A soldered aluminum heat exchanger, having tubes made of a core material through which tubes a coolant flows, and the tubes being connected to at least one header by means of an inner soldered joint; having a protective plating on the inner face of the core material comprising aluminum and using four-layer technology; having an inner solder plating on the protective plating; and having an outer solder plating on the outer face of the tube facing away from the coolant face.
SOLDERED ALUMINUM HEAT EXCHANGER

[0001] This nonprovisional application is a continuation of International Application No. PCT/EP2010/068010, which was filed on Nov. 23, 2010, and which claims priority to German Patent Application No. DE 10 2009 055 608.7, which was filed in Germany on Nov. 25, 2009, and which are both herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to soldered aluminum heat exchangers.

[0004] 2. Description of the Background Art

[0005] Tubes are among the components used for manufacturing soldered aluminum heat exchangers. The tubes may be welded, folded, and subsequently soldered, or may also be extruded.

[0006] DE 102005059717 A1, which is incorporated herein by reference, discloses a device for exchanging heat between an acidic gas and a heat exchange medium, having at least one flow passage for the acidic gas that is made substantially of aluminum and/or an aluminum alloy.

[0007] DE 1677069 B concerns a method for manufacturing from two aluminum plates and an apparatus for carrying out this method.

[0008] DE 60200818 T2, which corresponds to U.S. Pat. No. 6,708,869, concerns a method for manufacturing a heat exchanger comprising tubes made of an alloy, wherein each of the tubes has a layer thermally sprayed with Zn formed on the surface in question and a solder layer that is formed on the thermally sprayed-on zinc layer using a powdered solder made of an aluminum alloy composed of 5% to 60% by weight of Si with the remainder being Al and unavoidable impurities, and is soldered to a header that is made of Al or an Al alloy, that has a solder layer formed using a powdered solder made of an aluminum alloy having 5% to 60% by weight of Si with the remainder being Al and unavoidable impurities.

[0009] DE 909789 (C) concerns a soldering material, in particular for brazing of aluminum or aluminum alloys, and the use thereof.

[0010] DE 4120748 A1 concerns a method for manufacturing heat exchangers whose tube system has serpentine flat tubes, preferably made of a light metal, which heat exchangers are coated on the flat tube sides with a solder, wherein the flat sides of the tubes in the straight tube regions of the serpentine flat tubes are coated with a solder paste in the places that are to be joined to plates bent in a corrugated or zigzag manner.

[0011] The corrosion resistance of aluminum tubes that are formed from sheets and then welded or soldered can be increased by protective plating on the inside. A zinc-containing aluminum alloy is typically used for this purpose.

[0012] It is a disadvantage in the manufacture of prior art aluminum heat exchangers made from aluminum tubes with a zinc-containing protective plating on the inside, however, that soldering of the inside is no longer possible. Such soldering of the inside is desirable for increasing mechanical stability, however.

SUMMARY OF THE INVENTION

[0013] It is therefore an object of the present invention to create soldered aluminum heat exchangers with an increased resistance to corrosion on the coolant side while also avoiding the disadvantages known from the prior art, which heat exchangers have a long service life and are simple to manufacture.

[0014] The soldered aluminum heat exchanger according to the invention is characterized by soldering of the inside with coolant-carrying tubes made of a core material that are connected to at least one header, with an aluminum-containing protective plating in a four-layer technology on the inside of the core material, and with an inside solder plating on the protective plating, as well as with an outside solder plating on the outside of the tube facing away from the coolant side. The basic idea is to create a soldered aluminum heat exchanger that has a protective plating on the coolant side with an additional solder plating located thereon. The protective plating on the light metal component has various functions and advantages.

[0015] For example, platings can be made far thicker than galvanic coatings, and also have continuous, homogeneous surfaces. In addition, a significant increase in hot gas corrosion resistance can be achieved.

[0016] The aluminum in the protective plating can be present in pure form or in the form of an alloy.

[0017] The protective plating can contain a zinc-containing aluminum alloy. The protective plating here may include any desired aluminum alloy having added zinc. Within the scope of the present invention, protective coatings with base elements such as zinc have proven especially advantageous.

[0018] For example, the protective plating can contain an aluminum-manganese base alloy with the addition of 0.2% to 10% zinc by weight, in particular between 1% and 8% zinc by weight or between 2% and 6% zinc by weight, in order to achieve a mechanical strength comparable to that of the core alloy. These values have proven especially advantageous within the scope of the present invention.

[0019] One embodiment provides that a zinc alloy can be produced for the protective alloy in terms of a zinc diffusion depth of 20-200 μm, in particular 40-150 μm, or in particular 50-120 μm, and a maximum zinc content of 0.1% to 8% by weight, in particular 0.5% to 6% by weight, more advantageously 1% to 4% by weight, determined in each case at the surface of the coolant side, in particular the inside surface of a flow-carrying tube of the aluminum heat exchanger. These values have proven especially advantageous within the scope of the present invention.

[0020] Another soldered aluminum heat exchanger according to the invention can be created with coolant-carrying tubes made of a core material connected by inside soldering to at least one header, in particular to a base or cover, with solder plating on the inside on the coolant side, in particular aluminum 4045 or aluminum 4345 with 10% thickness, in four-layer technology, and with a solder plating on the outside of the core material facing away from the coolant side, as well as with a zinc-containing protective plating beneath this solder plating, in particular made of aluminum alloy of the XXXX series with X% Zn (X=0.2-20%) or the 7XXX series with Y% Zn (Y=0.2-20%), and of targeted modifications of alloyed
elements such as Mn, Cu, Si, and Fe. These values have proven especially advantageous within the scope of the present invention.

[0021] The use of a XXXX aluminum alloy (pure aluminum) with at least 99% aluminum could also come into consideration.

[0022] Even very small additions of the alloy elements magnesium, silicon, copper, zinc, or manganese change the properties of the pure aluminum very greatly. In particular, strength and hardness are increased and electric conductivity is reduced while workability is decreased only slightly.

[0023] For example, provision can be made to provide an additional protective plating on the inside.

[0024] Another embodiment provides for a soldered aluminum heat exchanger with coolant-carrying tubes made of a core material connected by inside soldering to at least one header, in particular to a base or cover; with solder plating, in particular 4045 or 4343 with 10% thickness, on the inside; and with a zinc-containing protective plating on the outside of the parts of the heat exchanger to be assembled.

[0025] Preferably, an application may be provided for the soldered aluminum heat exchanger in a condenser or an evaporator.

[0026] While core alloy, any core alloy that is customary for heat exchanger tubes may be used. Depending on the inside soldering method that will be used, the core alloy can contain manganese, for example. If a magnesium-containing core alloy is used, the inside soldering can take place without flux. If a magnesium-free core alloy is used, the inside soldering can take place with the use of flux.

[0027] Application of the flux can take place when desired, either on the strip material (coil flux) before tube manufacture, in-line during tube manufacture, or after tube manufacture, for example by dipping the tubes or the complete heat exchanger in flux suspension.

[0028] For example, with regard to the strip material (coil flux), the flux coating can be applied completely or only partially.

[0029] As a result of the lighter-weight heat exchangers, the fuel consumption of motor vehicles can be reduced. In comparison to laser welding, the heat exchangers produced using the soldering process are more economical and permit higher, throughput numbers.

[0030] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus, are not limiting of the present invention, and wherein:

[0032] FIG. 1 is a schematic four-layer construction of a tube for creating a soldered aluminum heat exchanger;

[0033] FIG. 2 schematically represents a first tube geometry;

[0034] FIG. 3 schematically represents a second tube geometry;

[0035] FIG. 4 schematically represents a third tube geometry.

DETAILED DESCRIPTION

[0036] FIG. 1 shows the schematically represented four-layer construction of a tube 1 to create a soldered aluminum heat exchanger.

[0037] The tube 1 is made of a core material 2 and an aluminum-containing protective plating 3 on the inside of the core material 2. In addition, an inside soldering plating 4 is provided on the protective plating 3, and an outside soldering plating 5 is provided on the outside 6 facing away from the coolant side of the tube 1.

[0038] FIG. 2 shows a schematically represented first tube geometry in cross-section. The tube 7 here is implemented as a welded, crimped tube. The crimp 8 can be produced manually or by machine, and forms a groove-like recess 9 in the tube 7, which serves primarily to increase stiffness.

[0039] FIG. 3 shows a schematically represented second tube geometry in cross-section. The tube 10 here is implemented as a soldered, crimped tube. The crimp 11 can be produced manually or by machine, and forms a groove-like recess 12 in the tube 10, which serves primarily to increase stiffness.

[0040] FIG. 4 shows a schematically represented third tube geometry in cross-section. The tube 13 here can be implemented as a welded, soldered, or extruded webbed tube.

[0041] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are to be included within the scope of the following claims.

What is claimed is:

1. A soldered aluminum heat exchanger comprising: coolant-carrying tubes made of a core material that are connectable to at least one header by soldering on the inside thereof; an aluminum-containing protective plating in a four-layer technology on the inside of the core material; an inside solder plating on the protective plating; and an outside solder plating on the outside of the tube facing away from the coolant side.

2. The soldered aluminum heat exchanger according to claim 1, further comprising a protective plating containing a zinc-containing aluminum alloy.

3. The soldered aluminum heat exchanger according to claim 1, further comprising a protective plating containing an aluminum-manganese base alloy with the addition of 0.2% to 10% zinc by weight, in particular between 1% and 8% by weight or between 2% and 6% by weight.

4. The soldered aluminum heat exchanger according to claim 1, further comprising a zinc alloy for the protective alloy in terms of a zinc diffusion depth of 20-200 μm, in particular 40-150 μm, or in particular 50-120 μm, and a maximum zinc content of 0.1% to 8% by weight, in particular 0.5% to 6% by weight, more advantageously 1% to 4% by weight, determined in each case at the surface of the coolant side, in particular the inside surface of a flow-carrying tube of the aluminum heat exchanger.
5. A soldered aluminum heat exchanger, comprising:
coolant-carrying tubes made of a core material connectable
by inside soldering to at least one header, in particular to
a base or cover;
solder plating on the inside on the coolant side,
wherein the core material comprises aluminum 4045 or
aluminum 4343 with 10% thickness, in four-layer tech-
ology;
a solder plating on the outside of the core material facing
away from the coolant side;
a zinc-containing protective plating beneath this solder
plating, in particular made of 3XXX series aluminum
alloy with X% Zn (X=0.2-20%) or 7XXX series alumi-
num alloy with Y% Zn (Y=0.2-20%), and of targeted
modifications of alloyed elements such as Mn, Cu, Si,
and Fe.
6. The soldered aluminum heat exchanger according to
claim 5, further comprising an additional protective plating
on the inside.

7. The soldered aluminum heat exchanger according to
claim 5, further comprising coolant-carrying tubes made of a
core material connected by inside soldering to at least one
header, in particular to a base or cover;—with solder plating,
in particular 4045 or 4343 with 10% thickness, on the inside;
and—with a zinc-containing protective plating on the outside
of the parts of the heat exchanger to be assembled.

8. The soldered aluminum heat exchanger according to
claim 1, wherein the soldered aluminum heat exchanger is a
condenser or an evaporator.

9. The soldered aluminum heat exchanger according to
claim 1, with a magnesium-containing alloy for the core
material and inside soldering without flux.

10. The soldered aluminum heat exchanger according to
claim 1, with a magnesium-free alloy for the core material
and inside soldering with the use of flux.

* * * * *