Trickle bed reactors are extensively used in chemical and associated industries such as petroleum, petrochemical, pharmaceutical, biochemical, and waste treatment due to their unique advantages in handling catalysts on a large scale and operating at high pressures over the slurry reactors. The overall performance of such types of reactors depends on several issues that influence hydrodynamics, fluid-phase mixing, interphase and intraparticle heat, and mass transfer and reaction kinetics. Some specific issues like particle shape and size distribution, bed packing characteristics, flow maldistribution, wetting of catalyst particles, and their influence on heat and mass transfer rates are critical for designing industrial trickle bed reactors. Consequently, current and future technologies based on trickle bed reactors demand a fundamental understanding of the functionality of such processes to enable manipulation and control of the trickle bed reactors to ensure improved performance to suit the specific requirements.

In ideal conditions, the liquid flow inside a trickle bed reactor is distributed uniformly over the whole volume of the packed bed. However, the random arrangement of particles is highly affected by the presence of the wall of the container which in typical applications is a cylindrical column. The wall introduces an ordering into the random structure which, although decreases with the distance from the boundary, leads to an oscillating pattern of local void fraction (porosity) of the packed bed. This, so-called *wall effect*, leads to significant non-uniformity of the fluid flow in the near-wall region, particularly on the wall itself.

It is expected that deviation from the regular shape must inevitably reduce the ordering of particles and decrease the variation of the local void fraction. Therefore, the main objective of the present project proposal is to examine how the structure of a random packed bed and fluid flow inside the packing is influenced by modifications made in the structure of the container’s wall. This goal will be attained by performing both experimental and numerical activities.

An initial part of the project will be focused on conducting a series of simulations aimed at examining the effect of different packed bed wall shapes on radial distribution of void fraction of obtained structures. The goal of this task will be searching for such configurations ensuring alleviation or even prevention of the wall effect in packed beds equipped with particles of different shape and size.

The most promising geometries (modifications of the column wall) will be fabricated using 3D printing technique in order to examine how the reduction (or prevention) of the wall effect contributes to the liquid distribution inside the packing structure. The key goal of this task will be a verification whether the corrugated wall enables reducing the liquid maldistiribution in the vicinity of the wall.

Also computational fluid dynamics (CFD) simulations of the fluid flow through the most interesting packing geometries distinguished at the earlier stage will be conducted to have even more detailed insight into fluid flow characteristic, particularly in the near-wall region.

The experimental results that will be obtained within the proposed project will serve as a reference database for validation of a number of numerical algorithms allowing to predict the liquid flow inside random packed beds. Exploration of a number of factors that may potentially affect the liquid flow (such as the particle's size, particle's aspect ratio, liquid and gas loads) will not only bring new and important data to the field but also it will provide a deeper understanding of liquid flow in random packings and may also contribute to more effective design of any type of technologies/processes employing the packing of random particle structures. Consequently, it will also positively contribute to the economic and societal impact.