ansys Icepak –uses Fluent for flow and FEA for structure
- Inbuilt automatic fine structured mesh
- Turbulent, steady state
- PyAEDT for DOE by varying the location of chip and heat sink
- Grille with free area ratio of 0.9

### Results

- Thickness and no.of fins have influence on required cooling from analytical model.
- Influence on location of chip-heatsink using PyAEDT Icepak results
- Results from simulations & RM had small differences in temperatures and velocities, due to simplicity in RM.

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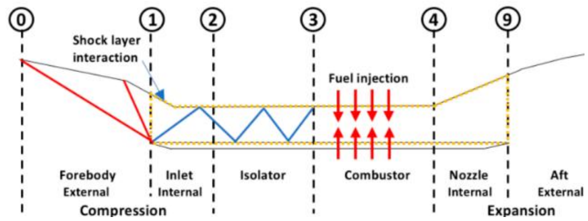
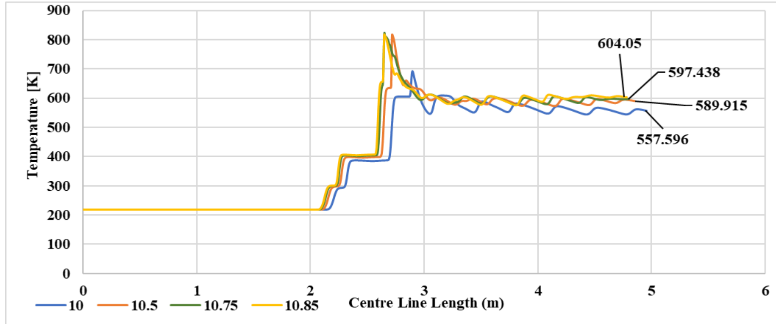
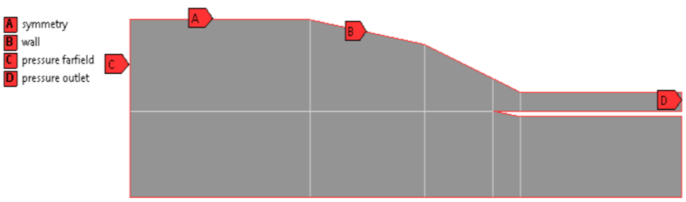
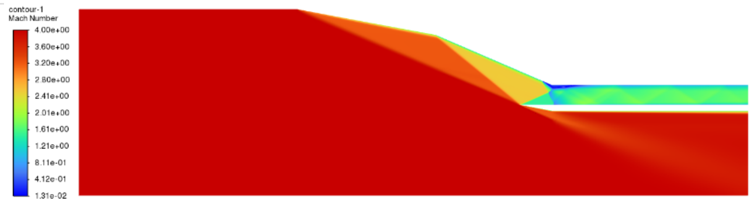
## Design of Scramjet Inlet for Shock on Lip Condition at Low Mach Number by Using CFD




### What?

- Engine for high speed flights with only 2 engines, Turbo-Ram and Scramjet
- At low Mach number 4&5 achieving minimum ignition temperature (MIT) by compression is challenging
- Using shock on lip for flow spillage and 2 ramps by varying angles for compression.

### How?

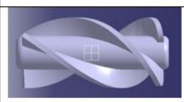
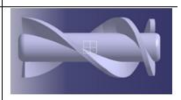
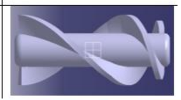
- Using Hypersonic aerodynamics, designed analytical geometry and modeled in Catia.
- Block-Structured mesh using Ansys meshing
- Ansys Fluent- RANS, Steady state, Density-based solver and ideal gas
- The Advection Upstream Splitting Method (AUSM) for shock capture

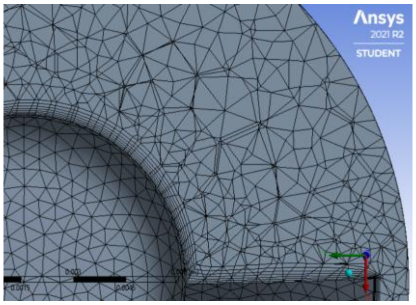
### Results

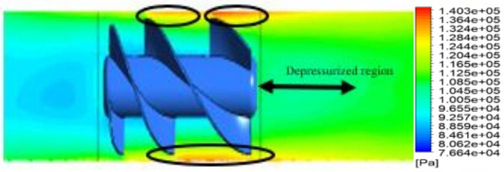
- Initial geometry doesn't give required MIT for JP-7 fuel.
- Varying angles of ramps by different combination got desired MIT for combustion in engine.
- Shock-on-lip observed in all simulations

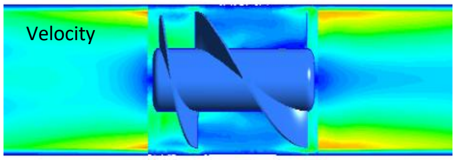
## Design and analysis of small-scale axial flow pump impeller using CFD (Ansys CFX)

| | Specification | |
|---|---|---|
| Pump | Revolution per Minute (RPM) | 10000 |
| | Discharge | 5[L/Min] |
| | Working Fluid | Water |
| | Desired Head | 1000[Kg/m³] |
| | Density of working fluid | 1[m] |
| Blade | Type | Helical |
| | Total length | 43.5[mm] |
| | Tip Diameter | 20[mm] |
| | Hub Diameter | 10[mm] |
| | Blade Height | 5[mm] |
| | Blade Thickness | 1[mm] |

| Leading Edge Profile | Wrap Angles 240° | 300° | 360° |
|---|---|---|---|
| Circular |  |  |  |
| Parabolic |  |  |  |




### What?

- Mini axial-flow pump for small-scale use: chemical dosing, blood pumps, dispensers
- Analyzed 6 impeller designs with:Wrap angles: **240°, 300°, 360°**
- Leading edge shapes: **circular** and **parabolic**

### How?

- Designed in **CATIA**, domains split into suction, pump, and delivery.
- **Meshed in ANSYS** with inflation near impeller walls for boundary layer accuracy
- Simulated in **ANSYS CFX**, steady-state, 10000 rpm, 5 L/min flow
- Used **k-ε turbulence model**, sliding interfaces between rotating and stationary domains

### Results

- **300° wrap angle + parabolic edge** gave best total head and smooth flow
- Parabolic edges minimized flow separation at leading corners
- **Head increased as discharge decreased**, confirming expected trend
- Improved pressure and velocity distribution observed near blade surfaces

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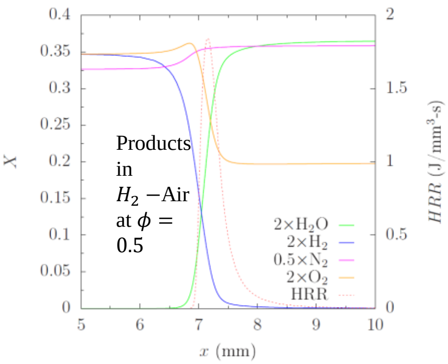
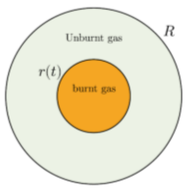
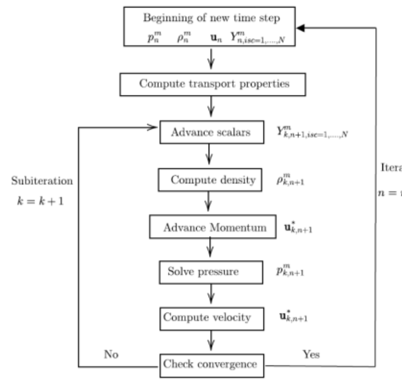
## Measurement of Flame Properties in CFD Simulated Premixed Cylindrically Expanding Flames



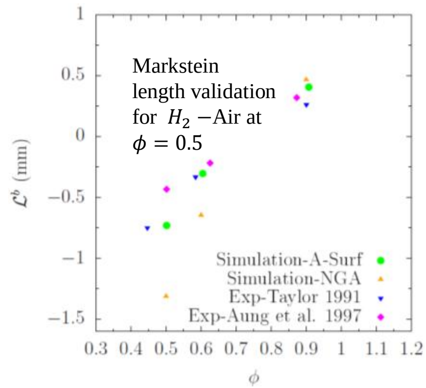




$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0, \qquad \frac{\partial (\rho \mathbf{u})}{\partial t} + \nabla \cdot (\rho \mathbf{u} \otimes \mathbf{u}) = -\nabla p + \nabla \cdot \boldsymbol{\sigma},$$

$$\frac{\partial \rho h}{\partial t} + \nabla \cdot (\rho h \mathbf{u}) = -\nabla \cdot \mathbf{q}, \quad \frac{\partial \rho Z}{\partial t} + \nabla \cdot (\rho u Z) = \nabla \cdot (\rho D_Z \nabla Z) + \dot{\omega},$$

$$\mathbb{K} = \frac{1}{r}\frac{dr}{dt}. \qquad S_f = S_L - \mathcal{L}\mathbb{K},$$




| Mixture | | MA | | MA-MC | | MA-MA | |
|---|---|---|---|---|---|---|---|
| Name | $p_0$ (atm) | $S_L$ (m/s) | $\mathcal{M}^b$ | $S_L$ (m/s) | $\mathcal{M}^b$ | $S_L$ (m/s) | $\mathcal{M}^b$ |
| D80E95 | 1 | 3.6894 | 2.7282 | 3.772 | 4.4887 | 3.6990 | 3.0011 |
| D82E90 | 1 | 3.2013 | 2.6941 | 3.2797 | 4.2494 | 3.2156 | 2.9735 |
| D84E90 | 1 | 2.8169 | 2.6861 | 2.8856 | 4.2689 | 2.8318 | 3.0155 |
| D89E65 | 1 | 1.0863 | 0.9635 | 1.0986 | 1.2127 | 1.0986 | 1.2127 |
| | 2 | 1.0273 | 0.9010 | 1.0427 | 1.1986 | 1.0381 | 0.9708 |
| | 3 | 0.9626 | 0.8340 | 0.9744 | 1.1514 | 0.9714 | 0.9051 |

**What?**

- Combustion research on alternate premixed fuel needs, a lot of Numerical studies
- Hydrogen-Air Combustion in Von Karman Combustion Chamber (VKCC)
- Creating a framework to calculate flame properties efficiently.

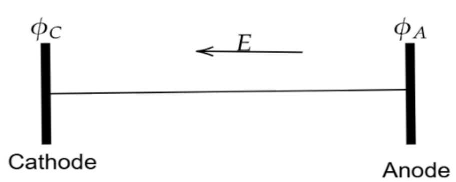
**How?**

- Usually 3D spherical solver are used- expensive. Here 1D cylindrical mapped solver is used, computationally efficient.
- Pre analysis using Cantera 1D-Planar
- Using Mixture-average model for diffusion velocity. Inhouse code NGA-HPC, Parallel, Soret effect included

**Results**

- Parameters interested – Flame speed, Markstein number and length
- NGA results are validated with experimental results.
- NGA is applied for premixed Hydrogen study.

## Design and analysis of small-scale axial flow pump impeller using CFD (Ansys CFX)




$$\frac{\partial n_s}{\partial t} + \nabla \cdot \Gamma_s = S$$

$$\Gamma_e = -\mu_e n_e E - D_e \nabla n_e, \Gamma_i = \mu_i n_i E - D_i \nabla n_i$$

$$S = \bar{\alpha}\left|\Gamma^{\text{drift}}\right| = \bar{\alpha}\mu_e |E| n_e$$

$\mu_e$, $D_e$ and $\bar{\alpha}$ are function of $|E|$

$$\nabla^2 \phi = -\frac{\rho}{\varepsilon_0}$$

$$E = -\nabla\phi \text{, where } \rho = (n_i - n_e)e$$

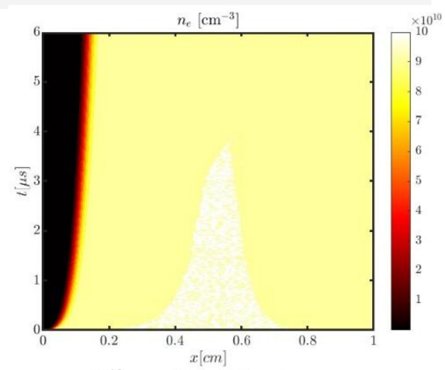
Cathode

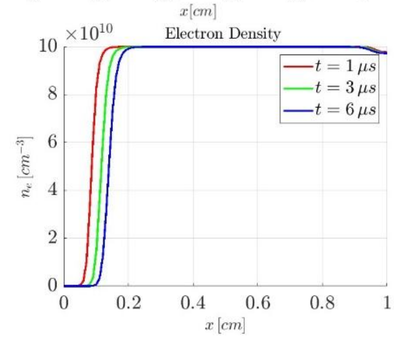
- $\nabla n_i = 0, \nabla n_e = 0$
- $\phi = \phi_C$
- $\Gamma_i = \frac{1}{4}\nu_i n_i + n_i \mu_i E$

  where $\mathrm{v}_j = \sqrt{8k_b T_j / \pi m_j}$
- $\Gamma_e = \frac{1}{4}\nu_e n_e \pm \gamma \Gamma_i$

Anode

- $\nabla n_i = 0, \nabla n_e = 0$
- $\phi = \phi_A$
- $\Gamma_i = \frac{1}{4}\nu_i n_i$
- $\Gamma_e = \frac{1}{4}\nu_e n_e$




**What?**

- Drift diffusion model, very common model in plasma physics to study number density of electron and ions.
- **Applications:** Plasma Confinement, Glow Discharges and Ionization Fronts, Electric Probe Diagnostics, Semiconductor Plasmas, Plasma Thrusters

**How?**

- FVM
- Explicit time discretization ODE45
- Convective term $\Gamma^{\text{drift}}$ - using Lax-Friedrich Flux Splitting and WENO5 for discretization
- Dirichlet B.C to solve the Electric Potential results a sparse matrix
- $\Delta t = 1$ ns, t $= 6\,\mu s$,
- $\Delta x = 1\,\mu$m, L $= 1$ cm

**Results**

- Captured the sheaths and number densities