METHOD FOR ACCOUNTING CARBON EMISSION OF WATER SYSTEM IN BUILDING OPERATION PERIOD

FIELD OF TECHNOLOGY

[0001] The present invention relates to the technical field of carbon emission calculation, in particular to a method for accounting carbon emission of a water system in a building operation period.

BACKGROUND

[0002] Peak carbon dioxide emission and carbon neutrality are the current global consensus initiative to address climate change and the main topic of international cooperation. On September 22, 2020, General Secretary Xi Jinping proposed the "Double Carbon" goal in the general debate of the 75th session of the United Nations General Assembly that "China will increase its national independent contribution, adopt more powerful policies and measures, and strive to reach the peak of carbon dioxide emission by 2030 and strive to achieve carbon neutrality by 2060". This important decision of the CPC Central Committee bears on the sustainable development of the Chinese nation and the building of a community with a shared future for mankind. It is closely related to China's economic development mode, energy structure, industrial production, and personal behavior and habits.

[0003] According to the United Nations Environment Program, nearly 40% of energy-related carbon dioxide emission comes from the building industry. Building carbon emission is the sum of greenhouse gas emission generated in a building material production and transportation period, a construction and demolition period, and an operation period related to buildings, while the carbon emission in the building operation period accounts for 70% or more. The energy form, system form, device parameters, operation and maintenance methods selected in a building design period directly affect the carbon emission of the building operation, so the technical measures to reduce carbon emission in the building operation period are important breakthroughs for low-carbon buildings.

[0004] The standards of the building industry on low-carbon content are gradually introduced and implemented. According to the full-text mandatory code "General Code for

Energy Efficiency and Renewable Energy Application in Buildings" (GB55015-2021), which will be implemented from April 1, 2022, Article 2.0.3 "The carbon emission intensity of new residential and public buildings shall be reduced by 40% on average on the basis of the energy-saving design standards implemented in 2016, and the carbon emission intensity shall be reduced by 7 $kgCO_2/(m^2.a)$ on average" and Article 2.0.5 "New buildings, extensions and alterations as well as energy-saving renovations of existing buildings shall be designed for building energy efficiency. Building project feasibility studies, construction plans and preliminary design documents should include building energy consumption, renewable energy application and a building carbon emission analysis report. The construction drawing design document should specify the technical requirements for building energy efficiency measures and the operational management of renewable energy application systems." Since then, there have been clear mandatory standards for building carbon emission and mandatory requirements for carbon emission intensity in China. The carbon emission analysis report is a necessary document before the construction drawing is carried out.

[0005] As one of the building electromechanical systems, a building water supply, drainage and firefighting system plays an important role in ensuring the normal operation and use of buildings. With the development of economy in China, building types and forms are increasingly rich, and to meet people's increasing needs for life safety and quality, the form of the building water system has also been greatly developed and improved, and related products are also being iterated and updated. At present, sub-items and forms of the building water supply system have reached more than ten kinds. The carbon emission of the building water supply and drainage system involves both energy consumption and water consumption, and how to accurately account the carbon emission becomes an important link in the research of low carbon key technology of the building water system.

[0006] At present, the existing national standards and industry standards related to building carbon emission have given carbon emission calculation methods in different periods from the perspective of the building life cycle. However, to complete the carbon emission analysis report required in the full-text mandatory specification "General Code for Energy Efficiency and Renewable Energy Application in Buildings" (GB55015-2021) in the design period, the building water system still has the problems that the carbon emission accounting

boundary is unclear, accounting methods are not systematic, calculation standards are not uniform, and low-carbon technical measures are uncertain. Specifically at the implementation level, designers do not know where to start.

SUMMARY

[0007] In view of the above analysis, an embodiment of the present invention aims to provide a method for accounting carbon emission of a water system in a building operation period, so as to solve the problem that there is no method for calculating the carbon emission of the water system in the building operation period in a building design period.

[0008] The present invention provides a method for accounting carbon emission of a water system in a building operation period. The method includes the following steps:

[0009] acquiring energy consumption Q_i of the building water system, a building design life y, and a building area A; and

[0010] calculating carbon emission C_M per unit of building area in the building operation period with the following formula:

$$C_M = \frac{(\sum_{i=1}^{n} Q_i q_i)\ y}{A}$$

[0011] where q_i denotes a carbon emission factor of an i-th type of energy; and

[0012] the energy consumption Q_i of the building water system at least includes annual heat consumption Q_w of a building domestic hot water system and electricity consumption Q_e for operation of electric devices in the building water system.

[0013] Further, a calculation formula of the annual heat consumption Q_w of the building domestic hot water system is as follows:

$$Q_w = \frac{\frac{Q_r}{\eta_r} - Q_s}{\eta_w}$$

[0014] where Q_r denotes annual heat consumption of domestic hot water;

[0015] Q_s denotes domestic hot water heat provided by renewable energy;

[0016] η_r denotes transportation and distribution efficiency of domestic hot water; and

[0017] η_w denotes average annual efficiency of a heat source of the domestic hot water system.

[0018] Further, a calculation formula of the annual heat consumption Q_r of the domestic hot water is:

$$Q_r = TQ_{rp}$$

$$Q_{rp} = \frac{4.187mq_r c_r(t_r - t_l)\rho_r}{3600 \cdot T_1}$$

[0019] where T denotes the number of hours of domestic hot water use per year, $T=T_1 \times T_2$, T_1 denotes the number of hours of domestic hot water use per day, and T_2 denotes the number of days of domestic heat use per year;

[0020] Q_{rp} denotes average daily heat consumption of domestic hot water;

[0021] m denotes a water consumption calculation unit;

[0022] q_r denotes a hot water consumption norm;

[0023] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

[0024] t_r denotes a design hot water temperature;

[0025] t_l denotes a design cold water temperature; and

[0026] ρ_r denotes density of hot water.

[0027] Further, a calculation formula of the domestic hot water heat Q_s provided by the renewable energy is:

$$Q_s = Q_{S,\ x} + Q_{S,sol}$$

[0028] where $Q_{s,sol}$ denotes annual renewable energy utilization of a solar domestic hot water system;

[0029] $Q_{s,x}$ denotes annual renewable energy utilization of the domestic hot water system except solar energy;

[0030] when the renewable energy used by the building only includes solar energy, $Q_{s,x}$ is zero; and

[0031] when the building uses renewable energy other than the solar energy, $Q_{s,x}$ is one or more of $Q_{s,geo}$, $Q_{s,air}$ and $Q_{s,bio}$, $Q_{s,geo}$ denoting annual renewable energy utilization of a geothermal heat pump domestic hot water system, $Q_{s,air}$ denoting annual renewable energy utilization of an air source heat pump domestic hot water system, $Q_{s,bio}$ denoting annual renewable energy utilization of a biomass domestic hot water system.

[0032] Further, a calculation formula of the annual renewable energy utilization $Q_{s,sol}$ of the solar domestic hot water system is:

$$Q_{S,sol} = \frac{0.28 A_C J_T (1 - \eta_L) \eta_{cd}}{3.6}$$

[0033] where A_c denotes an area of a solar collector;

[0034] J_T denotes average annual solar irradiation of a lighting surface of the solar collector;

[0035] η_{cd} denotes average heat collection efficiency of the collector based on a total area; and

[0036] η_L denotes a heat loss rate of a pipeline and a heat storage device.

[0037] Further, a calculation formula of the annual renewable energy utilization $Q_{s,geo}$ of the geothermal heat pump domestic hot water system is:

$$Q_{S,geo} = Q_{w,geo} - E_{w,geo}$$

[0038] where $Q_{w,geo}$ denotes annual domestic hot water heat supply of the geothermal heat pump system, and

[0039] $E_{w,geo}$ denotes annual electricity consumption of a geothermal heat pump unit for supplying domestic hot water; and

[0040] a calculation formula of the annual domestic hot water heat supply $Q_{w,geo}$ of the geothermal heat pump system is:

$$Q_{w,geo} = T_5 Q_{rprb}$$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_3}$$

[0041] where Q_{rprb} denotes average daily heat supply for hot water by a heat pump;

[0042] T_5 denotes the number of hours of domestic hot water use per year, $T_5 = T_3 \times T_4$, T_3 denotes design working time of the heat pump unit, and T_4 denotes the number of days of heat pump use per year;

[0043] m denotes a water consumption calculation unit;

[0044] q_r denotes a hot water consumption norm;

[0045] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

[0046] t_r denotes a design hot water temperature;

[0047] t_l denotes a design cold water temperature; and

[0048] ρ_r denotes density of hot water.

[0049] Further, a calculation formula of the annual renewable energy utilization $Q_{s,air}$ of the air source heat pump domestic hot water system is:

$$Q_{S,air} = Q_{w,air} - E_{w,air}$$

[0050] where $Q_{w,air}$ denotes annual domestic hot water heat supply of the air source heat pump system, and

[0051] $E_{w,air}$ denotes annual electricity consumption of an air source heat pump unit for supplying domestic hot water; and

[0052] a calculation formula of the annual domestic hot water heat supply $Q_{w,air}$ of the air source heat pump system is:

$$Q_{w,air} = T_5 Q_{rprb}$$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l)\rho_r}{3600 \cdot T_3}$$

[0053] where Q_{rprb} denotes average daily heat supply for hot water by a heat pump;

[0054] T_5 denotes the number of hours of domestic hot water use per year, $T_5=T_3\times T_4$, T_3 denotes design working time of the heat pump unit, and T_4 denotes the number of days of heat pump use per year;

[0055] m denotes a water consumption calculation unit;

[0056] q_r denotes a hot water consumption norm;

[0057] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

[0058] t_r denotes a design hot water temperature;

[0059] t_l denotes a design cold water temperature; and

[0060] ρ_r denotes density of hot water.

[0061] Further, a calculation formula of the electricity consumption Q_e for operation of the electric devices in the building water system is:

$$Q_e = \sum_{j=1}^{k} N_j \cdot P_{dj} \cdot T_{dj}$$

[0062] where P_{dj} denotes electric power of each of electric devices of a j-th type;

[0063] T_{dj} denotes the number of average annual operation hours of the electric devices of the *j*-th type; and

[0064] N_j denotes the number of the electric devices of the *j*-th type.

[0065] Further, when the electrical devices are capable of calculating the operation electricity consumption, summation is performed by using the operation electricity consumption during calculation of Q_e.

[0066] Further, the electric devices are secondary water supply devices, and a calculation formula of operation electricity consumption Q_c of the secondary water supply devices is:

$$Q_c = P_d \cdot Q_d \cdot H \cdot T_d$$

[0067] where P_d denotes unit water supply energy consumption;

[0068] Q_d denotes water supply flow;

[0069] H denotes a head of a water pump; and

[0070] T_d denotes the number of average annual operation hours of the water pump.

[0071] Compared with the prior art, the present invention may at least achieve one of the following beneficial effects: The present invention sorts out the carbon emission calculation boundary of the water system from the perspective of actual operation, and systematically gives the method for accounting the carbon emission of the building water system according to carbon emission calculation methods in the relevant national standards and industry standards and combined with the features of the building water system, thereby providing an accurate calculation method for further refining a carbon emission analysis report for the building water system in the design period.

[0072] In the present invention, the above technical solutions may also be combined with each other to achieve more preferred combined solutions. Other features and advantages of the present invention will be set forth in the following description, and may become apparent in part from the description, or may be learned by practice of the present invention. The object and other advantages of the present invention may be implemented and attained by the content particularly pointed out in the written description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0073] The accompanying drawings are for the purpose of illustrating specific embodiments only and are not to be construed as limiting the present invention. Throughout the accompanying drawings, the same reference numerals indicate the same components.

[0074] FIG. 1 shows a carbon emission accounting boundary of a building electromechanical system in a specific implementation.

DESCRIPTION OF THE EMBODIMENTS

[0075] Preferred embodiments of the present invention are described below in detail with reference to the accompanying drawings. The accompanying drawings constitute part of the present invention and, together with the embodiments of the present invention, serve to illustrate the principles of the present invention, and are not intended to limit the scope of the present invention.

[0076] In the description of the embodiments of the present invention, it is to be noted that, unless otherwise expressly specified and limited, the term "connected" is to be understood in a broad sense, for example, it may be a fixed connection, or a removable connection, or an integral connection; it may be a mechanical connection or an electrical connection; or it may be a direct connection or an indirect connection through an intermediate medium. The specific meanings of the above terms in the present invention may be understood by a person of ordinary skill in the art according to specific circumstances.

[0077] The terms "top", "bottom", "above", "below" and "on" as used throughout the description are relative positions with respect to components of an apparatus, for example, relative positions of top and bottom substrates inside the apparatus. It may be understood that the apparatus is multifunctional regardless of its orientation in space.

[0078] A common working surface of the present invention may be flat or curved, inclined, or horizontal. For convenience of illustration, embodiments of the present invention are placed on a horizontal surface and used on a horizontal surface, and thus qualify "high and low" and "up and down".

[0079] The development of terminal energy-using sectors in industrial, transportation and building in China is driving changes in energy consumption and carbon emission. Energy

consumption and carbon emission in all fields are affected by activity level, internal structure, technical efficiency, etc. The carbon emission accounting boundary in the building field is divided into two dimensions: physical boundary and time boundary, where the physical boundary takes a single building or a building group formed by similar buildings as an accounting unit, and the time boundary takes a building life cycle as an accounting object. At present, internationally, a building carbon emission calculation system of the building life cycle is divided into four major accounting scopes: building material, construction, operation, and demolition according to the construction process of buildings as a whole. In China, according to "Standard for Building Carbon Emission Calculation" (GB/T51366-2019), the building life cycle is divided into three periods: building material production and transportation, construction and demolition, and building operation.

[0080] At home and abroad, there are two definitions of the scope of building carbon emission, broad and narrow. The broad definition includes emission of the whole process of a building water system from building material production to construction, operation, demolition, etc. The narrow definition only includes carbon emission generated by energy consumption of domestic hot water and other electric devices in the building water system in the operation period.

[0081] The three periods of the building life cycle are divided according to energy consumption and carbon emission fields, where the building material production and transportation belong to the industry and transportation fields, and the construction and demolition and the building operation belong to the building field. The carbon emission of the building operation period accounts for 60%–80% of the building life cycle, as shown in FIG. 1.

[0082] A specific embodiment of the present invention discloses a method for accounting carbon emission of a water system in a building operation period. The method includes the following steps:

[0083] acquire energy consumption Q_i of the building water system, a building design life y, and a building area A; and

[0084] calculate carbon emission C_M per unit of building area in the building operation period with the following formula:

$$C_M = \frac{(\sum_{i=1}^{n} Q_i q_i)\, y}{A}$$

[0085] where q_i denotes a carbon emission factor of an i-th type of energy. A value of q_i is acquired from Table 1-Statistical table of carbon emission factors in an operation period of an electromechanical system.

[0086] The energy consumption Q_i of the building water system at least includes annual heat consumption Q_w of a building domestic hot water system and electricity consumption Q_e for operation of electric devices in the building water system.

[0087] It is to be noted that besides the annual heat consumption Q_w of the building domestic hot water system and the electricity consumption Q_e for operation of the electric devices in the building water system, the energy consumption Q_i of the building water system may further include other types of energy consumption and is not limited to the two types (that is, Q_w and Q_e). That is, although only these two types are used to calculate carbon emission of the water system in the operation period of most buildings, exceptions will not be excluded, or buildings have new types of energy consumption in the future.

[0088] The domestic hot water system in the building water system may choose a plurality of types of energy, such as fuel oil, gas, electricity, and municipal heat. System energy consumption other than domestic hot water is electricity, so the energy activity level of the building water system may be obtained by calculating the annual heat consumption of the building domestic hot water system and the electricity consumption for the operation of the electric devices, and then multiplied by carbon emission factors of different energy sources to obtain the carbon emission of the building water system.

[0089] It is to be noted that C_M is calculated by multiplying Q_w by a carbon emission factor of an energy source that supplies heat to the building domestic hot water. During calculation of C_M, the carbon emission factor corresponding to Q_e is an electricity carbon emission factor.

Table 1-Statistical table of carbon emission factors in an operation period of an electromechanical system

Energy name	Fuel oil	Gas	Electricity	Municipal heat
Carbon emission factor	77.4 $kgCO_2/GJ$	55.54 $tCO_2/(TJ)$	0.5810 tCO_2/MWh	57.4 $kgCO_2/(GJ)$

[0090] It should be noted that data in Table 1 are from "Standard for Building Carbon Emission Calculation". Although only four carbon emission factors of fuel oil, gas, electricity and municipal heat are given in Table 1, it does not mean that only these four energy sources are involved during calculation of C_M. The specific energy sources involved in the calculation mainly depend on the building design and energy composition of a building site is located. Carbon emission factors corresponding to each energy source may be obtained from "Standard for Building Carbon Emission Calculation".

[0091] The unit of the building design life is a.

[0092] The time boundary of carbon emission calculation should take the building life cycle as a calculation object. The adopted building design life y should be consistent with a design document and shall be calculated as 50 years when the design document is not available. The design process of a zero-carbon building electromechanical system should pay attention to the building life cycle, and device forms and system forms are reasonably selected according to different service life of buildings. According to provisions of the national standard “Uniform Standard for Design of Civil Buildings” GB50352-2019, the design service life of civil buildings is divided into four categories, as shown in Table 2, among which the service life of ordinary buildings and structures is 50 years. During actual calculation, it may refer to design documents, and when there is really no relevant information, it may be calculated as 50 years.

Table 2-Classification of design service life

Category	Design service life (years)	Example
1	5	Temporary buildings
2	25	Buildings with easily replaceable structural elements
3	50	Ordinary buildings and structures
4	100	Monumental buildings and buildings of special importance

[0093] The building area A is acquired from the design document, in m^2.

[0094] The energy consumption of the building water system is also classified into a direct carbon emission type and an indirect carbon emission type. An implementation path of the building water system under a goal constraint of peak carbon dioxide emission is clarified by improving the utilization rate of renewable energy, improving the utilization rate of waste heat, and increasing the proportion of non-fossil energy and other key paths. The present invention provides a method for accounting the annual heat consumption of building domestic hot water and a method for accounting the annual electricity consumption of the building water system respectively.

[0095] A zero-carbon building domestic hot water system has different carbon emission according to the choice of heat source. There is direct carbon emission from consumption of fossil energy such as fuel oil and gas, and indirect carbon emission from the use of electric heating. From the perspective of carbon emission, the trend of choosing a heat source of domestic hot water should gradually eliminate fossil energy causing direct carbon emission, reduce the amount of electricity consumption causing indirect carbon emission, and apply all renewable energy.

[0096] A calculation formula of the annual heat consumption Q_w of the building domestic hot water system is as follows:

$$Q_w = \frac{\frac{Q_r}{\eta_r} - Q_s}{\eta_w}$$

[0097] where Q_w is in kWh/a;

[0098] Q_r denotes annual heat consumption of domestic hot water, in kWh/a;

[0099] Q_s denotes domestic hot water heat provided by renewable energy, in kWh/a;

[0100] η_r denotes transportation and distribution efficiency of domestic hot water, including heat losses of all pipelines and heat storage devices of the domestic hot water system, and is acquired from the design document; and

[0101] η_w denotes average annual efficiency of a heat source of the domestic hot water system, and is acquired from the design document.

[0102] A calculation formula of the annual heat consumption Q_r of the domestic hot water is:

$$Q_r = TQ_{rp}$$

[0103] where T denotes the number of hours of domestic hot water use per year, in h/a; $T=T_1\times T_2$, T_1 denotes the number of hours of domestic hot water use per day, in h/d, and T_2 denotes the number of days of domestic heat use per year, in d/a; T_1 and T_2 are acquired from the design document;

[0104] Q_{rp} denotes average daily heat consumption of domestic hot water, in kW.

[0105] A calculation formula of the average daily heat consumption Q_r of domestic hot water is:

$$Q_{rp} = \frac{4.187mq_rc_r(t_r - t_l)\rho_r}{3600 \cdot T_1}$$

[0106] where m denotes a water consumption calculation unit, in either the number of persons or the number of beds (whichever is appropriate), and is acquired from the design document;

[0107] q_r denotes a hot water consumption norm, in L/person·d or L/bed·d (matched with the unit of m), and is acquired from Table 3;

[0108] ρ_r denotes density of hot water, in kg/L;

[0109] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15 (exemplarily, the value may be 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, etc.);

[0110] t_r denotes a design hot water temperature, in °C, and is acquired from the design

document; and

[0111] t_l denotes a design cold water temperature, in °C, and is acquired from the design document.

Table 3-Hot water consumption norm

No.	Building name		Unit	Water consumption norm		Service time (h)
				Maximum daily	Average daily	
1	Ordinary residential buildings	Having a water heater and bathing facilities	/person·d	40-80	20-60	24
		Having a central hot water supply (or domestic hot water set) and bathing facilities		60-100	25-70	24
2	Villa		/person·d	70-110	30-80	24
3	Serviced apartment		/person·d	80~100	65-80	24
4	Dormitory There is a toilet in a living room With a public washroom		/person·d /person·d	70-100 40-80	40-55 35-45	24 h or timed supply
5	Hostels, training centers, and ordinary hotels Having a public bathroom Having a public bathroom and a shower room Having a public bathroom, a		/person·d /person·d /person·d /person·d	25-40 40-60 50-80 60-100	20-30 35-45 45-55 50-70	24 h or timed supply

	shower room and a laundry room Having a separate toilet and a public laundry room				
6	Hotel guest room Passenger Employee	/bed·d /person·d	120-160 40-50	110-140 35-40	24 8-10
7	Hospital inpatient department Having a public bathroom Having a public bathroom and a shower room Having a separate toilet Medical staff Outpatient department and clinic Patient Medical staff Housing department of sanatorium and rest home	/bed·d /bed·d /bed·d /person·shift /patient·time /person·shift /bed·person·d	60-100 70-130 110-200 70-130 7-13 40-60 100-160	40-70 65-90 110-140 65-90 3-5 30-50 90-110	24 24 24 8 8-12 8 24
8	Retirement home and nursing home Full-time nursery Day-nursery	/bed·d	50-70 25--40	45-55 15-20	24 10
9	Kindergarten and nursery school With accommodation No accommodation	/child·d /child·d	25-50 20-30	20-40 15-20	24 10

10	Public shower room Shower Shower, tub Sauna bath (shower, massage pool)	/customer·time /customer·time /customer·time	40-60 60-80 70-100	35-40 55-70 60-70	12 12 12
11	Barber shop, beauty salon	/customer·time	20-45	20-35	12
12	Laundry room	Per kilogram of dry clothes	15-30	15-30	8
13	Catering industry Chinese restaurant Fast food restaurant, staff and student canteen Bar, cafe, teahouse, and karaoke room	/customer·time /customer·time /customer·time	15-20 10-12 3-8	8-12 7-10 3-5	10-12 12-16 8-18
14	Office building On-duty office Apartment office Hotel office	/person·shift /person·d /person·d	5-10 60-100 120-160	4-8 25-70 55-140	8-10 10-24 24
15	Fitness center	/person·time	15-25	10-20	8-12
16	Stadium (gym) Athlete shower	/person·ti	17-26	15-20	4

		me			
17	Conference hall	/seat·time	2-3	2	4

[0112] A calculation formula of the domestic hot water heat Q_s provided by the renewable energy is:

$$Q_s = Q_{S,\ x} + Q_{S,sol}$$

[0113] where $Q_{s,sol}$ denotes annual renewable energy utilization of a solar domestic hot water system, in kWh/a; and

[0114] $Q_{s,x}$ denotes annual renewable energy utilization of the domestic hot water system except solar energy, in kWh/a.

[0115] When renewable energy used by the building only includes solar energy, $Q_{s,x}$=0 kWh/a.

[0116] When the building uses renewable energy other than the solar energy, $Q_{s,x}$ is one or more of $Q_{s,geo}$, $Q_{s,air}$, $Q_{s,bio}$, etc. $Q_{s,geo}$ denotes annual renewable energy utilization of a geothermal heat pump domestic hot water system, in kWh/a; $Q_{s,air}$ denotes annual renewable energy utilization of an air source heat pump domestic hot water system, in kWh/a; and $Q_{s,bio}$ denotes annual renewable energy utilization of a biomass domestic hot water system, in kWh/a, which are acquired from the design document.

[0117] $Q_{s,x}$ is designed according to the energy composition of the building site, preferably, $Q_{s,x}$ is one of $Q_{s,geo}$, $Q_{s,air}$ and $Q_{s,bio}$.

[0118] A calculation formula of the annual renewable energy utilization $Q_{s,geo}$ of the geothermal heat pump domestic hot water system is:

$$Q_{S,geo} = Q_{w,geo} - E_{w,geo}$$

[0119] where $Q_{w,geo}$ denotes annual domestic hot water heat supply of the geothermal heat pump system, in kWh/a, and

[0120] $E_{w,geo}$ denotes annual electricity consumption of a geothermal heat pump unit for supplying domestic hot water, in kWh/a, which are acquired from the design document.

[0121] A calculation formula of the annual domestic hot water heat supply $Q_{w,geo}$ of the geothermal heat pump system is:

$$Q_{w,geo} = T_5 Q_{rprb}$$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_3}$$

[0122] where Q_{rprb} denotes average daily heat supply for hot water by a heat pump, in kW;

[0123] T_5 denotes the number of hours of domestic hot water use per year, in h/a, $T_5=T_3\times T_4$, T_3 denotes design working time of the heat pump unit, in h/d, and is 8–16 h, and T_4 denotes the number of days of heat pump use per year, in d/a, which are acquired from the design document; and ρ_r denotes density of hot water, in kg/L;

[0124] m denotes a water consumption calculation unit, in either the number of persons or the number of beds (whichever is appropriate), and is acquired from the design document;

[0125] q_r denotes a hot water consumption norm, in L/person·d or L/bed·d (matched with the unit of m), and is acquired from Table 3;

[0126] ρ_r denotes density of hot water, in kg/L;

[0127] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15 (exemplarily, the value may be 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, etc.);

[0128] t_r denotes a design hot water temperature, in °C, and is acquired from the design document; and

[0129] t_l denotes a design cold water temperature, in °C, and is acquired from the design document.

[0130] A calculation formula of the annual renewable energy utilization $Q_{s,air}$ of the air source heat pump domestic hot water system is:

$$Q_{S,air} = Q_{w,air} - E_{w,air}$$

[0131] where $Q_{w,air}$ denotes annual domestic hot water heat supply of the air source heat pump system, in kWh/a, and

[0132] $E_{w,air}$ denotes annual electricity consumption of an air source heat pump unit for supplying domestic hot water, in kWh/a, which are acquired from the design document.

[0133] A calculation formula of the annual domestic hot water heat supply $Q_{w,air}$ of the air source heat pump system is:

$$Q_{w,air} = T_5 Q_{rprb}$$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_3}$$

[0134] where Q_{rprb} denotes average daily heat supply for hot water by a heat pump, in kW;

[0135] T_5 denotes the number of hours of domestic hot water use per year, in h/a, $T_5=T_3\times T_4$, T_3 denotes design working time of the heat pump unit, in h/d and is 8–16 h, and T_4 denotes the number of days of heat pump use per year, in d/a, which are acquired from the design document;

[0136] m denotes a water consumption calculation unit, in either the number of persons or the number of beds (whichever is appropriate), and is acquired from the design document;

[0137] q_r denotes a hot water consumption norm, in L/person·d or L/bed·d (matched with the unit of m), and is acquired from Table 3;

[0138] ρ_r denotes density of hot water, in kg/L;

[0139] C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15 (exemplarily, the value may be 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, etc.);

[0140] t_r denotes a design hot water temperature, in °C, and is acquired from the design document; and

[0141] t_l denotes a design cold water temperature, in °C, and is acquired from the design document.

[0142] A calculation formula of the annual renewable energy utilization $Q_{s,sol}$ of the solar domestic hot water system is:

$$Q_{S,sol}=\frac{0.28A_CJ_T(1-\eta_L)\eta_{cd}}{3.6}$$

[0143] where A_c denotes an area of a solar collector, in m^2, and a value is an actual area of a solar panel, which is acquired from the design document;

[0144] J_T denotes average annual solar irradiation of a lighting surface of the solar collector, in $MJ/m^2.a$, and is acquired from Table 4;

[0145] η_{cd} denotes average heat collection efficiency of the collector based on a total area, in %. The average heat collection efficiency η_{cd} of the collector based on the total area should be determined by an efficiency value, when a normalized temperature difference is 0.03,

of an instantaneous efficiency equation based on the total area of the collector. The empirical values of η_{cd} of a distributed heat collection system and a distributed heating system are 40%–70%. The influences of system type, collector type and other factors should be considered in η_{cd} of a centralized heat collection system, and the empirical value is 30%–45%.

[0146] η_L denotes a heat loss rate of a pipeline and a heat storage device, in %. The heat loss η_L of the heat collection system should be determined according to the collector type, the length of the collector pipeline, the size of a heat collection water tank (pot), local climate conditions, the insulation performance of the heat collection system, and other factors. When the collector or a collector group is close to the heat collection water tank (pot), η_L is 15%–20%. When the collector or the collector group and the heat collection water tank (pot) are arranged in two places respectively, η_L is 20%–30%.

Table 4-Solar energy resource zones in China and features thereof

Zone	Solar irradiation [MJ/(m^2. a)]	Main regions	The number of days with monthly average temperature ≥10°C and sunshine duration ≥6 h
Regions with rich resources	≥6700	Southern Xinjiang and a corner of northwest Gansu	About 275
		Southern Xinjiang, northern Tibet, and western Qinghai	275-325
		Western Gansu, western Bayannur League of Inner Mongolia, and part of Qinghai	275-325
		Southern Qinghai	250-300
		Southwest Qinghai	250-275
		Most of Tibet	250-300
		Ulanqab League, Bayannur League, and part of Ordos City, Inner Mongolia	>300

Regions with relatively rich resources	5400-6700	Northern Xinjiang	About 275
		Hulunbuir City, Inner Mongolia	225-275
		Xilin Gol League and Ulanqab League, Inner Mongolia, and a corner of northern Hebei	>275
		Northern Shanxi, northern Hebei, a part of Liaoning	250-275
		Beijing, Tianjin, and northwest Shandong	250-275
		Most of Ordos City, Inner Mongolia	275-300
		Northern Shaanxi and a part of eastern Gansu	225-275
		Eastern Qinghai, southern Gansu, and western Sichuan	200-300
		Part of southern Sichuan and northern Yunnan	200-250
		Part of eastern Tibet, western Sichuan, and northern Yunnan	<250
		Coastal areas of Fujian and Guangdong	175-200
		Hainan	About 225
Average resources	4200-5400	Southern Shanxi, most of Henan, and parts of Anhui, Shandong and Jiangsu	200-250
		Most of Heilongjiang and Jilin	225-275
		Jilin, Liaoning, and Changbai Mountain region	<225
		Shanghai, Hunan, Anhui, southern Jiangsu, Zhejiang, Jiangxi, Fujian, northern Guangdong, eastern Hunan, and most of Guangxi	150-200
		Part of western Hunan and northern Guangxi	125-150
		Southern Shaanxi	125-175
		Western Hubei and Henan	150-175
		Western Sichuan	125-175
Regions with resource shortage	<4200	Part of southwest Yunnan	175-200
		Part of southeast Yunnan	About 175
		A corner of western Guizhou and southeast Yunnan	150-175
		Western Guangxi	150-175
		Most of Sichuan and Guizhou	<125
		Chengdu plain	<100

[0147] The building water system, except for the energy consumed by fossil fuels for domestic hot water, is the electricity consumption. The electricity consumption in the operation period should be obtained from monitoring data in the system operation process, or from energy consumption simulation data in the operation period of a simulation device. If the data is

insufficient, calculation may be performed according to the following formula. However, the operation efficiency of the electrical devices and the number of average annual hours under actual operation conditions should be taken into consideration.

[0148] A calculation formula of the electricity consumption Q_e for operation of the electric devices in the building water system is:

$$Q_e = \sum_{j=1}^{k} N_j \cdot P_{dj} \cdot T_{dj}$$

[0149] where P_{dj} denotes electric power of each of electric devices of a *j*-th type, in kW/set, and is acquired from the design document;

[0150] T_{dj} denotes the number of average annual operation hours of the electric devices of the *j*-th type, in h/a, and is acquired from the design document; and

[0151] N_j denotes the number of the electric devices of the *j*-th type, in set, and is acquired from the design document.

[0152] *j* is the type code of the electric devices, *j*=1, 2, ..., *k*, and *k* types of electric devices are provided in the building. Exemplarily, the electrical devices include an electric water boiler, a domestic hot water circulating pump, an electric water heater, an air source heat pump unit, a water source heat pump unit, a mechanical oil separator/oil-water separator, a circulating water pump, etc.

[0153] Preferably, when the electrical devices are able to calculate more accurate operation power consumption, during calculation of Q_e, summation is performed not with $l \cdot P_d \cdot T_d \cdot N$, but with the operation electricity consumption thereof. Exemplarily, a calculation formula of operation electricity consumption Q_c of a secondary water supply devices is:

$$Q_c = P_d \cdot Q_d \cdot H \cdot T_d$$

[0154] P_d denotes unit water supply energy consumption, in kWh/m^3.MPa, and is acquired from Table 5;

[0155] Q_d denotes water supply flow, in m^3/h, and is acquired from the design document;

[0156] *H* denotes a head of a water pump, in MPa, and is acquired from the design document; and

[0157] T_d denotes the number of average annual operation hours of the water pump, in h/a, and is acquired from the design document.

Table 5-Unit water supply energy consumption

Water supply device structure	Operation water supply flow range (m^3/h)	Unit water supply energy consumption (P_d) ($kWh/m^3.MPa$)
Two-pump device (one for use and one for backup)	Flow≤15	≤0.96
	Flow＞15	≤0.88
Three-pump device (two for use and one for backup)	Flow≤50	≤0.80
	Flow＞50	≤0.76
Four-pump device (three for use and one for backup)	45＜Flow≤80	≤0.72
	Flow＞80	≤0.64

[0158] It is to be noted that the above reference to acquiring from the design document means that these data are available from the building water system design document, that is, these data are known from the building water system design document.

[0159] The present invention creates the carbon accounting method for building water systems. According to Article 2.0.5 of the full-text mandatory specification "General Code for Energy Efficiency and Renewable Energy Application in Buildings" (GB 55015-2021), the carbon emission analysis report needs to be compiled. With establishment of the accounting method according to the present invention, the completeness and accuracy of carbon accounting for building water systems are achieved. Domestic and foreign carbon accounting methods for building water systems are all focused on domestic hot water. However, in addition to domestic hot water, there are nearly two dozen other systems for building water systems, all of which consume energy and produce carbon emission to varying degrees in the operation period of buildings. There is no systematic method at home or abroad to comprehensively sort out and integrate the energy consumption and carbon emission calculations of building water

systems, which may affect the completeness and accuracy of the carbon emission analysis report in the design process.

[0160] The carbon accounting method established by the present invention is the cornerstone of building energy consumption simulation of building water systems. The fundamental core of building carbon emission accounting is the accurate calculation of energy consumption, and only after the number of systems, energy consumption types and energy accounting methods are completely sorted out, may an energy consumption simulation platform be built for energy consumption simulation calculations. The current energy consumption simulation of building water systems is still in its infancy, but the accounting method is in the beginning, the accounting process structure is built, and the parameters are clearly chosen to provide technical support for promoting the energy consumption simulation of building water systems.

[0161] [Example] Project Overview: A university canteen, located in the northern China, has a building area of 13,200 m^2, a building volume of 79,872.1 m^3 and a building height of 16.2 m, and building storeys include three floors above the ground and two floors below the ground. The canteen serves 2618 students. Building water systems involved in energy consumption include a domestic water supply secondary pressurized water supply system, a domestic hot water system, a reclaimed water system, and a sewage and wastewater lifting system. The following is the process of calculating the carbon emission of the water system in the operation period of the university canteen:

[0162] 1. Calculation of annual consumption of the domestic hot water system of the canteen

[0163] A kitchen regularly supplies domestic hot water by 6 h a day and 240 days a year. A heat source is provided by a roof solar collector and an auxiliary heat source. The auxiliary heat source is a self-provided boiler. The hot water supply temperature is 60 °C.

[0164] (1) Annual heat consumption of domestic hot water

[0165] The average daily heat consumption Q_{rp} of domestic hot water is calculated as:

$$Q_{rp} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_1}$$

[0166] where q_r=12 L/person·time, which is acquired from Table 3; if each person uses

water twice a day, m=2618 persons ×2 times/d; C_r=1.1; t_r=60°C; t_l=5°C; T_1=6 h/d; and ρ_r=0.98 kg/L.

[0167] The values are substituted for calculation to obtain Q_{rp}=722.12 kW.

[0168] The annual heat consumption Q_r of the domestic hot water is calculated as:

$$Q_r = TQ_{rp}$$

[0169] where Q_{rp}=722.12 kW; and $T=T_1\times T_2$, T_1=6 h/d, and T_2=240 d/a, so T=1440 h/a.

[0170] The values are substituted for calculation to obtain Q_r=1039858 kWh/a.

[0171] (2) Calculation of the annual heat supply $Q_{s,sol}$ of the solar domestic hot water system

[0172] According to a location of the collector on the roof, the actual arrangement area of the collector on the roof is 432 m^2.

$$Q_{S,sol} = \frac{0.28A_CJ_T(1-\eta_L)\eta_{cd}}{3.6}$$

[0173] where A_c=432 m^2, J_T=6700 MJ/ m^2·a, which is acquired from Table 4; η_{cd}=0.3; and η_L=0.15.

[0174] The values are substituted for calculation to obtain $Q_{s,sol}$=57405.6 kWh/a.

[0175] (3) Calculation of the annual heat consumption Q_w of the domestic hot water system of the canteen

[0176] Based on relevant parameters in a design document and combined with the scale of domestic hot water and an on-site operation effect, the transmission and distribution efficiency η_r of domestic hot water is 0.8; the average annual efficiency η_w of the heat source of the domestic hot water system is 0.8; and Q_r=1039858 kWh/a, and $Q_s=Q_{s,sol}$=57405.6 kWh/a.

$$Q_w = \frac{\frac{Q_r}{\eta_r} - Q_s}{\eta_w}$$

[0177] The values are substituted for calculation to obtain Q_w=1553021 kWh/a.

[0178] 2. Calculation of electricity consumption for operation of electric devices in the water systems of the canteen

[0179] (1) Domestic water supply secondary pressurized water supply system

[0180] According to the design document, the minimum water supply pressure of the municipal pipe network is 0.25 MPa, and the domestic water supply is divided into two vertical

zones. A third floor is a middle zone, and is directly supplied with water through a water tank and a variable frequency pump set. The parameters of water pumps are selected as: the water supply flow is 36 m ^{3}/h, the head is 37 m, and the power is 5.5 kW. The water pumps are set as one for use and one for standby.

$$Q_{c1} = P_d \cdot Q_d \cdot H \cdot T_d$$

[0181] where P_d=0.88 kWh/m^3.MPa, which is acquired from Table 5; Q_d=36 m^3/h; H=37 m≈0.37 MPa; and T_d=1440 h/a.

[0182] The values are substituted for calculation to obtain Q_{c1}=16879.1 kWh/a.

[0183] (2) Reclaimed water secondary pressurized water supply system

[0184] According to the design document, flushing water for toilets on a first to third floor of the canteen is supplied through a water tank and a variable frequency pump set. The parameters of water pumps are selected as: the water supply flow is 14 m^3/h, the head is 40 m, and the power is 3 kW. The water pumps are set as one for use and one for standby.

$$Q_{c2} = P_d \cdot Q_d \cdot H \cdot T_d$$

[0185] where P_d=0.96 kWh/m^3.MPa, which is acquired from Table 5; Q_d=14 m^3/h; H=40 m≈0.40 MPa; and T_d=1440 h/a.

[0186] The values are substituted for calculation to obtain Q_{c2} =7741.44 kWh/a.

[0187] (3) A calculation formula of the electricity consumption Q_e for operation of other electric devices is:

$$Q_{e3} = \sum_{j=1}^{k} N_j \cdot P_{dj} \cdot T_{dj}$$

[0188] In addition to the secondary water supply system and the reclaimed water system, electric devices related to other water systems of the building as well as the number of average daily operation hours and the number of annual operation days are shown in the table below:

[0189]

Electric device	The number of average operation hours (h)	The number of annual operation days (d)	Electric power P_{dj} (kW/set) of each electric device	The number of average annual operation hours T_{dj} (h/a)	Number N_i (set)	Annual electricity consumption of device operation (kWh/a)
Electric water boiler	2	240	12	480	3	17280
Mechanical oil separator/oil-water separator	1	240	8	140	3	5760
Submersible pump	0.5	240	3	120	4	1440
Electricity consumption Q_{e3} for operation of other electric devices						24480

[0190] The values are substituted for calculation to obtain Q_{e3} =24480 kWh/a.

[0191] (4) Calculation of the electricity consumption Q_e for operation of the electric devices in the water systems of the canteen

$Q_e=Q_{c1}+Q_{c2}+Q_{e3}$=16879.1 +7741.44 +24480=49100.54 kWh/a

[0192] 3. Method for accounting the carbon emission of the water system in an operation period of the canteen

[0193] According to the design document, the carbon emission of the canteen is mainly from the domestic hot water system, the secondary pressurized water supply system, the reclaimed water system, the electric water boiler, the mechanical oil separator/oil-water separator, and the submersible pump. The domestic hot water is heated by solar energy and the self-provided gas boiler. The main energy consumption is gas, and other system energy

consumption is electricity. The annual energy consumption and carbon emission factors calculated by each system are shown in the table below.

$$C_M = \frac{（Q_w q_w + Q_e q_e） y}{A}$$

[0194] where y=50 a; A=13200 m^2; q_w is a carbon emission factor of gas, q_w=55.54tCO_2/(TJ), q_e is a carbon emission factor of electricity, and q_e=0.5810tCO_2/MWh, which is acquired from Table 1; and Q_w=1553021 kWh/a=5.55 TJ/a, Q_e=49100.54 kWh/a= 49.10 MWh/a.

[0195] The values are substituted for calculation to obtain C_M=50* (5.55*55.54+49.10*0.5810)/13200=1.2757t CO_2/ m^2.

[0196] The annual carbon emission of the water systems in the operation period of the canteen is $Q_w q_w + Q_e q_e$=336.774tCO_2.

[0197] It will be appreciated by those skilled in the art that all or part of the flow of the above method embodiment may be implemented by a computer program that instructs associated hardware. The program may be stored in a computer-readable storage medium. The computer-readable storage medium is a magnetic disk, a compact disk, a read-only memory (ROM), or a random access memory (RAM), etc.

[0198] The above description is merely preferred implementations of the present invention, and is not intended to limit the protection scope of the present invention. Any changes or substitutions which may be easily conceived by those skilled in the art within the technical scope disclosed in the present invention shall fall within the protection scope of the present invention.

CLAIMS

1. A method for accounting carbon emission of a water system in a building operation period, characterized by comprising the following steps:

acquiring energy consumption Q_i of the building water system, a building design life y, and a building area A; and

calculating carbon emission C_M per unit of building area in the building operation period with the following formula:

$$C_M = \frac{(\sum_{i=1}^{n} Q_i q_i)\ y}{A}$$

wherein q_i denotes a carbon emission factor of an i-th type of energy; and

the energy consumption Q_i of the building water system at least comprises annual heat consumption Q_w of a building domestic hot water system and electricity consumption Q_e for operation of electric devices in the building water system, a calculation formula of the annual heat consumption Q_w of the building domestic hot water system is as follows:

$$Q_w = \frac{\frac{Q_r}{\eta_r} - Q_s}{\eta_w}$$

wherein Q_r denotes annual heat consumption of domestic hot water;

Q_s denotes domestic hot water heat provided by renewable energy;

η_r denotes transportation and distribution efficiency of domestic hot water; and

η_w denotes average annual efficiency of a heat source of the domestic hot water system, a calculation formula of the domestic hot water heat Q_s provided by the renewable energy is:

$$Q_s = Q_{S,\ x} + Q_{S,sol}$$

wherein $Q_{s,sol}$ denotes annual renewable energy utilization of a solar domestic hot water system;

$Q_{s,x}$ denotes annual renewable energy utilization of the domestic hot water system except solar energy;

when the renewable energy used by the building only comprises solar energy, $Q_{s,x}$ is zero; and

when the building uses renewable energy other than the solar energy, $Q_{s,x}$ is one or more of $Q_{s,geo}$, $Q_{s,air}$ and $Q_{s,bio}$, $Q_{s,geo}$ denoting annual renewable energy utilization of a geothermal

heat pump domestic hot water system, $Q_{s,air}$ denoting annual renewable energy utilization of an air source heat pump domestic hot water system, $Q_{s,bio}$ denoting annual renewable energy utilization of a biomass domestic hot water system.

2. The method for accounting carbon emission of a water system in a building operation period according to claim 1, characterized in that a calculation formula of the annual heat consumption Q_r of the domestic hot water is:

$$Q_r = TQ_{rp}$$

$$Q_{rp} = \frac{4.187mq_r c_r(t_r - t_l)\rho_r}{3600 \cdot T_1}$$

wherein T denotes the number of hours of domestic hot water use per year; $T=T_1 \times T_2$, T_1 denotes the number of hours of domestic hot water use per day, and T_2 denotes the number of days of domestic heat use per year;

Q_{rp} denotes average daily heat consumption of domestic hot water;

m denotes a water consumption calculation unit;

q_r denotes a hot water consumption norm;

C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

t_r denotes a design hot water temperature;

t_l denotes a design cold water temperature; and

ρ_r denotes density of hot water.

3. The method for accounting carbon emission of a water system in a building operation period according to claim 1, characterized in that a calculation formula of the annual renewable energy utilization $Q_{s,sol}$ of the solar domestic hot water system is:

$$Q_{S,sol} = \frac{0.28A_C J_T(1 - \eta_L)\eta_{cd}}{3.6}$$

wherein A_c denotes an area of a solar collector;

J_T denotes average annual solar irradiation of a lighting surface of the solar collector;

η_{cd} denotes average heat collection efficiency of the collector based on a total area; and

η_L denotes a heat loss rate of a pipeline and a heat storage device.

4. The method for accounting carbon emission of a water system in a building operation period according to claim 1, characterized in that a calculation formula of the annual renewable energy utilization $Q_{s,geo}$ of the geothermal heat pump domestic hot water system is:

$$Q_{S,geo} = Q_{w,geo} - E_{w,geo}$$

wherein $Q_{w,geo}$ denotes annual domestic hot water heat supply of the geothermal heat pump system, and

$E_{w,geo}$ denotes annual electricity consumption of a geothermal heat pump unit for supplying domestic hot water; and

a calculation formula of the annual domestic hot water heat supply $Q_{w,geo}$ of the geothermal heat pump system is: $Q_{w,geo} = T_5 Q_{rprb}$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_3}$$

wherein Q_{rprb} denotes average daily heat supply for hot water by a heat pump;

T_5 denotes the number of hours of domestic hot water use per year, $T_5=T_3\times T_4$, T_3 denotes design working time of the heat pump unit, and T_4 denotes the number of days of heat pump use per year;

m denotes a water consumption calculation unit;

q_r denotes a hot water consumption norm;

C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

t_r denotes a design hot water temperature;

t_l denotes a design cold water temperature; and

ρ_r denotes density of hot water.

5. The method for accounting carbon emission of a water system in a building operation period according to claim 1, characterized in that a calculation formula of the annual renewable energy utilization $Q_{s,air}$ of the air source heat pump domestic hot water system is:

$$Q_{S,air} = Q_{w,air} - E_{w,air}$$

wherein $Q_{w,air}$ denotes annual domestic hot water heat supply of the air source heat pump system, and

$E_{w,air}$ denotes annual electricity consumption of an air source heat pump unit for supplying domestic hot water; and

a calculation formula of the annual domestic hot water heat supply $Q_{w,air}$ of the air source heat pump system is:

$$Q_{w,air} = T_5 Q_{rprb}$$

$$Q_{rprb} = \frac{4.187 m q_r c_r (t_r - t_l) \rho_r}{3600 \cdot T_3}$$

wherein Q_{rprb} denotes average daily heat supply for hot water by a heat pump;

T_5 denotes the number of hours of domestic hot water use per year, $T_5=T_3\times T_4$, T_3 denotes design working time of the heat pump unit, and T_4 denotes the number of days of heat pump use per year;

m denotes a water consumption calculation unit;

q_r denotes a hot water consumption norm;

C_r denotes a heat loss coefficient of a hot water supply system, and C_r =1.10–1.15;

t_r denotes a design hot water temperature;

t_l denotes a design cold water temperature; and

ρ_r denotes density of hot water.

6. The method for accounting carbon emission of a water system in a building operation period according to any one of claims 1 to 5, characterized in that a calculation formula of the electricity consumption Q_e for operation of the electric devices in the building water system is:

$$Q_e = \sum_{j=1}^{k} N_j \cdot P_{dj} \cdot T_{dj}$$

wherein P_{dj} denotes electric power of each of electric devices of a j-th type;

T_{dj} denotes the number of average annual operation hours of the electric devices of the j-th type; and

N_j denotes the number of the electric devices of the j-th type.

7. The method for accounting carbon emission of a water system in a building operation period according to of claim 6, characterized in that when the electrical devices are capable of calculating the operation electricity consumption, summation is performed by using the operation electricity consumption during calculation of Q_e.

8. The method for accounting carbon emission of a water system in a building operation period according to of claim 7, characterized in that the electric devices are secondary water supply devices, and a calculation formula of operation electricity consumption Q_c of the secondary water supply devices is:

$$Q_c = P_d \cdot Q_d \cdot H \cdot T_d$$

wherein P_d denotes unit water supply energy consumption;

Q_d denotes water supply flow;

H denotes a head of a water pump; and

T_d denotes the number of average annual operation hours of the water pump.