



Project Proposal for Ph.D.

Project Details	
Project Title	Investigation on the Performance of the Free-Falling Particle Receiver in a Central Tower for High-Temperature Solar Applications
Project Summary (Minimum 500 and maximum 2000 characters)	The central tower (CT) based solar thermal technology primarily utilizes surface receiver and cavity receiver for solar energy to thermal energy conversion. These receivers are facing the problems of operational difficulty and thermal stability of heat transfer fluid (HTF). The heat transfer fluids used in CT technology are solar salt, water, and air. The maximum operating temperature is limited to 565°C when the solar salt is used as the HTF. For water and air as HTF in the CT, the receiver experiences higher operating pressure which results in higher costs for the receiver and frequent requirements of operational maintenance. Therefore, the researchers are exploring free-falling solid nanoparticles such as ceramic, bauxite, etc. as HTF in the receiver of CT. Particles fall freely under gravity; however, the residence time for facing concentrated solar flux by a particle is less, thus, reducing the potential of the central receiver. Increasing the residence time of facing concentrated solar flux increases the heat energy collected by a particle. One of the ways to increase the residence time of movement of a particle is when the particle moves through a highly tortuous porous structure. Thus, the broad idea of the proposal is to consider a porous free falling particle receiver optimized in terms of material and structure. The proposed porous particle receiver provides the tortuous path to the particles’ movement, thus increasing residence time. The selection of suitable materials of particle and various porous structure configurations needs to be explored for better conversion of solar radiation in high-temperature heat. Objectives: • Design of receiver for Central Tower based solar thermal energy technology for the utilization of particles. • Numerical investigation of solar radiation flux profile on the particle receiver. • Numerical study for heat transfer in porous particle receivers under various structural configurations. • Development of an experimental test facility for testing the performance of particle receivers and to assess their thermodynamic performance. • Technoeconomic analysis of porous particle receiver. (Detailed proposal is enclosed herewith)

Ph.D. Supervisors			
Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Dr. Ravi Kumar	Dept. of Energy Science and Engineering	krk@dese.iitd.ac.in
Supervisor 2	Dr. Suresh Neelakantan	Dept. of Materials Science and Engineering	sureshn@iitd.ac.in

Project requirements (Student qualifications, experience required, etc) *The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)
• B.E./B.Tech or M.Tech in Energy Engineering/Thermal Engineering. Specific experience in thermal engineering, solar energy, and material science engineering would be beneficial.

Source of fellowship/funding (CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)
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Institute fellowship

Role of Faculty Members involved:	
Supervisor-1 (Dr. Ravi Kumar)	Studying the flux profile on the particle receiver and choosing suitable solar energy technology; Thermodynamic modeling, studying the effect of size, structure and tortuosity of porous particle receivers, and techno-economic analysis.
Supervisor-2 (Dr. Suresh Neelakantan)	Materials selection for a porous receiver, particle, and design of porous configuration; processing of materials along with activities for designing of free-falling particle receiver and related materials characterization.