Research of Design Concept on the Integration of Solar Water Heater and Building in Green Residential Building

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Abstract: By the analysis of current application form and characteristics of the solar energy water heater in the actual project in China, in the paper, it is mainly studied that the design concept on integration of solar water heater collector and building in green residential building design, by changing the traditional method of design, the reliable theoretical support and engineering reference is provided for the widely application of solar energy and heat in buildings.

Keywords: green resident building, solar water heater, integration, the green residential building, design concept

Introduction

The integral combination of solar energy and building has become a hot technology which has been greatly extended in the profession of the building and solar energy. At present, in the multi-story residential building, the most popular way to install solar water heater is to install it on the roof. But the method has a lot of defects, such as having a longer pipeline connection, great heat loss, and it is difficult of checking and maintenance, poor integrity, no standard of pipe set, uncoordinated of water heater installation and architectural appearance, and so on, all of which not only adverse effects the appearance of the city, but also have many hidden danger [1]. For the small tall buildings and tall buildings, because of the water supply division, the working pressure of water supply pipeline will rise gradually along the elevation level, the pressure on the bottom of the pipeline will increasing, it is impossible that the user in the lower and middle area provide water by water supply indoor to the water rank on the roof [2]. So that it is almost impossible to use solar water heating systems separated which is similar to multi-story house held in the small tall and tall building. Only if it is achieved of the integration of solar water heater and building (using centralized heat collector or balcony, wall) the solar water heater can be widely used in the small tall and tall building.

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Application Form and Characteristics of Solar Water Heater

At present, there are four main types of solar water heaters: flat plate, vacuum tube type, simple type (boring type) and light gathering type.

**The flat type.** It is mainly to absorb solar energy by using the heat pipe which is made of copper, aluminum or copper and aluminum alloy metal to (as shown in Fig.1 and Fig.2). In spite of easily absorbing, the heat loss rate is high and the heat efficiency is low. Due to lower costs and lower prices, it is popular in low latitude or higher temperature regions [3].

![Figure 1. Split plate type.](image1)
![Figure 2. Integral flat plate type.](image2)

![Figure 3. Split vacuum tube type.](image3)
![Figure 4. Integral vacuum tube type.](image4)

**The vacuum tube type** (see Fig.3 and Fig.4). Because vacuum tube solar collector is similar to hot water flask. It is a vacuum between two layers of glass, which greatly improves insulation performance of the collector heat, and improves the collector temperature. At the same time, the use of the selective coating of the vacuum tube inner wall, some tube back is also additionally provided with a reflecting plate, so it has high efficiency in heat collecting. Vacuum tube types have the lowest heat loss rate and the highest thermal efficiency, suitable for high latitude or cold areas but not lack of solar energy resources (such as the northeast). From the United States in 1978, the whole glass vacuum tube sample has been introduced in China, for years of efforts, it has been built that the whole glass vacuum tube industry with independent intellectual property rights of modern production capacity.

**The simple type** (see Fig.5). It is mostly belongs to the early products of solar hot water heater, with homemade majority, mainly through a large water storage containers which is in stuffy insolation, thermal efficiency is very low and greatly affected by the weather. At present, this kind of product is in the trend of being eliminated gradually, but in some tropical countries, because the solar energy resources are extremely rich so there are less demanding on the water heater efficiency, so there is still a considerable market.
The spotlight type (see Fig.6). It is mainly use the characteristic that the focal point of the mirror will gather energy, which is a more high technology products, at present, only in the United States to achieve its industrialization. Thought the efficiency of spotlight type solar water heater is higher, but because of its characteristic is that based on requirements in appearance it must be made arc or spherical surface, so the increasing difficulty in combination with buildings is the reason why it has not been widely used.

China has independent intellectual property rights for vacuum tube type solar water heater, and has rich resources of solar energy in the northwest, north China and the whole northern, the average annual temperature is relative low, and it is higher of the requirements for thermal efficiency of the solar water heater. So the vacuum tube type solar water heaters widely used in China[4].

Design Conception of Integration of Solar Water Heater and Building

The integration of solar water heater and building is to make the solar water heater and building fully integration and achieve the harmony and unity of the overall appearance of building, considering harmonious of the building structure and solar equipment, reasonable structure, namely the building form and content (function, material, structure and technology) should be consistent.

The characteristics of the residential building should be full considered in the architectural image design on the integration of residential building and the solar water heater. First, both tall residential and multi-story residential building, they are composed with flats, which have no big space, the plan, elevation and the architectural image are generally more regular. Secondly, restrictions to function of room is significant, it is highly stressed to natural lighting and natural wind. Thirdly, restrictions to cost for residential is significant. The exterior wall should also be as planar as possible. Because of these characteristics of residential, in the design of architectural image, it can have a large amount of change, but it is generally difficult to break the limit of the layer, flats and other elements of the unit. In practices, the repeat and decrease of the same elements are often used to achieve artistic effect. From this point of view, the architectural image design of residential buildings is more difficult than public buildings. But from another point of view, the leading position of internal structure and function of the residential is very consistent with the logicality and purposiveness emphasized from technology aesthetics. It is feasible to express technical aesthetics in the integration design of solar water heater and building in the residential performance, of course, tall residential buildings, multi-story residential have their own characteristics, it should be treated distinguish.
The tall residential buildings. The tall residential building itself marks the achievements of modern science and technology in the field of construction, the integration design of solar water heater and building can be complementary to each other. Due to the pipeline and the density of the household, the solar collectors in the tall buildings are often installed in the wall and balcony, and the collector on top of building can only provide hot water for the upper several layers. So the first discussion of vertical use, that means, the coordination of the elevation of the building and the heat collector.

First, a larger area of the collector can be used to enhance the vertical design. In China, tall residential buildings, especially the tower, will have some changes of the plane, but most of the shape features are tall and straight. Further strengthen the vertical design, it can make it have more modern style. The collector can be continuously and centralized arranged, and can be combined with the concave and convex design of the window or the balcony to form a vertical division, so that the whole building can be formed a strong sense of rhythm in the vertical direction. The water tank of the solar water heater should be placed in indoor as far as possible, so as to avoid the destruction for the overall effect of elevation, it is used that the forced circulation type or the direct current type heat collection device and the pipeline of top water type is selected.

Secondly, the utilizing of the collector can also be reflected in the elements and materials of residential. In recent years, for tall residential, the special shape or symbols are often used to strengthen the signs on the top or the beam of the outer concave part, in order to avoid the monotonous feeling. Because of the use of the absorbent coating with special color and texture for solar heat collector, the surface is very bright, if it can be combined with the elevator on the top or water tank, which not only can play a decorative role, but also can provide hot water for the upper layers resident. Large areas of glass window is usually used in residential in some tropical and subtropical regions, but it must be equipped with sunshade component and using overhanging heat collecting plate as a sunshade. The shadow is formed by it increases the contrast of the virtual reality and the space level.

The multi-story residential buildings. In the multi-story residential buildings, the integration design of solar water heater and buildings can begin from the form and proportion. Due to the collector needs the support of the slope roof facing south or wall for installation. It becomes the guiding ideology of residential integration design to get available area and space as much as possible. The design of draw back step shape and half ground connection are usually used. By means of three-dimensional cutting, the entire volume of the cross section is similar to the steps or triangles.

Integrated design of solar water heater can express the technology characteristics and modern style with the help of part component, because of the functional influence, the shape change of multi-story residential is often be limited. At this time the form of component and partial processing will play an important role.

Conclusion
Integration technology is a comprehensive technology, dealing with the application of
solar energy, architecture, fluid distribution, and other technical fields. Solar water heater, according to the characteristics of different types, can be used for the flat roof, sloping roof, balcony and wall. Usually, the covering type or frame type is generally used for flat roof, the mosaic, scaffolding or roof type are used for slope roof, the mosaic type or frame type are used for the balcony and wall. Balcony frame type can be applied to multi-story, small tall and tall buildings, the roof frame type is more suitable for small tall buildings with flat roof, the roof mosaic is suitable for multi-story and small tall buildings with slope roof. The best way to combine the solar water heater and the building are the roof overhead frame structure, the roof mosaic and the balcony frame, which will be the development tendency of the solar water heater application in the future.

With the development of society and the improvement of people's living standard in China, the stable hot water supply becomes one of the basic living needs of the residents. This is the main reason why integration of solar water heating equipment and systems and building has become the important reason of rapid development of solar energy field. At present, in the architectural design it should be pay attention to Chinese social development, technological progress, economic capacity, regional climate, life needs and so on, be as the breakthrough point to the hot water supply in the field of solar buildings, to expand the existing concept advantages of solar hot water supply, to advocate the principle of first conception, break through the demonstration, policy follow-up, to gradually promote the use of solar energy in phases and eventually reach the popularization and promotion of solar energy utilization in China.

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References