HEAT EXCHANGING DEVICE AND METHOD THEREFORE

The invention relates to a heat exchanging device (100, 200, 400), to a heat pump, to a domestic appliance, and to a method of operating a heat exchanging device (100, 200, 400). A first hollow profile (110, 210, 410) is configured to conduct a first medium. A second hollow profile (120, 220, 420) is configured to conduct a second medium. At least a part of the second hollow profile (120, 220, 420) is wound around at least a part of the first hollow profile (110, 210, 410). A nominal width (w) of the second hollow profile (120, 220, 420) is smaller than a nominal width of the first hollow profile (110, 210, 410). An outer surface of the first hollow profile (110, 210, 410) comprises a first contact portion, an outer surface of the second hollow profile (120, 220, 420) comprises a second contact portion, and the first contact portion and the second contact portion are coupled by means of a soldered connection.
Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanging device, to a heat pump, to a domestic appliance, to a method of operating a heat exchanging device, and to a method of providing a heat exchanging device.

BACKGROUND OF THE INVENTION

[0002] Many domestic appliances, such as, e.g., dishwashers or washing machines, are designed to heat water during operation of the appliance. Heating up water requires however a substantial amount of energy, where the domestic appliances at the same time produce wastewater that is often still warm. Efforts have thus been made to recover the thermal energy of wastewater in domestic appliances.

[0003] DE2743333A1 discloses a heat recovery system recovering heat from waste water from washing basins, sinks, bidets and showers. These sanitary installations have hot and cold water supply and smell trap in outlet. Heat recovered is used for fresh water preheating. The smell trap itself or a connected vessel forms heat exchanger with a helical hollow profile coil. Water from cold water supply flows through this helical coil and cold water is warmed by the waste water heat. The preheated water flows into a hot water boiler or mixing valve. The whole waste water vessel and heat exchanger can be built into a boiler tank.

[0004] There is however a problem with the prior art when a first medium (e.g., wastewater) completely surrounds a hollow profile carrying the second medium (e.g., fresh water). The material of the hollow profile carrying the second medium then has to be chosen appropriately, in order to avoid degradation from, e.g., corrosion.

[0005] It is therefore an object of the present invention to provide an improved heat exchanging device, an improved heat pump, an improved domestic appliance, an improved method of operating a heat exchanging device, and an improved method of providing a heat exchanging device.

SUMMARY OF THE INVENTION

[0006] According to a first aspect of the present invention, there is provided a heat exchanging device comprising a first hollow profile configured to conduct a first medium; a second hollow profile configured to conduct a second medium, wherein at least a part of the second hollow profile is wound around at least a part of the first hollow profile; wherein a nominal width of the second hollow profile is smaller than a nominal width of the first hollow profile; wherein an outer surface of the first hollow profile comprises a first contact portion, wherein an outer surface of the second hollow profile comprises a second contact portion, and wherein the first contact portion and the second contact portion are coupled by means of a soldered connection.

[0007] The term hollow profile, as used herein, shall not be limited to a hollow cylinder for conducting fluids. Specifically, the cross section of the first and second hollow profiles is not limited to a circular shape, but the term hollow profile shall include other hollow profiles suitable for conducting fluids as well.

[0008] The second medium may be, e.g., a refrigerant, or more generally a phase-changing, pure, non-polluted fluid. By conducting the second medium in the second hollow profile which is wound around the first hollow profile, the second hollow profile does not get into contact with the first medium. The first medium is typically a fluid, more specifically a fluid carrying dirt particles, even more specifically wastewater. If the first medium is water, such as, e.g., wastewater, the material of the second hollow profile therefore does not have to be adapted to provide sufficient protection from corrosion.

[0009] In order to ensure a sufficient thermal exchange between the first medium and the second medium to recover the heat from, e.g., wastewater in a domestic appliance, the first contact portion and the second contact portion are coupled by means of a soldered connection. Consequently, by providing soldering connections between the first and second hollow profiles, the present invention achieves an improved thermal contact between first medium and second medium.

[0010] In an embodiment, the outer surface of the second hollow profile comprises an outside portion arranged opposite to the second contact portion, wherein the outside portion and the second contact portion are parallel. By arranging the outside portion and the second contact portion in a parallel manner, the present embodiment achieves the effect of maintaining a small nominal width of the second hollow profile. In particular, when considering a cross section of the second hollow profile, a convex curving of the second hollow profile is avoided. Thereby, the present embodiment further improves on suppressing significant thermal differences along the cross section profile.

[0011] In a further embodiment, a cross section of the second hollow profile has a trapezoid shape, preferably a uniform trapezoid shape, where the second contact portion corresponds to a basis of the trapezoid shape. By providing a second hollow profile having a trapezoid shape, the present embodiment ensures that the outside portion and the second contact portion are arranged in a parallel manner, where the second hollow profile's cross section comprises a very simple shape, which is easier to manufacture.

[0012] In a further embodiment, the first hollow profile comprises a straight portion, wherein the second hollow profile is wound around at least a part of the straight portion. By providing at least a part of the first hollow profile in a straight manner, the second hollow profile can be provided in a cheaper and more straightforward way. This is because winding a hollow profile around a straight hol-
low profile is of course easier than adapting the winding to a complex shape.

[0013] In a further embodiment, a central axis of the part of the second hollow profile that is wound around the part of the first hollow profile corresponds to a helix having a uniform pitch. Choosing a uniform pitch is one possibility to have a uniform work piece. It further enables the manufacturer to prepare second hollow profiles of differing lengths without having to decide on the respective lengths during winding of a basic hollow profile work piece. In other words, it is possible to first prepare a wound hollow profile of a given standard length and to subsequently, depending on the desired respective lengths of second hollow profiles, cut the basic work piece into a number of second hollow profiles of desired lengths.

[0014] In a further embodiment, a distance between two adjacent windings of the second hollow profile is equal to or larger than 1.5 mm. By keeping adjacent windings of the second hollow profile at least 1.5 mm apart, it can be assured that the soldering connection remains between the first and second contact portions rather than distributing between the windings as well so that a soldering connection would be provided between adjacent windings. In other words, the proposed minimum distance between adjacent windings ascertains that no soldering connection between adjacent windings occurs.

[0015] In a further embodiment, a distance between two adjacent windings of the second hollow profile is equal to or smaller than 0.3 mm. By keeping adjacent windings of the second hollow profile closer than 0.3 mm together, a soldering connection between the windings may be provided as well. In other words, the proposed maximum distance between adjacent windings enables to provide a soldering connection between adjacent windings.

[0016] In a further embodiment, the first hollow profile comprises stainless steel, wherein the first hollow profile preferably consists of stainless steel. Stainless steel has superior properties in suppressing corrosion, rust or water stains. Preferably, the first medium conducted in the first hollow profile corresponds to water, specifically wastewater from a domestic appliance, such as a dishwasher or washing machine. By choosing the first hollow profile to comprise stainless steel, the first hollow profile's lifetime can thus be increased in view of its frequent contact with water.

[0017] In a further embodiment, the second hollow profile comprises aluminum, wherein the second hollow profile preferably consists of aluminum. Due to its excellent thermal conductivity, aluminum is well-suited as a heat sink material. Preferably, the second medium conducted in the second hollow profile corresponds to a refrigerant, specifically, a refrigerant configured to regain the heat of wastewater in a domestic appliance, such as a dishwasher or washing machine. By choosing the second hollow profile to comprise aluminum, it improves the thermal contact between the first medium and the second medium.

[0018] In a further embodiment, the nominal width of the second hollow profile corresponds to a distance between a first inner surface section of the second hollow profile arranged opposite to the second contact portion and a second inner surface section of the second hollow profile arranged opposite to the outside portion. By limiting the radial width of the second hollow profile in the above-described manner, the present invention provides a second hollow profile of lesser height, where thermal differences along the cross section of the second hollow profile are avoided or at least suppressed.

[0019] In a further embodiment, at least a part of the first hollow profile has a circular cross section. Choosing a circular cross section for the first hollow profile simplifies the manufacturing process for the second hollow profile, since the second hollow profile is wound around the first hollow profile and thus follows the first hollow profile's periphery.

[0020] In a further embodiment, the nominal width of the first hollow profile is equal to or larger than 20 mm and smaller than 120 mm. By providing a minimum nominal width of 20 mm, the present embodiment ensures a sufficiently fast flow rate of the first medium. Keeping the nominal width of the first hollow profile below 120 mm ascertains that the first medium flows slow enough to provide sufficient thermal coupling between the first medium and the second medium.

[0021] In a further embodiment, the nominal width of the second hollow profile is equal to or larger than 5 mm and smaller than 25 mm. By keeping the nominal width of the second hollow profile at a small value (e.g., 25 mm), the present embodiment provides a small height of the cross section profile, thereby leading to avoiding significant thermal differences along the second hollow profile's cross section profile.

[0022] According to another aspect of the present invention, there is provided a heat pump comprising the heat exchanging device according to the present invention, wherein the heat exchanging device is employed as one of an evaporator or a compressor.

[0023] According to another aspect of the present invention, there is provided a domestic appliance, preferably one of a washing machine or a dishwasher, comprising a heat pump according to the present invention.

[0024] According to another aspect of the present invention, there is provided a method of operating a heat exchanging device according to the present invention. The method comprises the steps of: conducting a first medium in a first hollow profile; conducting a second medium in a second hollow profile, wherein at least a part of the second hollow profile is wound around at least a part of the first hollow profile; wherein a nominal width of the second hollow profile is smaller than a nominal width of the first hollow profile; wherein an outer surface of the first hollow profile comprises a first contact portion, wherein an outer surface of the second hollow profile comprises a second contact portion, and wherein the first
contact portion and the second contact portion are coupled by means of a soldered connection.

It shall be understood that the heating system component of claim 1 and the method of providing a heating system component of claim 14 have similar and/or identical preferred embodiments as defined in the dependent claims.

It shall be understood that the heating exchanging device of claim 1, the heat pump of claim 14, the domestic appliance of claim 15, the method of operating a heat exchanging device of claim 16, and the method of providing a heat exchanging device of claim 17 have similar and/or identical preferred embodiments as defined in the dependent claims.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following drawings:

Fig. 1 shows schematically and exemplarily an embodiment of a heat exchanging device;

Fig. 2 shows schematically and exemplarily an embodiment of a heat exchanging device;

Fig. 3 provides a more detailed view of the second hollow profile shown in Fig. 2;

Fig. 4 shows schematically and exemplarily an embodiment of a heat exchanging device;

Fig. 5 provides a more detailed view of the second hollow profile shown in Fig. 4; and

Fig. 6 shows schematically and exemplarily an embodiment of.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 shows schematically and exemplarily an embodiment of a heat exchanging device 100 in accordance with the present invention. Heat exchanging device 100 comprises a first hollow profile 110 configured to conduct a first medium. In an example, the first medium may be water, in particular wastewater from a dishwasher, a washing machine, or other domestic appliance. The flow direction of the first medium is indicated by arrow 130. Heat exchanging device 100 further comprises a second hollow profile 120 configured to conduct a second medium. In an example, the second medium may be a refrigerant. The flow direction of the second medium is indicated by arrow 140. As illustrated in Fig. 1, at least a part of second hollow profile 120 is wound around at least a part of first hollow profile 110. The present invention proposes to select a nominal width of second hollow profile 120 to be smaller than a nominal width of first hollow profile 110. The nominal width of second hollow profile 120 corresponds to a distance between a first inner surface section of second hollow profile 120 arranged opposite to the second contact portion and a second inner surface section of second hollow profile 120 arranged opposite to the outside portion.

In the heat exchanging device 100 of Fig. 1, first hollow profile 110 and second hollow profile 120 are coupled by means of a soldered connection. Specifically, an outer surface of first hollow profile 110 comprises a first contact portion, and an outer surface of second hollow profile 120 comprises a second contact portion. The first contact portion and the second contact portion are then coupled by means of a soldered connection. Second hollow profile 120 further comprises optional second hollow profile straight sections 120a, 120b, configured to connect second hollow profile 120 to respective inlets and outlets. In an example, first hollow profile 110 comprises stainless steel. In an example, second hollow profile 120 comprises aluminum.

Fig. 2 shows schematically and exemplarily an embodiment of a heat exchanging device 200 in accordance with the present invention. Heat exchanging device 200 comprises a first hollow profile 210 configured to conduct a first medium. In an example, the first medium may be water, in particular wastewater from a dishwasher, a washing machine, or other domestic appliance. Heat exchanging device 200 further comprises a second hollow profile 220 configured to conduct a second medium. In an example, the second medium may be a refrigerant. At least a part of second hollow profile 220 is wound around at least a part of first hollow profile 210. In the heat exchanging device 200 of Fig. 2, first hollow profile 210 and second hollow profile 220 are coupled by means of a soldered connection. Specifically, an outer surface of first hollow profile 210 comprises a first contact portion, and an outer surface of second hollow profile 220 comprises a second contact portion. The first contact portion and the second contact portion are then coupled by means of a soldered connection. Second hollow profile 220 further comprises optional second hollow profile straight sections 220a, 220b, configured to connect second hollow profile 220 to respective inlets and outlets. In an example, first hollow profile 210 comprises stainless steel. In an example, second hollow profile 220 comprises aluminum.

Fig. 3 provides a more detailed view of second hollow profile 220. As is illustrated in Fig. 3, a cross section of second hollow profile 220 has the shape of a rounded uniform trapezoid. The second contact portion corresponds to a basis of the trapezoid.

A nominal width w of second hollow profile 220 is smaller than a nominal width of first hollow profile 210. In an example, a typical value for the nominal width w of second hollow profile 220 is in the range of 5 to 25 mm. In an example, a typical value for the nominal width of first hollow profile 210 is in the range of 20 to 120 mm.
As further illustrated in Fig. 3, a distance d between two adjacent windings of second hollow profile 220 is equal to or larger than 1.5 mm. By keeping adjacent windings of second hollow profile 220 at least 1.5 mm apart, it can be assured that the soldering connection remains between the first and second contact portions rather than distributing between the windings as well so that a soldering connection would be provided between adjacent windings. In other words, the proposed minimum distance between adjacent windings ascertains that no soldering connection between adjacent windings occurs.

Fig. 4 shows schematically and exemplarily an embodiment of a heat exchanging device 400 in accordance with the present invention. Heat exchanging device 400 comprises a first hollow profile 410 configured to conduct a first medium. In an example, the first medium may be water, in particular wastewater from a dishwasher, a washing machine, or other domestic appliance. Heat exchanging device 400 further comprises a second hollow profile 420 configured to conduct a second medium. In an example, the second medium may be a refrigerant. At least a part of second hollow profile 420 is wound around at least a part of first hollow profile 410. In the heat exchanging device 400 of Fig. 4, first hollow profile 410 and second hollow profile 420 are coupled by means of a soldered connection. Specifically, an outer surface of first hollow profile 410 comprises a first contact portion, and an outer surface of second hollow profile 420 comprises a second contact portion. The first contact portion and the second contact portion are then coupled by means of a soldered connection. Second hollow profile 420 further comprises optional second hollow profile straight sections 420a, 420b, configured to connect second hollow profile 420 to respective inlets and outlets. In an example, first hollow profile 410 comprises stainless steel. In an example, second hollow profile 420 comprises aluminum.

Fig. 5 provides a more detailed view of second hollow profile 420. As is illustrated in Fig. 5, a cross section of second hollow profile 420 has the shape of a flattened and rounded uniform trapezoid. The second contact portion corresponds to a basis of the trapezoid.

A nominal width w of second hollow profile 420 is smaller than a nominal width of first hollow profile 410. In an example, a typical value for the nominal width w of second hollow profile 420 is in the range of 5 to 25 mm. In an example, a typical value for the nominal width of first hollow profile 410 is in the range of 20 to 120 mm.

As further illustrated in Fig. 5, a distance d between two adjacent windings of second hollow profile 420 is equal to or smaller than 0.3 mm. By keeping adjacent windings of second hollow profile 420 closer than 0.3 mm together, a soldering connection between the windings may be provided as well. In other words, the proposed maximum distance between adjacent windings enables to provide a soldering connection between adjacent windings.

Fig. 6 shows schematically and exemplarily an embodiment of a refrigeration cycle 6000 comprising an evaporator 6100, a condenser 6200, a compressor 6300, and a thermal expansion valve 6400. In an example, evaporator 6100 and condenser 6200 comprise heat exchanging devices in accordance with the present invention. Evaporator 6100 comprises a first hollow profile 6110 and a second hollow profile 6120 that is wound around first hollow profile 6110. Condenser 6200 comprises a first hollow profile 6210 and a second hollow profile 6220 that is wound around first hollow profile 6210. The flow directions of the medium flowing through first hollow profile 6110 are indicated by arrows 6130. The flow directions of the medium flowing through first hollow profile 6210 are indicated by arrows 6230. The flow directions of the medium flowing through second hollow profiles 6120, 6220, compressor 6300 and thermal expansion valve 6400 is indicated by arrows 6340 and 6440. In an example, the second medium corresponds to a refrigerant.

The circulating refrigerant enters compressor 6300 as a saturated vapor. The vapor is then compressed and exits compressor 6300 as a superheated vapor. Next, the vapor travels through part of condenser 6200 which removes the superheat by cooling the vapor. Having travelled through the remainder of condenser 6200, the vapor is condensed into a saturated liquid. The saturated liquid refrigerant passes through expansion valve 6400 and undergoes an abrupt decrease of pressure. The cold and partially vaporized refrigerant then travels through second hollow profile 6120 of evaporator 6100 where it is totally vaporized by the warm first medium. The resulting refrigerant vapor returns to an inlet of compressor 6300.

By means of the arrangement illustrated in Fig. 6, it is possible to regain thermal energy from a medium flowing through first hollow profile 6110 and to then use this energy to heat up a medium flowing through first hollow profile 6210.

An example application of the invention generally relates to heat exchanging devices in refrigeration cycles of domestic appliances, such as, e.g., dishwashers, washing machines, etc.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

A single unit or device may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Any reference signs in the claims should not be construed as limiting the scope.

The invention relates to a heat exchanging de-
The heat exchanging device (100, 200, 400) comprising a first hollow profile (110, 210, 410) configured to conduct a first medium; a second hollow profile (120, 220, 420) configured to conduct a second medium, wherein at least a part of the second hollow profile (120, 220, 420) is wound around at least a part of the first hollow profile. A nominal width of the second hollow profile is smaller than a nominal width of the first hollow profile. An outer surface of the first hollow profile comprises a first contact portion, an outer surface of the second hollow profile comprises a second contact portion, and the first contact portion and the second contact portion are coupled by means of a soldered connection.

Claims

1. Heat exchanging device (100, 200, 400) comprising a first hollow profile (110, 210, 410) configured to conduct a first medium; a second hollow profile (120, 220, 420) configured to conduct a second medium, wherein at least a part of the second hollow profile (120, 220, 420) is wound around at least a part of the first hollow profile (110, 210, 410); wherein a nominal width (w) of the second hollow profile (120, 220, 420) is smaller than a nominal width of the first hollow profile (110, 210, 410); wherein an outer surface of the first hollow profile (110, 210, 410) comprises a first contact portion, wherein an outer surface of the second hollow profile (120, 220, 420) comprises a second contact portion, and wherein the first contact portion and the second contact portion are coupled by means of a soldered connection.

2. The heat exchanging device (100, 200, 400) according to claim 1, wherein the outer surface of the second hollow profile (120, 220, 420) comprises an outside portion arranged opposite to the second contact portion, wherein the outside portion and the second contact portion are parallel.

3. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein a cross section of the second hollow profile (120, 220, 420) has a trapezoid shape, preferably a uniform trapezoid shape, where the second contact portion corresponds to a basis of the trapezoid shape.

4. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the first hollow profile (110, 210, 410) comprises a straight portion, wherein the second hollow profile (120, 220, 420) is wound around at least a part of the straight portion.

5. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein a central axis of the part of the second hollow profile (120, 220, 420) that is wound around the part of the first hollow profile (110, 210, 410) corresponds to a helix having a uniform pitch.

6. The heat exchanging device (200) according to one of the preceding claims, wherein a distance (d) between two adjacent windings of the second hollow profile (220) is equal to or larger than 1.5 mm.

7. The heat exchanging device (400) according to one of the preceding claims, wherein a distance (d) between two adjacent windings of the second hollow profile (420) is equal to or smaller than 0.3 mm.

8. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the first hollow profile (110, 210, 410) comprises stainless steel, wherein the first hollow profile (110, 210, 410) preferably consists of stainless steel.

9. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the second hollow profile (120, 220, 420) comprises aluminum, wherein the second hollow profile (120, 220, 420) preferably consists of aluminum.

10. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the nominal width (w) of the second hollow profile (120, 220, 420) corresponds to a distance between a first inner surface section of the second hollow profile (120, 220, 420) arranged opposite to the second contact portion and a second inner surface section of the second hollow profile (120, 220, 420) arranged opposite to the outside portion.

11. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein at least a part of the first hollow profile (110, 210, 410) has a circular cross section.

12. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the nominal width of the first hollow profile (110, 210, 410) is equal to or larger than 20 mm and smaller than 120 mm.

13. The heat exchanging device (100, 200, 400) according to one of the preceding claims, wherein the nominal width (w) of the second hollow profile (120, 220, 420) is equal to or larger than 5 mm and smaller than 25 mm.

14. Heat pump comprising the heat exchanging device (100, 200, 400) according to one of claims 1 to 13, wherein the heat exchanging device (100, 200, 400)
is employed as one of an evaporator or a compressor.

15. Domestic appliances, preferably one of a washing machine or a dishwasher, comprising a heat pump according to claim 14.

16. A method of operating a heat exchanging device (100, 200, 400) according to one of claims 1 to 13, wherein the method comprises the steps of:

conducting a first medium in a first hollow profile (110, 210, 410);
conducting a second medium in a second hollow profile (120, 220, 420), wherein at least a part of the second hollow profile (120, 220, 420) is wound around at least a part of the first hollow profile (110, 210, 410);
wherein a nominal width (w) of the second hollow profile (120, 220, 420) is smaller than a nominal width of the first hollow profile (110, 210, 410);
wherein an outer surface of the first hollow profile (110, 210, 410) comprises a first contact portion, wherein an outer surface of the second hollow profile (120, 220, 420) comprises a second contact portion, and wherein the first contact portion and the second contact portion are coupled by means of a soldered connection.

17. A method of providing a heat exchanging device (100, 200, 400) comprising
providing a first hollow profile (110, 210, 410) comprising configured to conduct a first medium;
providing a second hollow profile (120, 220, 420) configured to conduct a second medium, wherein a nominal width (w) of the second hollow profile (120, 220, 420) is smaller than a nominal width of the first hollow profile (110, 210, 410);
winding at least a part of the second hollow profile (120, 220, 420) around at least a part of the first hollow profile (110, 210, 410);
providing a soldered connection to couple a first contact portion and a second contact portion, wherein an outer surface of the first hollow profile (110, 210, 410) comprises the first contact portion, and wherein an outer surface of the second hollow profile (120, 220, 420) comprises the second contact portion.
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**Date of completion of the search**: 22 January 2016  
**Examiner**: Merkt, Andreas
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For more details about this annex: see Official Journal of the European Patent Office, No. 12/82.
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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