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Optimum Design and Analyze Performance Parameters of Ice Plant Test Rig using R32 Refrigerant

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Abstract: *Ice plant systems have evolved significantly since the early development of mechanical refrigeration in the 19th century. Initially used for commercial ice production, these systems have been adapted over time for academic and research applications. The Ice Plant Test Rig, in particular, serves as an experimental platform to understand the practical workings of the vapor compression refrigeration cycle. It allows students and researchers to study key thermodynamic principles, component performance, and the behavior of refrigerants under varying thermal loads. Modern test rigs have incorporated advanced components and environmentally friendly refrigerants to align with current energy and sustainability standards. Various studies have investigated the performance of ice plant systems using different refrigerants and design configurations. Traditional refrigerants like R22 and R134a have been widely studied but are being phased out due to their high global warming potential. Recent research has focused on alternative refrigerants such as R32, known for its low GWP, high efficiency, and favorable thermodynamic characteristics. Shell-and-tube evaporators and air-cooled condensers have also been highlighted in the literature for their effectiveness in heat exchange and system simplicity. These findings provided a foundation for the current project, influencing the choice of components and refrigerant in the test rig design.*

This project involved the design, fabrication, and performance analysis of an Ice Plant Test Rig utilizing R32 refrigerant, targeting improved thermal efficiency and reduced environmental impact. The system comprised a hermetically sealed compressor, air-cooled condenser, capillary tube, and a shell-and-tube evaporator immersed in brine. It was designed for a cooling capacity of 0.25 TR, capable of managing a total heat load of about 390 W. Experimental evaluations included monitoring temperature profiles and calculating the Coefficient of Performance (COP). Results indicated that the system operated effectively within design parameters, with experimental COP values closely matching theoretical expectations. This confirms that the setup is efficient, cost-effective, and suitable for both small-scale ice production and educational use.

Keywords: Coefficient of Performance, cooling effect, work done, R-32 refrigerant, Global warming potential, Ton of Refrigeration, efficiency