Operation & Control of Full Ice-storage System

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Abstract: In a dividing time ice-storage system, the refrigerator does not operate during power's on-peak period, and all the cooling is supplied by the ice stored in off-peak period, so that the use of electricity can be maintained. When the ice is thawing in this system, quantity of flow varies very much, which is different from conventional air conditioning system. Therefore, new strategies should be taken to solve this problem.

Key words: ice-storage pump system   problem of flow   thaw

1．PREFACE

In a conventional air conditioning system, the quantity of flow of freezing pump is decided by circulating quantity of flow which is selected by the refrigerator of freezing apparatus. However, in a ice-storage air conditioning system, because of part, full and dividing time ice storage, the problem whether set up a based load refrigerator. Therefore, the system becomes more complex, to be the worse, the decision of pump quantity of flow is not easy as the conventional way. This text will take a specifiable project as an example to explain the strategies for dividing time ice-storage operating in air conditioning system.

Tab.1 the power price of dividing time and segment in Wuhan

Segment	Time	Power price （yuan/kw*h）
On-peak	7:00～11:00 19:00～22:00	1.16
Normal	11:00～19:00 22:00～0:00	0.83
Off-peak	0:00～7:00	0.332

2．DIVIDING TIME ICE-STORAGE AND TOPIC LOAD BALANCE FIGURE

The way of dividing time is major to store ice during the power's off-peak period, and at on-peak period, do not operate the refrigerator, and all the cooling is supplied by the ice stood in off-peak period, so that the use of electricity can be maintained.

Figure 1: the calculate load per hour in specifiable project example. The all load is 2197RTH.

Figure 2: the topic load balance of dividing time ice-storage. From the figure2, we can see that at the on-peak period, it all depends on ice stored in off-peak period. At the normal period, the refrigerator takes up a dominant place. If it is not enough, the ice-storage equipment will be thawing to support. In this situation, we can maximum avoid to operate the refrigerator at on-peak period, so that the use of electricity can be maintained, at same time, reduce the capacity of machine.

3．THE MATCH AND ANALYSIS OF TIME SEGMENT QUANTITY OF FLOW

Figure 3: Flow chart of project example. There is non-based load refrigerator ice-storage cycle system. The refrigerator compressor is RTHB180 which own lengthen and ice making & refrigerant double function.

Day refrigerant operating: Q=161RT, operating time: 11:00-18:00.There is 7 hours in all. (avoid on-peak period 3 hours)

Night ice making operating: Q=107RT, operating time: 18:00-19:00, 22:00-7:00. There is 10 hours in all. (normal period 3 hours ,off-peak 7 hours)

Day thawing time: 8:00-18:00. There is 10 hours.

Chilling unit capacity: 161RT * 7h =1127RTH

Thawing capacity: 107RT * 10h =2197RTH

Ice-storage machine style: TSU-467M, TSU-761M ice-storage tank

All ice-storage:

476+761=1237RTH>1127RTH.

The refrigeration ability should be more than capacity.

According to the operating function of ice-storage tank, the circulating quantity of flow usually set up at 400 GPM- 450GPM. The Figure 4 and 5 are the thawing curve.

In 10 hours, off-peak period and normal period, in figure 3, circulating quantity of flow is suit for normal function value of ice-storage machine.

From8:00-10:00, almost air-conditioner cooling load is supplied by thawing, so that is the pattern for dividing time. In this 3hours, as to figure 1, we can draw the cooling load per hour. Based on ice-storage tank thawing curve, we can know the total energy of thaw in ice-storage tank per hour.
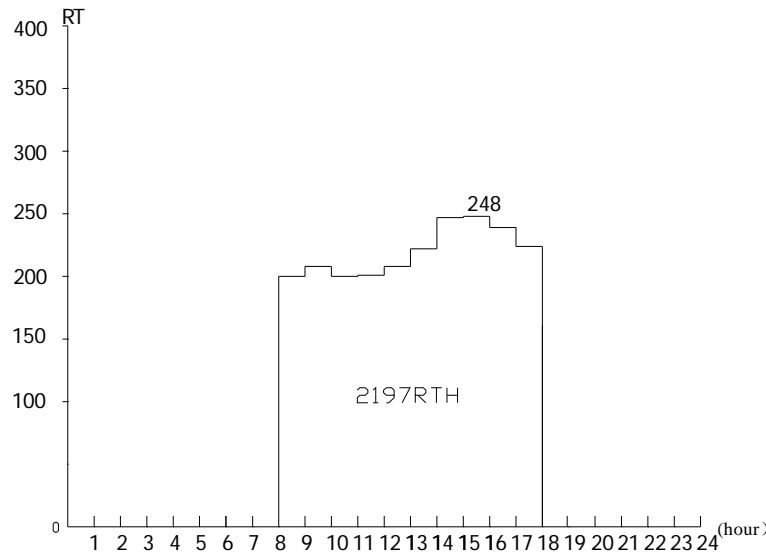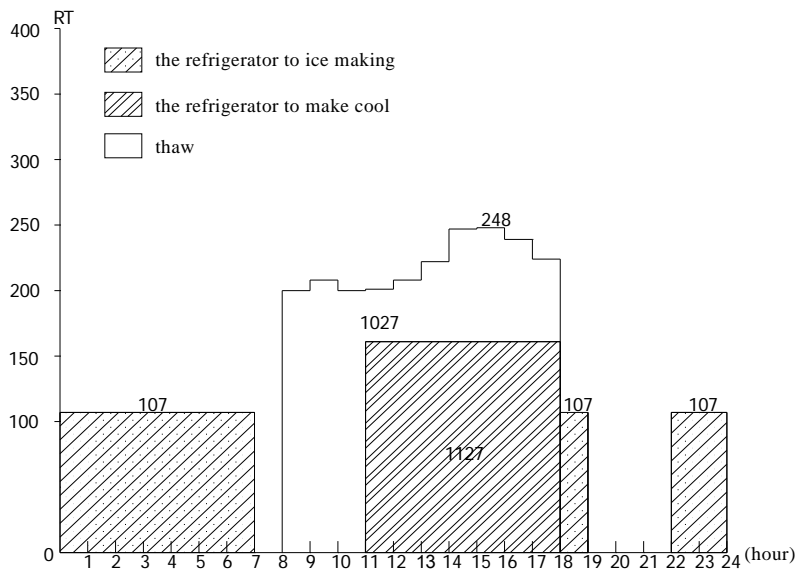

Fig.1 The calculate load per hour

Fig.2 The topic load balance of timeshare ice-storage

Tab.2 the Total Energy of Thawing Ice-storage tank per hour

Time	Load	The total energy of thaw
8:00～9:00	203RT	185RT
9:00～10:00	207RT	130RT
10:00～11:00	203RT	123RT

From the table 2, in the supplying and recycling process, If the water temperature constants, the energy of thaw could not satisfy the load. The way that solves the problem is enlarge the quantity of flow to ice-storage machine to obtain more refrigerating capacity to ensure the request of thaw in ice-storage machine. In addition, when enlarge the system circulating flow, we should consider that the variety of system resistance will make a diversification in pump work center.

4. CIRCULATING SYSTEM EQUIPMENT AND OPERATING STRATEGIES

4.1 Single Pump, Refrigerator and Ice-storage machine in Tandem Operating Mode
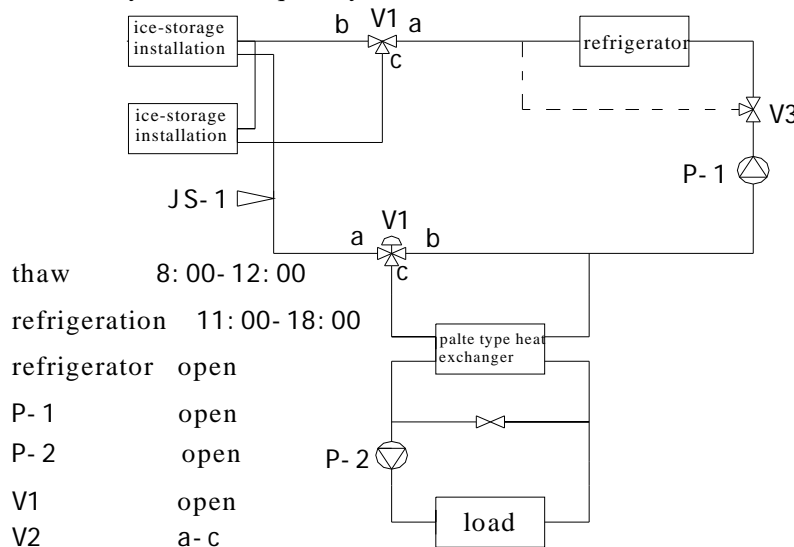
In this system, The quantity of flow chart is

figure 3, when we conceive the circulating system, may consider design a special value next to the refrigeration conditioner.(broken line in Figure 6) The triple valve is also able to adjust to meet greater quantity of flow. When we select the water pump, we should consider acquirement of flow in the largest load.

4.2 Double pump, Refrigerator and Ice-storage machine Parallel Operating Mode

In this system, the quantity flow chart is figure 6. When dividing time ice-storage need add flow in some segment, reduce quantity of flow a-b in V3 until close a-b. Enlarge quantity of flow a-c in V3, until a-c all open. Water P1 stops operating to satisfy air-conditioner load in dividing time ice-storage segment.
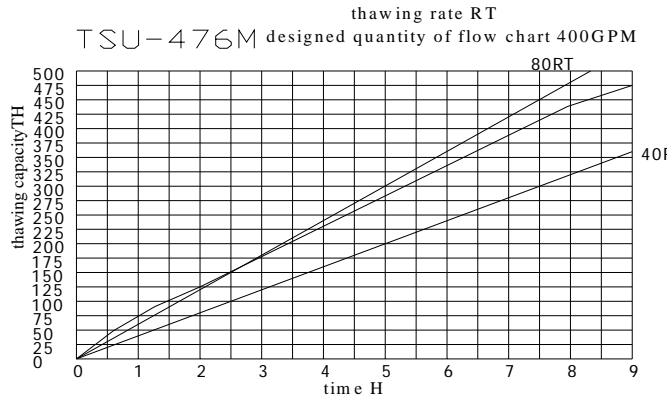
4.3 Double pump, Double plate type heat exchanger. Refrigerator and Ice-storage machine Parallel Operating Mode.

In this system, the flow chart is Figure 7.the dividing time ice-storage is operating, when some segment need large quantity of flow a-b in V3 until close a-b. Enlarge quantity of flow a-c in V3, until a-c all open. Water P1 stops operating to satisfy air-conditioner load in dividing time ice-storage segment.

Fig.3 The system flow chart

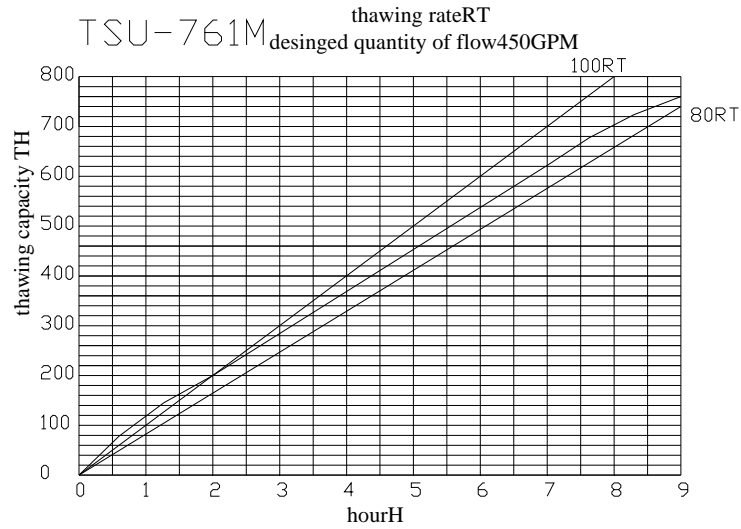**Fig.4 TSU-476M thawing tank curve**
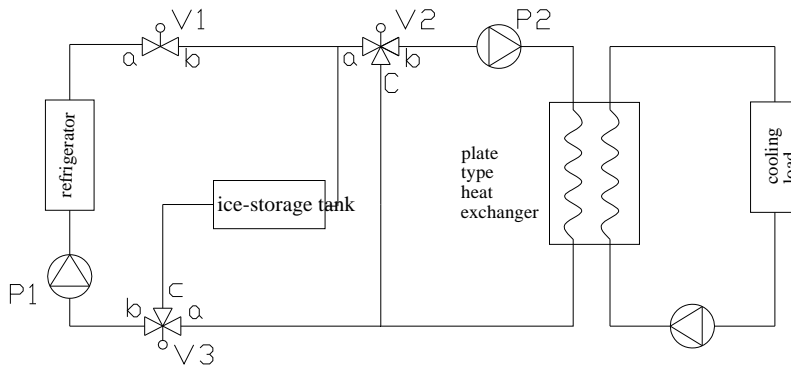

Fig.5 TSU-761M thawing tank curve

Fig.6 Double pump, Refrigerator and Ice-storage machine
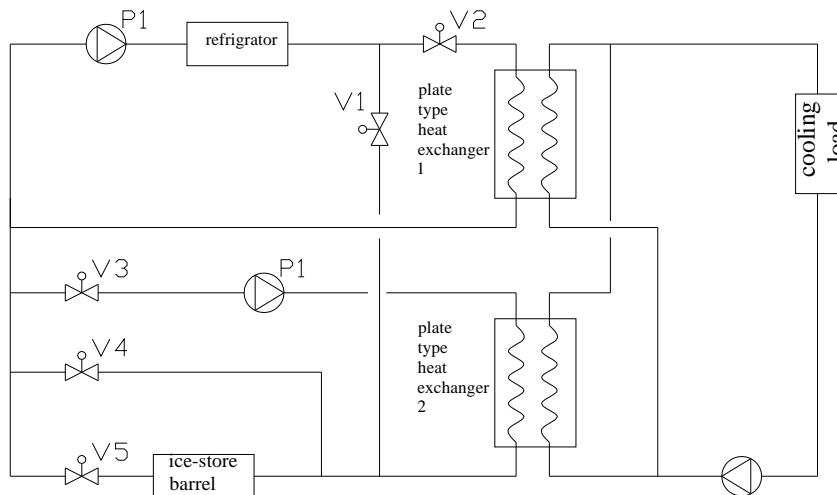**Parallel Operating Mode**

Fig.7 Double pump, double plate type heat exchanger, refrigerator and ice-storage machine parallel operating mode.

4.4 Triple Pump Operating Mode

In this system, the flow chart is Figure 8.When the system is thaw to supply cool, in order to gain most refrigerating capacity from ice-storage machine, the quantity of flow which come through ice-storage will enlarge. Therefore a-b in V1 closed, b-c fully open, a-b in V2 closed, b-c fully open. a-c in V3 closed, a-b fully open. At that time, the gained refrigerating capacity and quantity of flow is the largest, in other words, thaw rate is highest. Refrigerator stops supplying cool. P1 stop operating.

5.　CONCLUSION

When the dividing time ice-storage thaw is operating, it fully depends on thaw to achieve the acquirement in air-conditioner load. Therefore, we should consider in the certain temperature differential situation, quantity of flow is different in each time segment, and the segment may maximum in the operating mode of quantity of flow, so that we should take up the corresponding strategies. Otherwise, it may cause lack of supplying cool, and could not reach the acquirement in air-conditioner load.
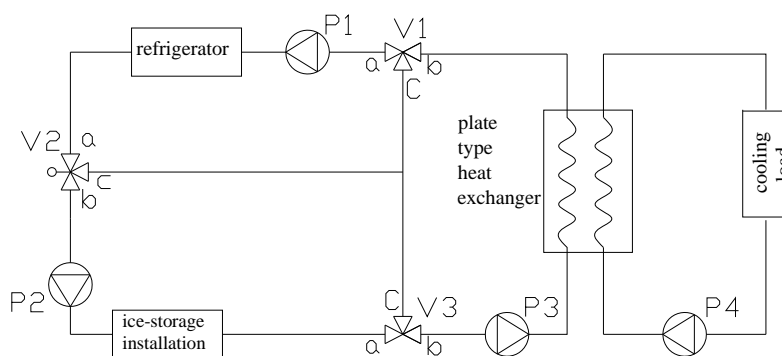

Fig.8 Triple Pump Operating Mode

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