PhD Project

Project Details

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<tr>
<th>Project Title</th>
<th>Investigating thermal runaway and fire-propagation aspects of electrical systems in domestic and small-scale commercial applications for enhancing fire safety</th>
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<td>Project Summary</td>
<td>Fires originating from electrical appliances are matter of common news all over India, with many small and scattered incidences not even making up to the headlines. Still, this subject area is not studied in detail from an engineering perspective. There are some individual industrial case studies required by regulations, however there is dearth of basic studies in the domestic and commercial sector. It is especially needed in this sector due to its scattered nature, absence of technical knowledge on fire-safety and prevalence of unnecessary cost saving measures compromising fire safety. Yet many arrangements in these sectors are quite common and can be studied systematically. It is hoped that with insights from research in thermal aspects of common electrical systems in households and commercial complexes, low-cost technical interventions can be made to avoid potential fire-hazards. Electrical design of various appliances and circuitry only focuses on maximum current and heat generation in a setup. However, the problem needs to be studied more holistically including thermal dissipation and thermal buildup aspects as well as subsequent ignition and combustion (leading to fire). Present proposal targets at performing fundamental studies on heat and mass transfer (of volatiles) from various electrical systems in domestic and small-scale commercial applications and then assessing the fluid mechanics, ignition, and subsequent combustion propagation from the heat sources in these systems. This project will be a collaboration between the department of Mechanical and Electrical engineering at the institute. The electrical portion will focus on correctly estimating the heat source distribution at various locations in the device, and the mechanical (thermal and fluids specialization) engineering will be studying heat transfer and energy balance, temperature rise, volatiles generation due to heating, ignition of combustible material nearby and subsequent flame development. This could be further extended to fire propagation in the room. There is a fire research facility in Dept. of Mechanical Engineering with high resolution infrared camera and dedicated fire creation space for studying such setup. The same physics can also be simulated using variety of computational tools such as ANSYS, Fire Dynamics Simulator (FDS), COMSOL Multiphysics etc. Simulations have advantage of providing detailed spatio-temporal insights in the phenomena when properly validated against experiments. With a combined experimental and simulation approach, insights will be gained on common-day electrical arrangements and when they start becoming a fire-hazard risk. This will lead to design of better prevention methods.</td>
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PhD Supervisors

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<tr>
<th>Role</th>
<th>Faculty</th>
<th>Academic Unit in IITD</th>
<th>Email ID</th>
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<tr>
<td>Supervisor 1</td>
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### Project requirements (Student qualifications, experience required, etc)

- Bachelor’s degree in mechanical or related engineering discipline with courses on fluid mechanics, heat and mass transfer and thermodynamics.
- Elementary courses on electrical systems design as part of the bachelor’s degree

### Source of funding (IRD/FITT Project details, if any)

Institute scholarship (Institute PhD student quota of Prof. Krishnakaant Agrawal available for this)

### Role of Faculty Members involved:

#### Prof. Krishnakant Agrawal (ME):
- Creation of an experimental setup in the fire dynamics lab of ME Dept. with the identified electrical setup and loading.
- Study heat and mass transfer from the hot-spots (heat generation points) in the setup using measurement techniques such as infrared imaging, thermocouples, anemometry, schlieren, shadowgraph imaging etc.
- Create numerical models using commercial CFD (Computational Fluid Dynamics) software such as ANSYS, COMSOL, Fire Dynamics Simulator (FDS) to simulate heat and mass transfer, flow field, energy balance, thermal buildup and dissipation, ignition potential and flame propagation.
- Create a match between simulation and experiments to validate the former, and then explore design options to mitigate fire hazard at low cost.

#### Prof. Sumit Pramanick (EE):
- Definition of electrical systems and circuitry encountered in common household and commercial applications
- Perform analysis of these systems using electrical circuit simulation tools to provide hotspots and distribution of heat generation rates in the system
- Define components for creating a lab scale electrical setup with access to the target study area for thermal and fluid dynamics studies
- Provide electrical parameters of the circuit in a deteriorating (burning) state.