

TEMPERATURE ADJUSTMENT SYSTEM AND TEMPERATURE ADJUSTMENT METHOD OF PRODUCT

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to a temperature adjustment system and a temperature adjustment method of a product and, more particularly, to a temperature adjustment system and a temperature adjustment method which are preferable when a product is indirectly heated or cooled using a heat medium.

(b) Description of the Related Art

In the field of health foods and the like, a product is held in a tank, a reaction vessel, or the like for subjecting the product to a fermentation reaction, an enzyme reaction, or the like, and the temperature of the product is adjusted by a heat medium supplied into a temperature adjustment jacket tank placed around the tank, the reaction vessel, or the like. Note that the heat medium supplied to the temperature adjustment jacket tank is stored in tanks after it is previously heated or cooled to a predetermined temperature, the heated or cooled medium is supplied to the product according to a temperature setting.

Behind adopting the above way of manufacturing, the heat load of the product, the accuracy of a temperature adjustment, and the like are related. Generally, the heat load of a product varies over time, and a capability for heating or cooling the product is set in the state that a maximum heat load is applied

to the product. However, when the product has a small heat load, the heating or cooling capability is wasted. Further, there is a situation that the accuracy of the temperature adjustment for correcting a small amount of heat is liable to be deteriorated.

To cope with the above problem, the tank for storing heated and cooled heat mediums is provided to serve as a buffer for compensating a heat load when a product is heated or cooled so that the wasteful use of the heating and cooling capabilities can be eliminated. Since the temperatures of the respective tanks are kept constant, the temperature adjustment of the product can be realized with a high accuracy.

The system disclosed in Japanese Examined Patent Application Publication (JP-B) No. 7-16396 can be exemplified as a system for adjusting the temperature of a product by applying a temperature change to a heat medium. The system disclosed in JP-B-7-16396 uses hot water as a heat medium, and the temperature of the product is adjusted by changing the temperature of the hot water. JP-B-7-16396 is characterized in that when the product is heated, the temperature of the heat medium is increased by blowing steam to the hot water, and when the product is cooled, the temperature of the heat medium is lowered by mixing cold water with the hot water.

Incidentally, the heat medium, which is stored in a storage tank for storing a heated or cooled heat medium and supplied from the tank to a jacket portion, is ordinarily returned to the storage tank again after it is subjected to heat exchange. If a product has a large heat load when it is heated or cooled,

the difference between the amount of heat of the heat medium stored in the tank and that of the heat medium returned to the tank becomes large, thereby the temperature of the heat medium stored in the tank may become unstable. Further, when the temperature varies as described above, a large amount of energy is required to heat or cool the heat medium stored in the tank back to a predetermined temperature,

Accordingly, embodiments of the present invention seek to eliminate the aforesaid problems of the conventional technique and to provide a temperature adjustment system and a temperature adjustment method of a product capable of suppressing the temperature variation of a tank, and save the energy required to adjust the temperature of the product.

SUMMARY OF THE INVENTION

It is considered preferable to provide a means serving as a buffer for suppressing a temperature variation in order to suppress the temperature variation of a heat medium stored in a heating tank or a cooling tank. Further, it is considered preferable to effectively use a heat medium whose temperature varies over time in order to reduce required energy.

According to a first aspect of the present invention, there is provided a temperature adjustment system with a temperature adjustment jacket tank for adjusting the temperature of a product to a temperature setting and for adjusting the temperature of the product by supplying a heated or cooled heat medium to a jacket portion of the temperature adjustment jacket tank, the temperature adjustment system comprising: a

heating tank for storing the heat medium of a temperature kept higher than the temperature setting, a cooling tank for storing the heat medium of a temperature kept lower than the temperature setting, an intermediate tank for storing the heat medium of a temperature which is not adjusted and ranging between the temperature of the heat medium stored in the heating tank and the temperature of the heat medium stored in the cooling tank, a temperature detection means provided on each of the jacket portion and the respective tanks, and an adjustment means for adjusting the temperature of the product by selecting any of the tanks including the intermediate tank based on the temperatures detected by the temperature detection means and supplying the heat medium stored in the selected tank to the jacket portion.

In the temperature adjustment system having the above aspect, the adjustment means may supply the heat mediums stored in the two tanks, which store the heat mediums whose temperatures are respectively higher and lower than the temperature setting, out of the heating tank, the cooling tank, and the intermediate tank.

In the temperature adjustment system of the above aspect, it is preferable that the intermediate tank includes a heat absorption means or/and a heat radiation means for adjusting the temperature of the heat medium stored in the intermediate tank.

Further, in the temperature adjustment system of the above aspect, the adjustment means may supply the heat medium

stored in the intermediate tank to the jacket portion preferentially over the heat medium stored in the heating tank or the cooling tank.

According to a second aspect, there is provided a temperature adjustment method for supplying a heat medium whose temperature is set higher than a temperature setting or a heat medium whose temperature is set lower than the temperature setting to a jacket portion and for adjusting the temperature of a product to the temperature setting, includes a step of adjusting the temperature gradient of the product when the temperature thereof is adjusted by using, when the temperature of the product is increased, an intermediate temperature heat medium having a temperature between the best medium set to the high temperature and the heat medium set to the low temperature and the heat medium set to the high temperature, and using, when the product is cooled, the intermediate temperature heat medium and the heat medium set to the low temperature.

According to the temperature adjustment system and the temperature adjustment method having the above feature, the loss of energy which is consumed when the heat medium is heated or cooled can be suppressed. Further, according to the system, since the intermediate tank is provided as a buffer, the temperature variation of the heat medium stored in the heating tank or the cooling tank can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view showing an arrangement of a temperature adjustment system according to a first embodiment;

FIG. 2A is a diagram showing a temperature relation in a first case when heating a material easy to be altered;

FIG. 2B is a graph chart showing a temperature relation in a first case when heating a material easy to be altered;

FIG. 3A is a diagram showing a temperature relation in a second case when heating the material easy to be altered;

FIG. 3B is a graph chart showing a temperature relation in a second case when heating the material easy to be altered;

FIG. 4A is a diagram showing a temperature relation in a first case when heating a material easy to be altered;

FIG. 4B is a graph chart showing a temperature relation in a first case when heating a material easy to be altered;

FIG. 5A is a diagram showing a temperature relation in a second case when heating the material easy to be altered;

FIG. 5B is a graph chart showing a temperature relation in a second case when heating the material easy to be altered;

FIG. 6A is a diagram showing a temperature relation in a case when cooling the material easy to be altered; and

FIG. 6B is a graph chart showing a temperature relation in a case when cooling the material easy to be altered; and

FIG. 7 is a view showing an arrangement of a temperature adjustment system according the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments according to a temperature adjustment system

and a temperature adjustment method of the present invention will be explained below in detail referring to FIG. 1. Note that it is assumed that the embodiments described below show a part of the embodiments according to the present invention, and the present invention may be embodied in various aspects as far as the main component of the present invention is not changed.

First, a first embodiment according to the temperature adjustment system of the present invention will be explained referring to FIG. 1. The temperature adjustment system 10 of a product in the embodiment is basically arranged such that it includes a temperature adjustment jacket tank 20 into which the product is held, a jacket portion 18 placed around the temperature adjustment jacket tank 20, a heating tank 12, a cooling tank 14, an intermediate tank 16, and a heat medium circulating in these tanks.

As described above, the jacket portion 18 is a space placed around the temperature adjustment jacket tank and has a role for causing heat exchange between the heat medium supplied into the space and the temperature adjustment jacket tank 20. A heat medium supply pipe 18a for supplying the heat medium into the space and a heat medium discharge pipe 18b for discharging the heat medium subjected to heat exchange are provided on the jacket portion 18.

The heating tank 12 is a tank for storing the heat medium heated to a temperature higher than the temperature set to the temperature adjustment jacket tank 20. A heating equipment 22

For heating the heat medium stored therein to a predetermined temperature is connected to the heating tank 12, and a carrying pump 22a is provided to a pipe 21 forming a circulating path to connect the heating equipment 22 to the heating tank 12. The heat medium stored in the heating tank 12 is kept at a predetermined temperature through a process in which the heat medium supplied by the carrying pump 22a passes the heating equipment 22 through the pipe 21 and returns to the heating tank 12. Further, the heat medium stored in the tank can be circulated by employing such an arrangement that the heat medium is discharged from lower portion of the tank where the temperature thereof is liable to be lowered and returned to the upper portion of the tank after it is heated, thereby the heat medium stored in the tank can be homogenized.

As described above, since the heating tank 12, which stores the heat medium whose temperature is always kept higher than the temperature set to the temperature adjustment jacket tank 20, is provided, the temperature of the temperature adjustment jacket tank 20 can be quickly increased by supplying the heat medium stored in the tank to the jacket portion 18. Accordingly, the heating tank 12 is provided with a heat medium carrying-out pipe 12a connected to the heat medium supply pipe 18a for supplying the heat medium to the jacket portion 18 and a heat medium carrying-in pipe 12b connected to the heat medium discharge pipe 18b so that the heat medium supplied to the jacket portion 18 can be returned. A carrying pump 26 is provided to the heat medium carrying-out pipe 12a to carry the heat medium.

The cooling tank 14 is a tank for storing the heat medium cooled to a temperature lower than the temperature set to the temperature adjustment jacket tank 20. A cooling equipment 24 for cooling the heat medium stored therein to a predetermined temperature is connected to the cooling tank 14, and a carrying pump 24a is provided to a pipe 23 forming a circulating path to connect the cooling equipment 24 to the cooling tank 14. The heat medium stored in the cooling tank 14 is kept to a predetermined temperature through a process in which the heat medium sucked out by the carrying pump 24 passes the cooling equipment 24 through the pipe 23 and returns to the cooling tank 14. Further, the heat medium stored in the tank can be circulated by employing such an arrangement that the heat medium is discharged from the upper portion of the tank where the temperature thereof is liable to increase and returned to the lower portion of the tank after it is cooled, thereby the heat medium stored in the tank can be homogenized.

As described above, since the cooling tank 14, which stores the heat medium whose temperature is always kept lower than the temperature set to the temperature adjustment jacket tank 20, is provided, the temperature adjustment jacket tank 20 can be quickly cooled by supplying the heat medium stored in the tank to the jacket portion 18. Accordingly, the cooling tank 14 is provided with a heat medium carrying-out pipe 14a connected to the heat medium supply pipe 18a for supplying the heat medium to the jacket portion 18 and a heat medium carrying-in pipe 14b connected to the heat medium discharge pipe 18b so that the heat

medium supplied to the jacket portion 18 can be returned. And, a carrying pump 28 is provided to the heat medium carrying-out pipe 14a to carry the heat medium.

The intermediate tank 16 is a tank for storing the heat medium of a temperature ranging between that of the heat medium stored in the heating tank 12 and that of the heat medium stored in the cooling tank 14. The intermediate tank 16 of the embodiment is not provided with the heating equipment 22 or the cooling equipment 24 provided to the heating tank 12 and the cooling tank 14 described above. Accordingly, the temperature of the heat medium stored in the intermediate tank 16 varies depending on the temperature of the heat medium supplied thereto and the environmental temperature around the tank.

Thus, usage of the heat medium stored in the intermediate tank 16, which stores the heat medium having temperature varying to a high temperature or to a low temperature relative to the temperature setting of the temperature adjustment jacket tank 29 over time, can be changed by relatively comparing the temperature of the temperature adjustment jacket tank 20, the temperature setting of the temperature adjustment jacket tank 20, the temperature of the heat medium stored therein, and the like. When, for example, the temperature of the temperature adjustment jacket tank 20 is lower than the temperature of the heat medium stored in the intermediate tank 16 and it is desired to increase the temperature of the temperature adjustment jacket tank 20, heat energy can be effectively used by preferentially using the heat medium stored in the intermediate tank 16 over

the heat medium stored in the high temperature tank 12. Further, when the temperature of the temperature adjustment jacket tank 20 is higher than the temperature of the heat medium stored in the intermediate tank 16 and it is desired to further increase the temperature of the temperature adjustment jacket tank 20, a cooling action is performed by quickly increasing the temperature of the temperature adjustment jacket tank 20 using the heat medium stored in the high temperature tank 12 and switching the heat medium to be supplied to the jacket portion 18 to the heat medium stored in the intermediate tank 16 at a certain timing. With this operation, a temperature gradient can be adjusted so that an overshoot in relation to the temperature setting can be prevented. Note that this is the same when the temperature adjustment jacket tank 20 is cooled.

Accordingly, likewise the heating tank 12 and the cooling tank 14, the intermediate tank 16 is provided with a heat medium carrying-out pipe 16a connected to the heat medium supply pipe 18a for supplying the heat medium to the jacket portion 18 and a heat medium carrying-in pipe 16b connected to the heat medium discharge pipe 18b so that the heat medium supplied to the jacket portion 18 can be returned. Then, a carrying pump 30 is provided to the heat medium carrying-out pipe 16a to carry the heat medium.

In the temperature adjustment system 10 arranged as described above, control valves 32, 34, 36 are provided to the heat medium carrying-out pipes 12a, 14a, 16a, respectively so that a tank for supplying the heat medium to the jacket portion 18 can be selectively specified. Further, the heat medium

discharge pipes 12b, 14b, 16b are provided with control valves 32a, 34a, 36a, which are opened and closed in correspondence to the control valves 32, 34, 36, respectively so that the heat medium of amount corresponding to the amount of the heat medium carried out from any of the tanks is carried into the same tank.

Note that the heat medium, which is referred to in the embodiment, may be various types of fluids that can be used for heating and cooling.

Further, temperature detection means 12T, 14T, 16T, 18T are provided to the above-described tanks respectively, and a tank, in which the heat medium to be used is stored, is selected by an adjustment means 37 which determines the tank by comparing the temperatures of the heat mediums detected by the temperature detection means, the temperature of the temperature adjustment jacket tank, and the like.

The larger temperature difference between the temperature setting of the heating tank 12 or the cooling tank 14 and the an environmental temperature is, the more the amount of energy required to heat or cool the heat medium or to keep the temperature thereof. According to the temperature adjustment system 10 arranged as described above, the temperature of the temperature adjustment jacket tank 20 can be adjusted by preferentially using the heat medium stored in the intermediate tank 16, which does not require energy to store the heat medium, over the heat medium stored in the heating tank 12 or the cooling tank 14, which requires a large amount of energy to store the heat medium. Accordingly, the operation for heating the heat medium discharged from the

jacket portion 18 to the heating tank 12 to a predetermined temperature instead of the heat medium supplied from the heating tank 12 to the jacket portion 18 or the operation for cooling the heat medium supplied from the cooling tank 14 and of capacity subjected to heat exchange to a predetermined temperature can be reduced. Accordingly, energy consumed for heating and cooling can be reduced.

Methods of adjusting the temperature of the temperature adjustment jacket tank 20 using the temperature adjustment system 10 arranged as described above will be explained below as to a case that the product in the temperature adjustment jacket tank 20 is of a substance easy to be altered (by temperature) and a case that the product therein is of a substance uneasy to be altered by exemplifying several examples.

First, an example of a case that the product is of a substance easy to be altered will be explained referring to FIG. 2. Here, Fig. 2A is a view showing the relation between the temperatures of the heat mediums stored in the heating tank 12, the cooling tank 14, and the intermediate tank 16, the temperature of a product, and the temperature setting of the product, and FIG. 2B is a graph showing the relation between the behavior of the temperature changes of the product and the intermediate tank 16 and the tanks in which the heat medium is used. FIG. 2 is a view showing an example when the product is heated.

As can be seen from FIG. 2A, in the embodiment, the temperature T_0 of the product is higher than the temperature T_b of the heat medium stored in the intermediate tank 16, and

the temperature setting T_s of the product is higher than the temperature T_0 . In this case, in order to increase the temperature T_0 of the product to the temperature setting T_s , it is preferable to increase the temperature T_0 while adjusting the temperature gradient of the temperature T_0 of the product using the two tanks, in which the heat mediums whose temperatures are respectively higher and lower than the temperature setting of the product is stored.

First, the temperature T_0 of the product is quickly increased by supplying the heat medium of a high temperature T_h stored in the heating tank 12 to the jacket portion 18 until the temperature of the product reaches to a temperature ($T_s - T_1$) which is lower than the temperature setting T_s by a certain temperature T_1 . After the temperature T_0 of the product reaches to the certain temperature ($T_s - T_1$), the heat medium to be supplied to the jacket portion 18 is switched to the heat medium stored in the intermediate tank 16. With this operation, the average temperature of the heat medium remaining in the jacket portion 18 is lowered and the temperature gradient is adjusted, thereby the product can be prevented from overshooting in relation to the temperature setting.

Next, an example of a case that a product of temperature lower than the temperature T_h of the heat medium stored in the intermediate tank 16 is heated will be explained referring to parts FIG. 3A and FIG. 3B. Note that the embodiment also relates to the case that the product is of a substance easy to be altered.

In the case of the embodiment, the product is heated by

supplying the heat medium stored in the intermediate tank 16 to the jacket portion 18 until the temperature T_0 of the product reaches to the temperature T_b of the heat medium stored in the intermediate tank 16. Thereafter, the heat medium to be supplied to the jacket portion 18 is switched to the heat medium stored in the heating tank 12 and then the product is continuously heated until the temperature thereof reaches to the certain temperature $(T_s - T_1)$. After the temperature T_0 of the product reaches to the certain temperature $(T_s - T_1)$, the heat medium to be supplied to the jacket portion 18 is switched back to the heat medium stored in the intermediate tank 16. With this operation, the average temperature of the heat medium remaining in the jacket portion 18 is lowered and the temperature gradient of the temperature T_0 of the product is adjusted, thereby the product can be prevented from overshooting in relation to the temperature setting.

Next, an example of a case that a product is of a substance uneasy to be altered will be explained referring to FIG. 4A and FIG. 4B. Note that the drawings are arranged similarly to those of FIG. 2.

In the embodiment, the temperature adjustment of the product is similarly performed to the case that the product is easy to be altered. That is, a method employed in this case is such that the heat medium stored in the heating tank 12 is supplied to the jacket portion 18 until the temperature T_0 of the product reaches to the certain temperature $(T_s - T_1)$, and the heat medium to be supplied to the jacket portion 18 is switched

to the heat medium stored in the intermediate tank 16 after the temperature T_0 reaches to the temperature $(T_s - T_1)$. Accordingly, it can be found that similar heating can be performed in these cases regardless of the altering characteristics of the products.

Next, an example that a product is of a substance uneasy to be altered and the temperature of which is lower than the temperature T_h of the heat medium stored in the intermediate tank, will be explained referring to FIG. 5A and FIG. 5B.

In the embodiment, since the product is uneasy to be altered, the heat medium of the high temperature T_h stored in the heating tank is supplied to the jacket portion from the beginning. Although it is also possible to heat the product using the heat medium in the intermediate tank 16, the time required for heating and the amount of the heat medium would be much more. Accordingly, it is advantageous in efficiency to heat the product using the heat medium stored in the heating tank 12. The heat medium supplied from the heating tank 12 to the jacket portion 18 is stopped at the time the temperature T_0 of the product reaches to the certain temperature $(T_s - T_1)$ and switched to the heat medium stored in the intermediate tank 16. With this operation, the temperature gradient of the temperature T_0 of the product is adjusted likewise the above case, thereby the product can be prevented from overshooting in relation to the temperature setting.

All the examples described above are explained as to the case that the products are heated. In contrast, a product may be cooled, by replacing an operation for supplying the heat medium

stored in the heating tank 12 to the jacket portion 18 with the operation for supplying the heat medium stored in the cooling tank 14 described above. There will be explained an example of a case that a product, which is of a substance easy to be altered and the temperature T_0 of which is higher than the temperature T_b of the heat medium stored in the intermediate tank 16, is cooled to the temperature setting T_s which is lower than the temperature T_b referring to FIG. 6.

In the embodiment, the product is cooled by supplying the heat medium in the intermediate tank 16 to the jacket portion 18 until the temperature T_0 of the product reaches to the temperature T_b of the heat medium stored in the intermediate tank 16. Thereafter, the heat medium to be supplied to the jacket portion 18 is switched to the heat medium stored in the cooling tank and then the product is continuously heated until the temperature thereof reaches to the certain temperature ($T_s + T_1$). After the temperature T_0 of the product reaches to the certain temperature ($T_s + T_1$), the heat medium to be supplied to the jacket portion 18 is switched back to the heat medium stored in the intermediate tank 16. With this operation, the heat medium remaining in the jacket portion 18 is heated, thereby the product can be prevented from overshooting in relation to the temperature setting.

Conventionally, when a product is heated or cooled, the heat medium stored in the heating tank 12 or the cooling tank 14 is used in any case. In contrast, when the heat medium is stored in the intermediate tank 16 whose temperature is not

adjusted and the heat medium stored in the intermediate tank 16 is used as in the embodiment, the same amount of heat as the conventional calorie can be obtained while reducing the manufacturing amount of a high temperature heat medium or a low temperature heat medium which requires a large amount of energy with a result that an energy saving effect can be achieved.

Next, a second embodiment according to the temperature adjustment system of the present invention will be explained referring to FIG. 7. Note that almost all the arrangements of the temperature adjustment system according to the second embodiment are the same as those of the temperature adjustment system 10 according to the first embodiment shown in FIG. 1. Accordingly, the portions showing the same arrangements are shown by reference numerals obtained by adding 100 to the reference numerals shown in FIG. 1, and the detailed explanation thereof is not provided here.

The temperature adjustment system 110 of the embodiment is characterized in that a heat absorption means, a heat radiating means, or both of them (hereinafter, they are referred to as a heat absorbing/radiating means 115a as a whole) are connected to an intermediate tank 116 so that the temperature of a heat medium stored in the intermediate tank 116 can be adjusted. A carrying pump 115b is provided to a pipe forming a circulating path 115 to connect the intermediate tank 116 to the heat absorbing/radiating means 115a. It is assumed here that the heat absorbing/radiating means 115a specifically indicates a means such as a heating tower or a cooling tower for enabling

heating or cooling to be performed while saving energy. As described above, the temperature of a product can be more effectively adjusted by employing the arrangement, which is capable of adjusting the temperature of the heat medium stored in the intermediate tank 116 to some degree by a smaller amount of energy. Note that regarding to other arrangements, other operation/working effect, and the like of the temperature adjustment system 110 of the second embodiment, the same is said as the temperature adjustment system 10 according to the first embodiment described above.

It has been described that either of the temperature adjustment systems 10, 110 according to the embodiments can achieve the energy saving effect to the conventional temperature adjustment system. The energy saving effect will be explained below by showing examples using specific numerals.

The following examples relate to a case that a product of 100°C filled in a tank having a volume of 5 m³ is cooled up to 0°C. When the specific heat of the product is 2[K J/kg°C] and the unit mass thereof is 500 kg/m³, the amount of heat required to cool the product is as shown in the follows expression.

$$2 \times 500 \times 5 \times 100 = 500 \text{ [MJ]} \quad \dots (1)$$

Then, it is assumed that the temperature of the heat medium stored in the intermediate tank at a certain time is 80°C and half the temperature difference between the product and the heat medium can be cooled by the heat medium in the intermediate tank. Thus, a substantial cooling temperature is 90°C and the amount of heat necessary to cool the product is as shown in the following

expression.

$$2 \times 500 \times 5 \times 90 = 450 [MJ] \quad \dots (2)$$

When it is assumed here that the amount of electric power, which is required for a cooler to consume the amount of heat of 500 MJ, is 145 kWh, about 131 kWh is required for the cooler to consume the amount of heat of 450 MJ. In the example, the amount of electric power consumed by the cooler can be reduced about 10% by providing the intermediate tank. Although the effect of reducing the energy consumption naturally increases or decreases depending on the initial temperature of the intermediate tank, the reduction effect can be obtained in any case.

Further, when the intermediate tank is provided with the cooling tower as in the second embodiment, a much larger energy saving effect can be expected even under the same condition. When, for example, the temperature of the heat medium in the intermediate tank is cooled from 80°C to 50°C by the cooling operation in the cooling tower, the temperature of a product can be cooled up to 75°C by the heat medium stored in the intermediate tank. The amount of heat required to cool the product of 75°C to 0°C is as shown by the following expression.

$$2 \times 500 \times 5 \times 75 = 375 [MJ] \quad \dots (3)$$

Accordingly, it can be said that the amount of electric power consumed by the cooler is about 109 kWh. When it is assumed that the amount of electric power consumed by the cooling tower to cool the heat medium in the intermediate tank is about 5 kWh, the total amount of electric power consumption is 114 kWh, from

which it can be found that an energy saving effect higher than that of the temperature adjustment system according to the first embodiment can be obtained. Note that although the effect is different also in this case depending on the environment temperature around the intermediate tank and the initial temperature of the heat medium, the energy saving effect can be achieved regardless of those temperatures.

Table 1 shows the summary of the relation between the temperature adjustment and energy according to the above example.

Table 1

Tank conditions	Amount of Power of Cooling Tower (kWh)	Cooling by Heat Medium in Intermediate Tank	Cooling by Heat Medium in Cooling tank	Cooling Amount of Heat by Heat medium in Cooling Tank (MJ)	Amount of Power Consumed by cooling equipment (kWh)	Total Amount of Consumed Power (kWh)	Energy Saving Effect
Conventional Type (Without Intermediate Tank)			100→0	500	145	145	1
With Intermediate Tank (Initial Temperature; 80°C)		100→90	90→0	450	131	131	0.9
With Intermediate Tank having Cooling Tower (Initial Temperature; 50°C)	5	100→75	75→0	375	109	114	0.79

As described above, according to the temperature adjustment system and the temperature adjustment method of the present invention, an energy loss and the variation of a tank temperature can be suppressed.

Although it is explained in the embodiments that the heat medium is liquid, it is not always necessary that the heat medium is liquid for embodying the present invention, and the heat medium may be gas. In this case, the carrying pump provided to the piping may be replaced with a carrying fan or the like.

WHAT IS CLAIMED IS:

1. A temperature adjustment system with a temperature adjustment jacket tank for adjusting the temperature of a product to a temperature setting and for adjusting the temperature of the product by supplying a heated or cooled heat medium to a jacket portion of the temperature adjustment jacket tank, the temperature adjustment system comprising:

a heating tank for storing the heat medium of a temperature kept higher than the temperature setting;

a cooling tank for storing the heat medium of a temperature kept lower than the temperature setting;

an intermediate tank for storing the heat medium of a temperature which is not adjusted and ranging between the temperature of the heat medium stored in the heating tank and the temperature of the heat medium stored in the cooling tank;

a temperature detection means provided to each of the jacket portion and the respective tanks; and

an adjustment means for adjusting the temperature of the product by selecting any of the tanks including the intermediate tank based on the temperatures detected by the temperature detection means and supplying the heat medium stored in the selected tank to the jacket portion.

2. A temperature adjustment system according to claim 1, wherein the adjustment means supplies the heat mediums stored in the two tanks, which store the heat mediums whose temperatures are respectively higher and lower than the temperature setting, out of the heating tank, the cooling tank, and the intermediate

tank.

3. A temperature adjustment system according to claim 1 or 2, wherein the intermediate tank comprises heat absorption means or/and heat radiation means for adjusting the temperature of the heat medium stored in the intermediate tank.

4. A temperature adjustment system according to any one of claims 1 to 3, wherein the adjustment means supplies the heat medium stored in the intermediate tank to the jacket portion preferentially over the heat medium stored in the heating tank or the cooling tank.

5. A temperature adjustment method of supplying a heat medium whose temperature is set higher than a temperature setting or a heat medium whose temperature is set lower than the temperature setting to a jacket portion and adjusting the temperature of a product to the temperature setting, the method comprising a step of adjusting the temperature gradient of the product when the temperature thereof is adjusted by using, when the temperature of the product is increased, an intermediate temperature heat medium having a temperature between the heat medium set to the high temperature and the heat medium set to the low temperature and the heat medium set to the high temperature, and using, when the product is cooled, the intermediate temperature heat medium and the heat medium set to the low temperature.