Due to the progressive climate change associated with global warming, the growing demand for cooling production is observed in various areas of human life: food storage, medicines and vaccines, air conditioning. The biggest problems with refrigeration devices happen in the summer months, when intensive exploitation of conventional coolers leads to excessive power demand. Therefore, alternative sources of cooling production necessary to assure the sustainable development of the global economy. In addition, the industry generates large amounts of waste heat, which are currently not used effectively. These inexhaustible resources of "renewable energy" is considered as potential sources for of environmentally friendly cooling technology, which is adsorptive refrigeration systems.

Adsorption chillers use thermal effects that accompany the alternating adsorption and desorption cycles in the sorbent bed. During evaporation of the refrigerant, the heat is removed and condensed during condensation stage. The working process of the device proceeds at a very low pressure, which corresponds to the saturated vapor pressure at an adsorbent temperature of 10-15 ° C. In adsorption chillers intended for air conditioning purposes, water is used as the adsorbate, which is a chemically stable substance and an environmentally safe fluid. Adsorbents, being porous materials with a highly developed specific surface area physical adsorption processes take place. The adsorbate molecules are bound to the surface of the adsorbent by van der Waals forces, which are so weak that heating the bed to a certain temperature starts desorption process, which is a bed regeneration stage at the same time preparing the adsorbent for the consecutive adsorption cycle.

The effectiveness of using adsorption technology for cooling production is determined not only by the selection of an effective adsorbent-adsorbate vapor, the temperature of the power source. First of all, the efficient adsorption chiller should use the heat of as low temperature as possible to produce cold, which still allows the bed to desorb. As a result, it will be possible to supply the refrigerator with the waste heat already mentioned above, which is a by-product and is present in excess in many branches of industry. An alternative source of power may also be photochemical solar energy, which, after conversion in solar collectors to useful heat, can be successfully used for the cooling production purposes. The use of solar energy as a source of power for adsorption chillers is an opportunity for countries in the tropic zone, which is characterized by the strongest sunshine, associated with the greatest demand for air conditioning devices. Lowering the required hot water temperature also allows the heat produced in cogeneration to be used for the regeneration of the deposit. This will also have a positive impact on the development of a combined heat and power plant in Poland, which currently cannot effectively produce electricity due to the lack of district heat consumers in the summer months. All these possibilities have one common advantage which is a significant reduction in the energy consumption by the refrigeration equipment. However, currently adsorption devices achieve too low coefficient of performance (COP) and the increase in efficiency of devices is associated with an increase in weight and size which limits the potential consumers market at the current state of knowledge.

A chance for an increase in cooling efficiency is the development of an innovative adsorption bed configuration, which will be characterized by a high heat transfer coefficient between the adsorbent and the surface of the heat exchangers. Therefore, the aim of the project's research is to study the heat and mass transfer in porous media that occurs during the adsorption / desorption cycles, evaluation of methods for intensifying these processes. In order to improve heat transfer processes, materials of good heat conduction coefficient will be introduced, including metals particles and carbon nanotubes, which have a very high thermal conductivity ratio of 6000 kW/m. The scope of research will concern adsorption beds of innovative cylindrical construction and includes mainly analysis of the influence of selected parameters of the working cycle and the geometry of the bed on the sorption processes.

As a result, a set of bed and sorbent properties as well as operating conditions will be defined, which are desirable due to the effectiveness of the adsorption/desorption cycles. The possibility of adsorbent fluidization will also be considered during the study, since the fluidization state provides better heat and mass transfer conditions within an adsorbent bed, comparing to the fixed beds.

The obtained empirical data will be used to validate mathematical models describing processes occurring in the adsorption chiller. The validated model will constitute a tools for further numerical and design analyzes. The obtained results allow to develop of effective, innovative constructions of sorbent beds i.e. key working elements of highly efficient adsorption chillers. An additional innovative aspect of the project is the use of artificial intelligence methods to optimize the design and parameters of the work cycle, which are now intensively developed by the largest scientific centers in the world.