

## Modeling and Fluid Flow Analysis of Wavy Fin Based Automotive Radiator

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### Highlights

- ✓ Modeling of Wavy fin based Heavy vehicle automotive radiator.
- ✓ CFD simulation of cross flow heat transfer of nanofluids in circular tubes.
- ✓ Compare the cooling capacity by estimating temperature distribution of nanofluid as coolant to water/EG as base fluid alone.

### Abstract:

In continuous technological development, an automotive industry has increased the demand for high efficiency engines. A high efficiency engine is not only based on its performance but also for better fuel economy and less emission rate.

Radiator is one of the important parts of the internal combustion engine cooling system. The manufacturing cost of the radiator is 20 percent of the whole cost of the engine. So improving the performance and reducing cost of radiators are necessary research. For higher cooling capacity of radiator, addition of fins is one of the approaches to increase the cooling rate of the radiator. In addition, heat transfer fluids at air and fluid side such as water and ethylene glycol exhibit very low thermal conductivity. As a result there is a need for new and innovative heat transfer fluids, known as "Nanofluid" for improving heat transfer rate in an automotive radiator. Recently there have been considerable research findings highlighting superior heat transfer performance of nanofluids about 15-25% of heat transfer enhancement can be achieved by using types of nanofluids. With these specific characteristics, the size and weight of an automotive car radiator can be reduced without affecting its heat transfer performance.

An automotive radiator (Wavy fin type) model is modeled on modeling software CATIA V5 and performance evaluation is done on pre-processing software ANSYS 14.0. The temperature and velocity distribution of coolant and air are analyzed by using Computational fluid dynamics environment software CFD. Results have shown that the rate of heat transfer is better when water fluid (ie C + water) is used as coolant, than the conventional coolant.

**Keywords:** Automotive radiator, Nanofluid, Wavy fin and circular tube geometry, performance parameters.

### 1. Introduction

As a type of compact heat exchangers, plate fin heat exchangers are used in a wide variety of applications. Typical among these are automobile radiators, air conditioning evaporators and condensers, charge air coolers, electronic cooling devices and cryogenic exchangers to meet the demand for saving energy and resources. To reduce the size and weight of heat exchangers, various augmented surfaces have been developed to improve the air side heat transfer performances. Typical fin geometries are plain fins, wavy fins, offset fins, perforated fins, pin fins and louvered fins. For the complex geometries, which are usually set up in a cross flow arrangement, with wavy fin geometry in a compact automotive radiator, heat exchangers are used either individually or as components of a large thermal system, in a wide variety of commercial, industrial and household applications, e.g. power

generation, refrigeration, ventilating and air-conditioning systems, process manufacturing, aerospace industries, electronic chip cooling as well as in environmental engineering. The improvements in the performance of the heat exchangers have attracted many researchers for a long time as they are of great technical, economical, and not the least, ecological importance.

Recent technological development in automotive industries has required for high efficiency engines. A high efficiency engine is not only based on the performance of radiator but also depends on better fuel economy and less emission rate. Reducing the vehicle weight by optimizing design and size of a radiator is a capital feature. Addition of fins is one of the approaches to increase the heat transfer rate of radiator, provides greater heat transfer area and enhances the air convective heat transfer coefficient. The typical tube geometry used in the compact

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