Study of Cooling System in Internal Combustion Engine Improving Performance with Analyzing the Material Alloy FHT 004 Surface Roughness

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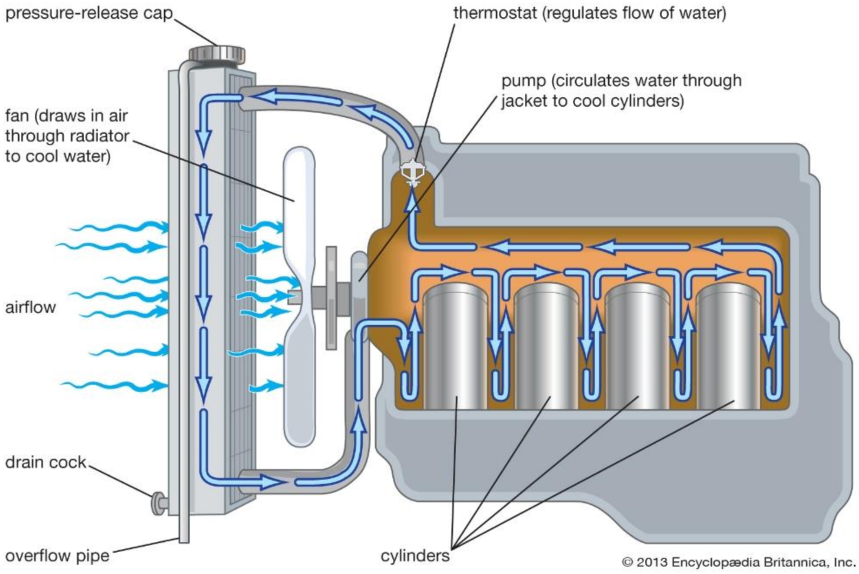
ABSTRACT

Cooling system of the engine is one of main essential systems for automobiles, which maintains the engine temperature to the sustain conditions. Hence the main objective of this project work is to propose a study case on production of Auto Climate Control LLC radiator T-250 and its material Alloy FHT 004 which is used for water tube as a part of radiator. Main purpose of this article is clarifying the negative impacts of newly-produced radiators and study case on material surface roughness.

Keywords: Automobiles, Internal Combustion System, Radiator, Cooling System, Alloy, Water tube, Material roughness.

Introduction: The majority of Internal Combustion engines have cooled by liquor (antifreeze) coolant passing via air fins and radiator. The majority of the liquor-cooled Internal Combustion engines using coolant oil which has been combination of water as well as chemical like antifreeze and rust inhibitors. The industry word of antifreeze mixture is coolant oil for engine cooling system. Coolant oil based cooling system minimizes the happening of hot spot that difficult to avoid when applying air cool. A simple schematic of thermo siphon cooling system is shown in Figure 1. This type of cooling system is employing in recent automobile vehicles. The coolant water presents in the system circulated by pump through water passage in the head and block of the engine. The heat generated by engine is absorbing by coolant water method of heat conduction. The hot coolant water allows into the radiator for cooling after that this cycle is repetitive. Thus temperature of the engine is detached to avoid overheating and maintain the engine with working temperature.



Picture 1: Schematic of thermo siphon cooling system

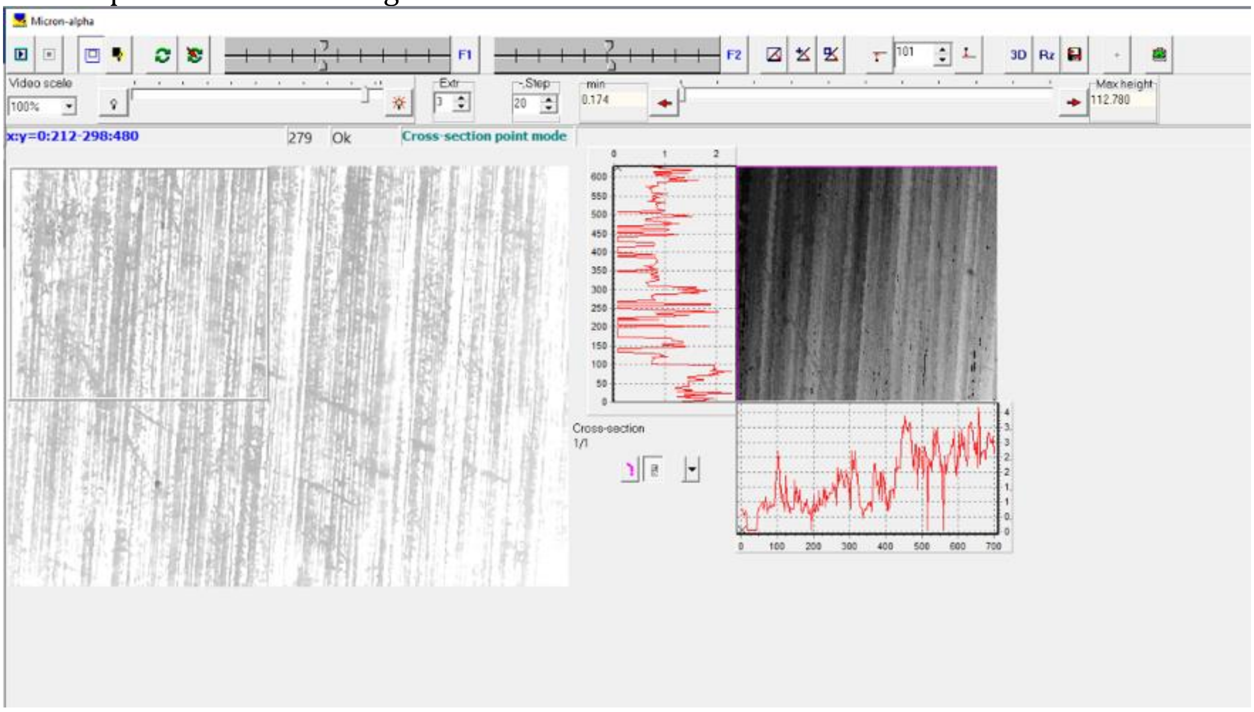
The radiator is located in front of the engine. It has a top and bottom tanks to accommodate coolant water. The cooling fins in the form of tube are arranged vertically in between these two tanks. When the engine attains above normal temperature the thermostat allows the coolant water into the radiator top tank. Then coolant water flows to the bottom tank of the radiator via cooling fins. The heat presents in the coolant water transfer to the atmosphere by conduction and convection methods by the fin materials and cooling fan air respectively. Thus the radiator is acts as a heat exchanger of the cooling system in internal combustion engine. Figure 2 shows T-250 radiator, it has overall 53 water tube, 54 center air and each center air has 183 steps. Two sides of radiator have coolant tank with inner and out hoses. Material of radiator water tube is made from Alloy FHT 004.

Picture 2: T-250 Radiator in cooling system

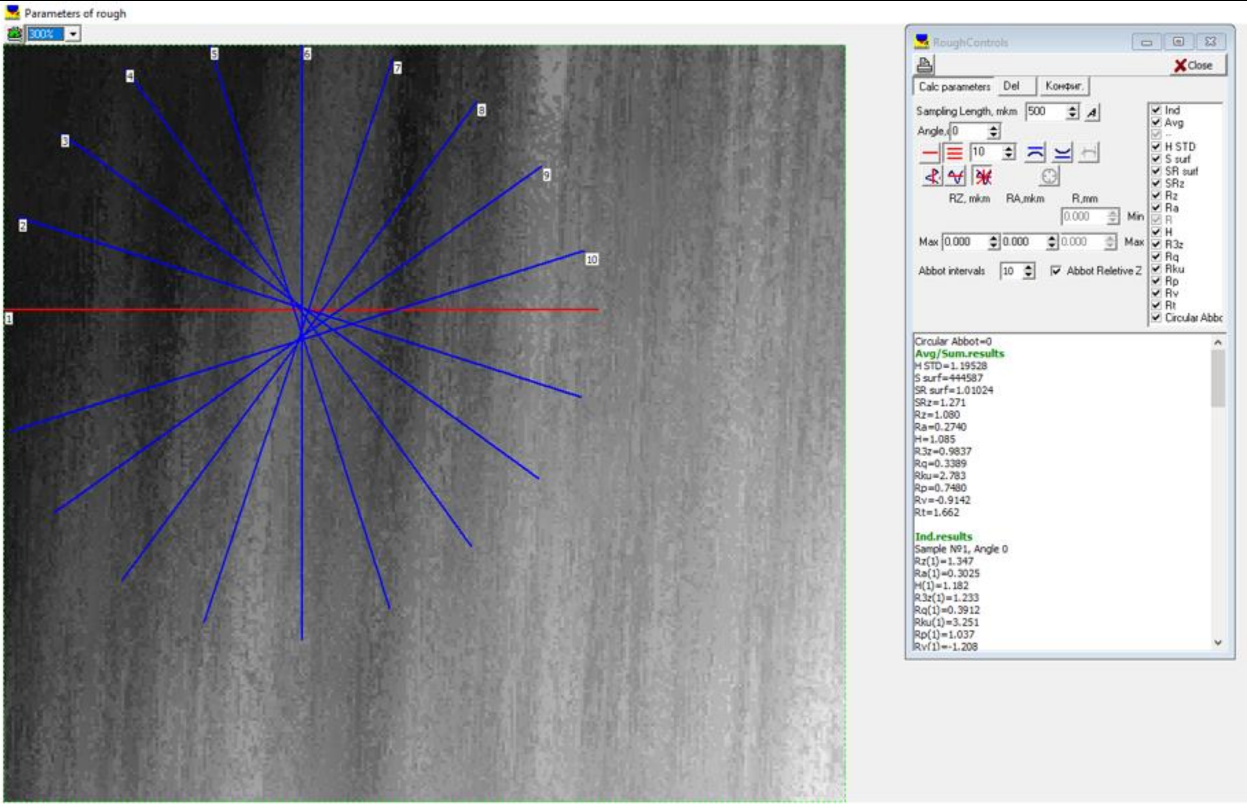
In earlier internal combustion engine system of cooling was using only water. In order to improve the cooling effect and suitable for weather condition such as winter and summer coolant oil is added with water to avoid boiling and freezing of cooling water in the system during operation. Nowadays in modern internal combustion engine cooling system water is mixed with Monoethylene Glycol fluid to improve system of cooling performance with low cost. In addition, propylene glycol also added with coolant water for the application of automotive and heavy duty internal combustion engine in view of obtaining effective cooling system performance. Mixing of coolant oil also prevent the corrosion, rust formation, oxidation of the engine parts. It also avoids bubble formation during the circulation to improve the performance.

Main part: In this article we take an experiment on Alloy FHT 004 material surface roughness with Interference Profilometer which help us to restore micro-topography of surfaces by processing a sequence of interference patterns in white light. The most accurate methods of non-contact testing of non-smooth surfaces are known to be interference methods. One of the non-contact optical methods for measuring the height of micro-roughnesses or traces of processing on metal and other surfaces of high accuracy class is the Linnik MII-4 micro interferometer, which is a combination of an interferometer and a microscope.

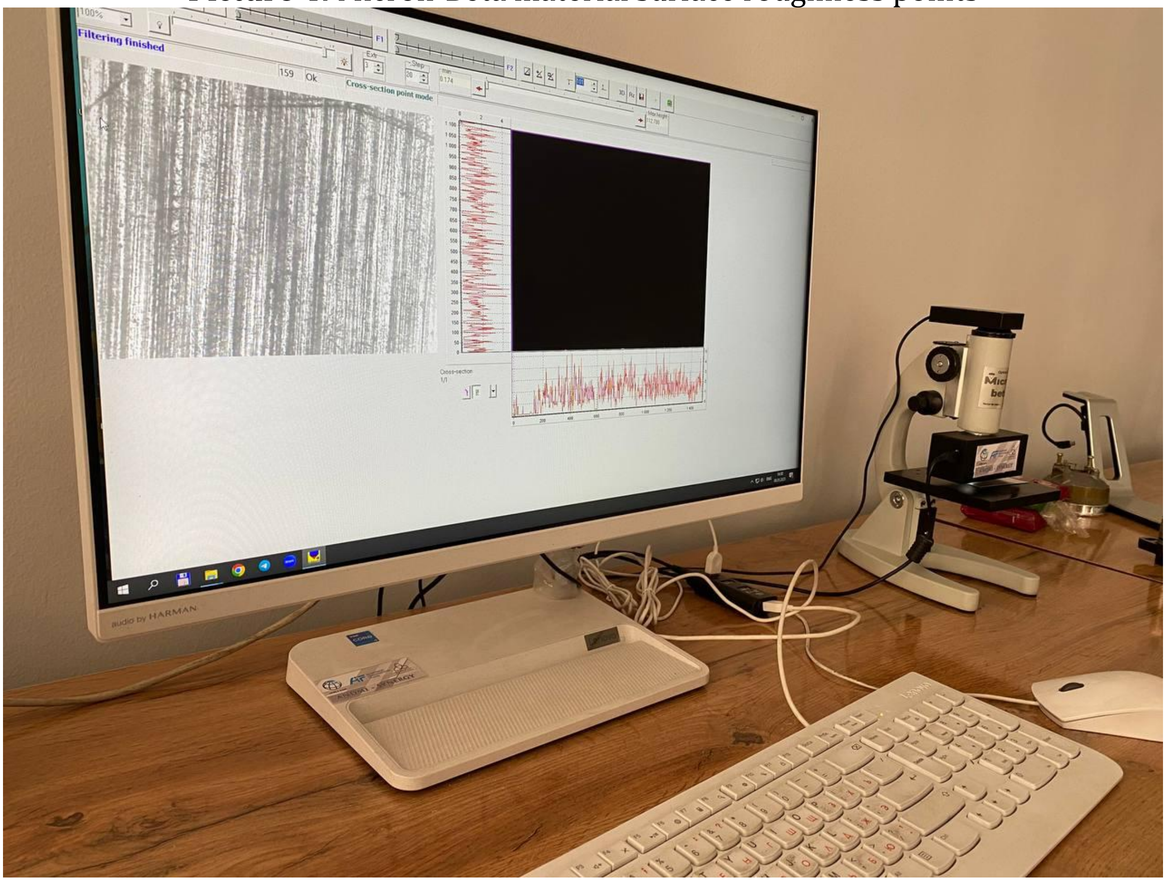
With the help of Interference Profilometer we can analyze the micro-roughness of water tube part of the T-250 radiator and we can discuss that material surface roughness and how the coolant is effecting the material surfaces with flow distribution.



Picture 3: Micron-Beta Interface

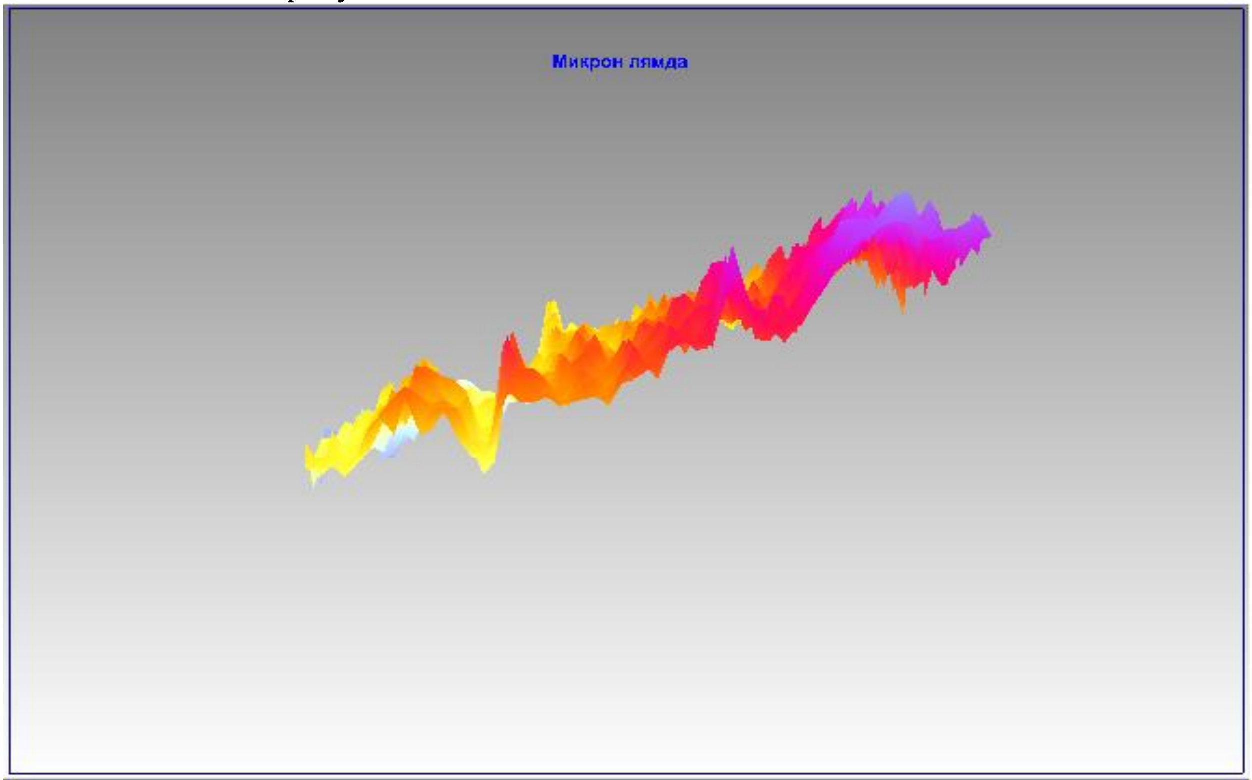


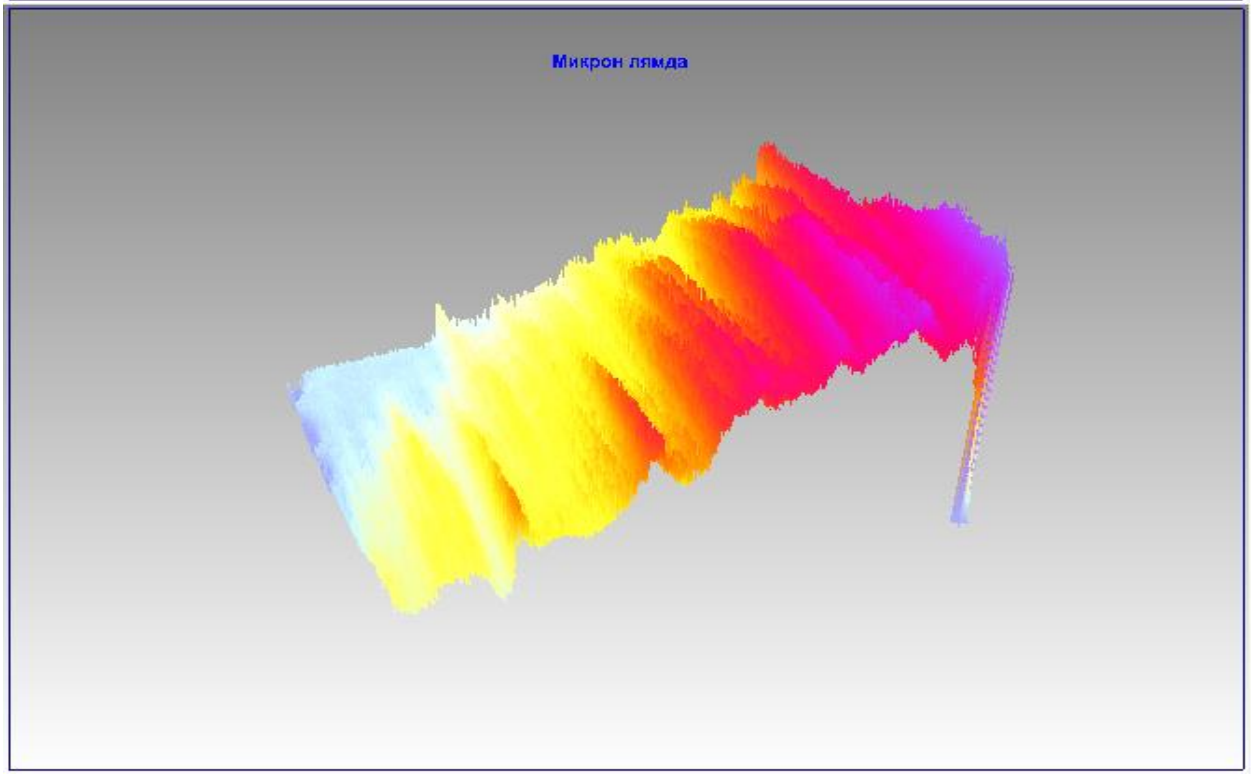
Picture 4: Micron-Beta material surface roughness points



Picture 5: Process of analyzing material surface roughness with Micron-Beta

Continous analyze of material FHT 004 gave us different results due to we conducted the experiments on different parts of the material, but overall we could take the avarage of R_a as a 0.2903 and it is equal to N5 category in ISO 4287:1997. After deep researches we were able to get damaged radiator from UzERAE Climate Control LLC for further researches and we conclude that used radiators water tube surface roughness dramatically high if we compared with N5 results. In this case, flow distributions are strongly effect the material surface roughness and as a solution we can recommend that as a company Uz Auto Motors needs to use nano particles as a liquid of cooling system or need to replace the material Alloy FHT 004 to other durable material in order to tackle issues occurring in the hot weathers in Uzbekistan. By doing so, we can improve the quality of our products as well as automobiles durability durations.





Results	R_z	R_a	H	R_{3z}	R_q	R_{ku}	R_p	R_v	R_t
Avg/Sum.results	1.216	0.2903	1.169	1.138	0.3622	2.931	0.9240	0.9547	1.878
Sample №1	1.399	0.3324	1.317	1.1376	0.4281	3.774	1.186	1.311	1.311
Sample №2	1.570	0.3284	1.275	1.685	0.4270	3.820	1.147	1.574	1.574
Sample №3	1.182	0.3082	1.257	1.134	0.3755	2.494	0.8121	0.8748	0.8748
Sample №4	1.072	0.2779	1.135	0.9429	0.3484	2.808	0.7263	0.8936	0.8936
Sample №5	1.170	0.3122	1.196	1.112	0.3662	2.199	0.7849	0.7893	0.7893
Sample №6	0.7500	0.1603	0.6139	0.6857	0.1900	2.581	0.5008	0.5168	0.5168
Sample №7	0.9847	0.2054	0.8757	0.9047	0.2525	2.677	0.6911	0.5941	0.5941
Sample №8	1.255	0.3745	1.492	0.9298	0.4667	2.642	1.086	0.9044	0.9044
Sample №9	1.422	0.2913	1.292	1.439	0.3643	2.763	1.044	0.7457	0.7457
Sample №10	1.359	0.3150	1.238	1.173	0.4032	3.556	1.260	1.343	1.343

Conclusion: The objectives of the study were design and simulation of the radiator and cooling system of an automobile was successfully performed. The simulation and analysis of radiator was completed on Micron-beta profilometer. Optimal results were found after the complete analysis of the two radiator materials. The two radiators were compared based on their material surface roughness degrees and conditions.

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