

## Nano particle a reliable source for energy efficient eco friendly chilling for fish processing

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**Need :** Cold chain management is the only art which is very tedious in this current scenario. To save the fish and agricultural products from decay and biological activities it is mandatory to keep them in sub zero temperature. Vapour compression refrigeration system provide a suitable and viable option to do so. But energy loss is inevitable. Hence the nano additives along with refrigerants were tried to be incorporated in the freezer technology for fish preservation and processing.

**Principle and concept :** The performance analysis used three different nano particles each with five combinations for the assessment for R404a. The co-efficient of Performance analysis was with R404a along with nano particle of  $Al_2O_3$ , CuO and  $TiO_2$ . Comparison was done based on the values of co-efficient of Performance, compressor work input and refrigerating effect on blast freezer type evaporator unit capable of handling  $-20^\circ C$  inside. The best performance of the system was identified using the comparison of system parameters like Coefficient of Performance, compressor work input, refrigerating effect, compressor suction and discharge pressure and temperature at all the state points of the system.  $Ag_2O$ , CuO and  $TiO_2$  were mixed with the compressor oil through suction valve provided for each compressor and the R404a refrigerant is charged into the setup. Refrigerant is allowed to work and the co-efficient of Performance for the system was analyzed. Heat leak test and uncertainty analysis with the predicted value of 0.02047 or 2.047 % was used for conducting experiments.

**Modelling and governing equations :** Exergy or availability is a thermodynamic property that represents the maximum work that can be obtained from a fluid stream in a reversible process until it reaches the thermodynamic equilibrium with the surroundings. Exergy analysis can be used to evaluate the performance of thermodynamic system. Unlike energy, exergy is not conserved but it will be destroyed.

$$j = h - T_0^s \quad (1)$$

$$j = (h - h_0) - T_0 (s - s_0) \quad (2)$$

Lower the work input to the compressor and higher the co-efficient of performance being the best operating conditions of any refrigerating system, the recommended percentage of nano particle ( $Al_2O_3$ ) is 3% when used along with R404a with 3.23 as co-efficient of performance and 34.37 kJ/kg-K work input to the compressor. Observed readings reveal the concepts for the nano particles CuO (3% with 3.97 as co-efficient of performance and 29.60 kJ/kg-K work input to the compressor) and  $TiO_2$  (3% with 3.53 as co-efficient of performance and 32.46 kJ/kg-K work input to the compressor).



**Fig. 1 :** Photographic view of nano particle eco friendly chilling plant for fish processing

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