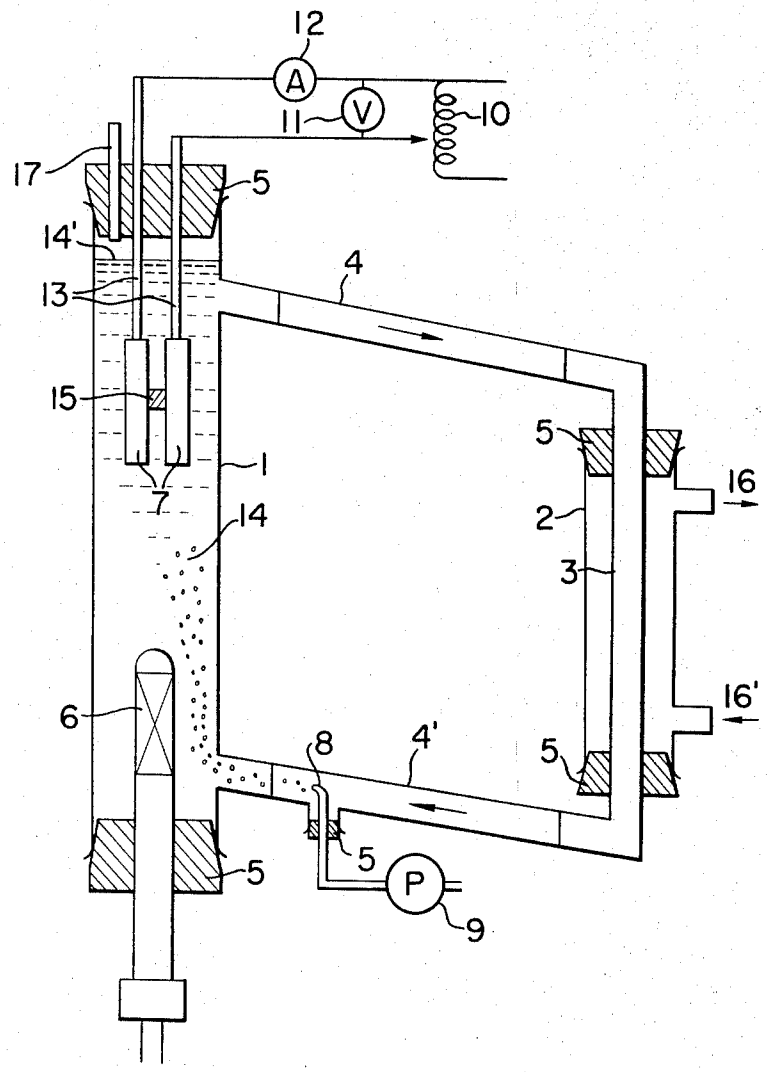
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METHOD FOR TESTING RADIATOR-TUBE-CLOGGING PROPERTY OF ANTIFREEZING COOLANTS

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METHOD FOR TESTING RADIATOR-TUBE-CLOGGING PROPERTY OF ANTIFREEZING COOLANTS

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ABSTRACT OF THE DISCLOSURE

A method of rapidly testing radiator tube clogging properties of antifreezing coolants for automotive engines in which the coolant to be tested is circulated through a heating zone and a cooling zone. Metal pieces are inserted in the coolant in the heating zone and a source of electric current is connected to the metal pieces for electrolyzing the same and the amount of material deposited in the cooling zone is measured.

This invention relates to a method of testing antifreezing coolants, in order to determine the coolant property of clogging the radiator tubes of the cooling systems for engines.

As a testing method for the anti-freezing coolants for engines, the so-called ASTM method (ASTM D–1384, "Glassware Corrosion Test for Engine Anti-Freezes") is in use. However, it is merely an ordinary corrosion testing method or a technique of comparatively evaluating the degrees of corrosion of metals, and is disadvantageous because it fails to indicate the amounts of metallic compounds which may choke up radiator tubes.

With water-cooled automotive engines using aluminum-alloy cylinder heads, there were reported many instances of overheating of engines due to clogging of the radiator tubes. Investigations for the cause revealed that the compositions of antifreezing coolants were responsible. A testing method has, therefore, been looked for which permits quick determination of the property of antifreezing colants to clog the radiator tubes of the cooling systems of engines.

Since the inner surface of an aluminum-alloy cylinder head which is in contact with cooling water attains a temperature of about 130° C., the aluminum alloy material is readily corroded even by an antifreezing coolant which has given a good result with the ASTM method.

The antifreezing coolants for engines in extensive use are those which are prepared by adding anti-rusting agent and other additives to ethylene glycol which is main ingredient having both properties of antifreezing and cooling. The mixture is diluted by water to a suitable concentration. It is considered that these constituents of antifreezing coolants coact with the precipitates principally of hydroxides of aluminum produced by corrosion, the resultant products deposit on the inner walls of radiator tubes where the temperature is the lowest throughout the cooling water system. This deposition results in the clogging of the radiator tubes.

With these in view, the present invention has its object to provide a simplified method which is capable of testing the radiator-tube-clogging property of an antifreezing coolant in a short period of time, without carrying out a running test with an actual engine.

Other objects and advantages of the present invention will be apparent from the following description, taken in conjunction with the accompanying drawing which is a schematic representation, in cross-section, of a preferred embodiment of the present invention.

A heating tube **1** of glass or metal and a cooling tube **3** of glass or metal are connected together as by upper and lower glass tubes **4** and **4'** to constitute a circuit for liquid circulation. The interior of the heating tube **1** constitutes a heating zone. The cooling tube **3** is surrounded by cooling device **2** in which cooling water circulates from an inlet **16'** to an outlet **16**, for effecting forced cooling of the tube **3**. This tube **3** is therefore simulated to one of the radiator tubes of a water-cooled engine.

In the lower part of the heating tube **1** is inserted a heater means **6** such as a bar-shaped quartz heater, and in the upper part are inserted test pieces **7** of metal such as aluminum and, if necessary, anti-cathodes (not shown), in a spaced relationship. They are fixed to leading wires **13** such as platinum wires. The wires **13** are connected to a suitable electric source for electrolysis such as an alternating current source **10** in the form of a transformer or variable resistor, of which current and volatage are checked by an ammeter **12** and a voltmeter **11**.

A test solution **14** (antifreezing coolant) is filled in the heating tube **1** up to a level above the upper branched part thereof as shown by a reference numeral **14'**. The test pieces **7**, with or without the anti-cathodes are fixed in a given spaced relationship by means of an insulation **15**.

A bubble nozzle **8** of glass or metal is inserted in the lower part of the circuit for the purpose of the circulation of the coolant to be tested. From this nozzle **8**, gas bubbles such as air bubbles, are fed by the action of a pump **9** and aid the circulation of the coolant in addition of the circulation effect of the convection by the heater means **6**. The gas pressure caused by the bubbles is vented from a vent tube **17** arranged upwards of the coolant level **14'**.

Reference numeral **5** indicates sealing members such as rubber stoppers.

As described, the test solution **14** (antifreezing coolant) is filled in the heating tube **1** up to a point above the upper branched part to the glass tube **4**, and if the heating by the heater means **6** and cooling by the cooling cylinder **2** are started, a temperature gradient is produced inside the circuit and the test solution **14** begins circulation in the direction indicated by arrows. This circulation of the test solution **14** is facilitated by air supplied by the nozzle **8** and pump **9**.

The metal constituents electrically dissolved out of the metallic test pieces **7** (as of aluminum alloy) upon the conduction of current from the source **10** become as precipitates composed essentially of hydroxides when the pH of the test solution **14** is in the precipitation range of the particular metals, and circulate together with the test solution **14** through the circuit and gradually deposit on the inner wall of the cooling tube **3**.

The difference of temperatures of the test solution **14** at the inlet and outlet of the cooling tube **3** is so adjusted as to simulate the temperature gradient of the cooling system of an engine, by way of controlling the heater means **6** or of the flow rate of the cooling water through the cooling device **2** and the volume of the gas that is supplied by the gas pumping means **9**. The current and voltage required for the electric dissolution of the metallic test pieces can be suitably chosen according to the compositions of the test solution **14**.

Next, examples of the present invention performed by the above-mentioned apparatus with aluminum alloy will be given below.

EXAMPLE 1

Using aluminum alloy (JIS AC4B) pieces as test pieces, A.C. electrolysis tests were carried out with a solution A (a 10% aqueous solution of a commercially available antifreezing coolant mixture A for engines—consisting of 100 parts ethylene glycol, 2.5 parts borax, and 8.0 parts sodium benzoate). The results were as tabled in Table 1.

TABLE 1

Number	Voltage (v.)	Current (a.)	Test time (hr.)	Amount of test piece dissolved (mg.)	Accretion efficiency (percent)
1	16.0	1.5	12	194.3	39.5
2	13.0	1.0	12	127.2	38.0

EXAMPLE 2

As metallic test pieces, aluminum alloy (JIS AC4B) pieces were used, and A.C. electrolysis tests were conducted of a solution B (a 30% aqueous solution of a commrcially available antifreezing coolant mixture A for engines), and then results shown in Table 2 were obtained:

TABLE 2

Number	Voltage (v.)	Current (a.)	Test time (hr.)	Amount of test piece dissolved (mg.)	Accretion efficiency (percent)
3	17.0	1.5	12	145.3	36.1
4	19.0	1.8	12	179.3	34.5

EXAMPLE 3

As metallic test pieces, aluminum alloy (JIS AC4B) pieces were used, and A.C. electrolysis tests were carried out of a solution C (a 10% aqueous solution of a commercially available antifreezing coolant mixture B (of ethylene glycol type) for engines) and the results as shown in Table 3 were obtained:

TABLE 3

Number	Voltage (v.)	Current (a.)	Test time (hr.)	Amount of test piece dissolved (mg.)	Accretion efficiency (percent)
5	16.0	1.2	12	666.4	0.2
6	12.0	0.7	12	382.6	0.2

EXAMPLE 4

As metallic test pieces aluminum alloy (JIS AC4B) pieces were used, and D.C. electrolysis tests were carried out with 50% aqueous solutions of commercially available antifreezing coolant mixtures C and D for engines (both of ethylene glycol type). The results were as shown in Table 4:

TABLE 4

No.	Test solution	Voltage (v.)	Current (a.)	Test time (hr.)	Test specimen dissolved (mg.)	Accretion condition
7	50% aq. soln. of C.	10.0	0.5	7	37.2	Very little accretion.
8	50% aq. soln. of D.	10.0	0.3	7	110.6	Slight accretion.

As will be obvious from the test examples above given, it is observed that, when tested by the apparatus according to this invention, any test solution which contains at least a constituent contributory to clogging of radiator tubes will, in about 10 hours, form together with a certain metal a deposit on the inner wall of the cooling tube. The result is well in agreement with the phenomenon of clogging of an actual radiator on an automobiles using a defective antifreezing coolant.

Thus, by calculating the efficiency of deposition to the cooling tube on the basis of the weight loss due to dissolution of the metallic test pieces or the weight of the metal that is dissolved out into the test solution and the inner wall of the cooling tube, it would become quantitatively possible to do comparative evaluation of the radiator-tube-clogging property of a given antifreezing coolant.

It is not impossible to employ a common procedure of dissolving the metal by virtue of the corrosive action of the test solution itself, which has been promoted by heating. But it should be noted that in such a case the test time will be as much as several ten hours (e.g., 50 to 70 hours) because a weakly corrosive solution must be used to simulate the test conditions to the actual ones. On the other hand, where electrolysis is resorted to as in the examples of this invention, the test with an antifreezing coolant of commerce can be completed within a period of only about 10 hours.

Since the deposition efficiency of the metal is constant with all test solutions regardless of the different solubility of the metal test pieces, no strict control is required of the electrolysis conditions for the electrical dissolution of the metal test pieces.

As described in connection with the examples above, the present invention provides an apparatus comprising a cooling tube comparable to one of the radiator tubes of a water-cooled engine, a heating tube communicated at both ends with tubes to said cooling tube, thus constituting a circuit for circulation of an antifreezing coolant for engine, heating means provided inside the heating tube to heat the circulating antifreezing coolant thereby to produce a temperature gradient in the system, and electrolyzing means for a corrosive metal which forms a precipitate with the coolant upon electrolysis, in such a manner that the precipitate is caused to deposit over the inner wall of the cooling tube while the antifreezing coolant is being circulated through the system.

The present invention is thus characterized by the circulation of an antifreezing coolant with simultaneous dissolution electrically of a metal susceptible to corrosion. As compared with conventional methods such as circulation of a metal electrically dissolved beforehand in a separate container and allowed to stand for a lengthy period of time or addition of hydroxides of the particular metal, all of which have failed to reproduce the actual cloggage of radiator tubes, the present invention enables to simplify the quantitative and comparative evaluation of the property of a given antifreezing coolant to clog the radiator tubes for engine, from the calculation of the efficiency of deposition to the inner wall of the cooling tube on the basis of the weight loss due to electrolytic dissolution of a corrosive metal (or the weight of the same metal that is dissolved out in the antifreezing coolant) within a short period of time and also of the weight of the same metal in the precipitate that deposits on the inner wall of the cooling tube.

As the circuit for the circulation of the antifreezing coolant, or the combination of the heating tube, cooling tube, and tubes communicating them together may be formed of glass or the like, there is no danger as is noted when they are formed of a more susceptible material such as a metal and, moreover, the manufacturing cost can be saved.

Of course the present invention is not limited to the embodiment described and shown which were given solely by way of example.

What is claimed is:

1. A method of testing radiator-tube-clogging property of radiator antifreezing coolants for automotive engines, comprising circulating an antifreezing coolant in a closed circulation path which has a heating zone and a cooling zone having a wall portion that is in contact with the coolant, conducting electric current between metal test pieces disposed in spaced relation in said heating zone, and measuring the amount of deposit attached to said wall portion of said cooling zone.

2. A method as claimed in claim **1**, wherein the coolant circulation is effected by the convection caused by elec-

trical heating and also by introduction of gas bubbles in said heating zone.

3. A method as claimed in claim 2, wherein said test pieces are composed of an aluminum alloy.

4. A method as claimed in claim 3 wherein the temperature in the cooling zone is controlled at about 130° C.

5. A method according to claim 1 wherein the heat is supplied in the heating zone by heating means disposed within the closed circulation path.

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