ANALYSIS OF AND COUNTERMEASURES FOR THE HIGH ENERGY CONSUMPTION OF DESUPERHEATER IN THE CO-PRODUCTION OF HEAT AND ELECTRICITY

Qi-chun XUE

Jiangsu Provincial Huaihai Salt and Chemical Co., Ltd. Huai' an, Jiangsu 223007

Abstract: This paper briefly introduces the energy consumption of desuperheater in the salt making enterprises with co—production of heat and electricity and puts forward the solutions. At the same time, it briefly analyzes the investment and setting requirements for the small steam turbine which drives the feed water pump.

Key Words: Co-production of heat and electricity,Desuperheater,Energy saving,Feed water pump driven by steam turbine,Coumtermeasures

INTRODUCTION

In the co-production of heat and electricity, desuperheater is a kind of thermal equipment which is commonly used. This kind of equipment reduces the temperature and pressure of high parameter steam in power plant, which convenient for recycling and fully utilizing of working fluid. At present, in the vacuum salt-making enterprise, the drying of salty product is processed by steams and heat pump with steam jet (its rank is 0.98MPa saturated steam), generally is provided by desuperheater installment.

Desuperheater installment has the advantages of low investment, smaller footprints and easy to operate, but come into operation in the long term without using the steam heat energy gradient reasonably causes energy wasting and low thermal efficiency in the whole power plant. In the present situation of high coal price, the shortcoming high energy consumption appears especially serious. Therefore various enterprises are carrying on the transformation of this aspect and try their best to reduce the situation of high energy consumption. This paper briefly introduces the energy consumption of desuperheater in Huaihai Salt and Chemical Company and puts forward the solutions, in order to lead the situation in the area of similar industry.

ANALYSIS ON ENERGY CONSUMPTION AND TRANSFORMATION COUNTERMEASURES

Jiangsu Provincial Huaihai Salt and Chemical Co.,Ltd . established in 1991, underwent nearly 20 years development, the scale of vacuum salt-making is 600,000 tons/year and the scale of liquid salt is 500,000 cubic/year nowadays. The power plant equips three medium temperature and pressure chain grate boilers in 35 t/h, one axis condensing unit in 6000kW, one backpressure unit in 3000kW and a set of desuperheater with the pressure of 0.98MPa and rated flow of 20t/h. Three boilers in parallel operation are controlled by a main steam header. The steam pressure rank of evaporation in salt-making system is 0.40MPa, which is provided by 1# exhaust back pressure of back pressure generator and 2# steam extraction of abstraction-condensing turbine. The pressure rank of steam used in drying and steam jet in salt-making system is 0.98MPa, which is provided by the main steam in boiler after reducing its temperature and pressure by desuperheater with approximately 1 lt/h. Due to the large demand of steam in salt-making system, three boilers are all operating with full load in regular production and sometimes the phenomenon of overload is happened. The thermodynamic system diagram is shown as Figure 1.

The pressure in main steam header is 3.82MPa and the temperature is 435℃.

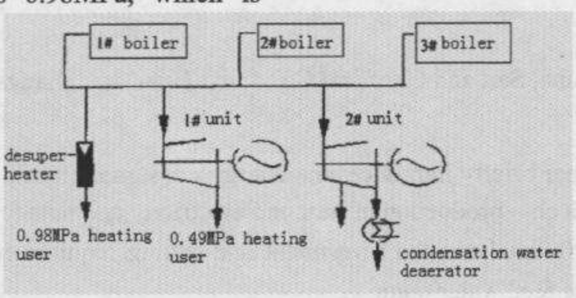

Figure 1. Thermodynamic system diagram in Huaihai company

Energy consumption of desuperheater

The desuperheater in thermal diagram is used for providing the steam to dry and steam jet of salty production. The balanced graph of desuperheater is shown in Figure 2.

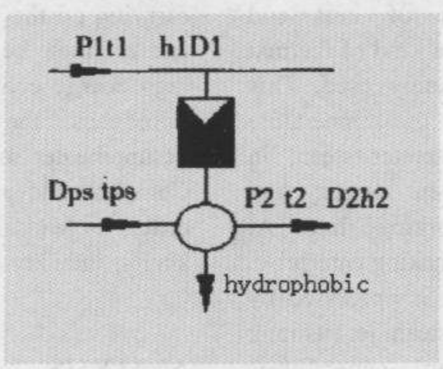

Figure 2. Balanced graph of desuperheater

Working fluid inlet = working fluid outlet

$$D1+Dps=D2 \quad (1)$$

Heat brings in by working fluid = Heat brings out by working fluid

$$D1 * h1 + Dps * tps = D2 * h2 \quad (2)$$

In the above two equations, steam and water losing is not included and an assumption was made that the attempering water transfers to steam completely. In the production of our company, the demanding of saturated steam at 0.8~ 0.9MPa is approximately 1 lt/h, the new steam enters desuperheater is approximately 9t/h and the demand of whole year is around 63,000 tons. To produce this steam, the boiler needs coal consumption at 1.8t/h and annual coal consumption is 12600 tons. If this part of steam enters the steam turbine, the electricity generation may increase approximately 900kW/h and 6300000 kilowatts is increased every year. (The annual running of the equipment is calculated as 7000 hours). Through the above analysis, near 9t of new steam each hour is reduced to the lower grade steam by desuperheater, the heat energy gradient has not been used. It is obviously not energy-saving and the waste is serious.

According to the national energy policy, when energy auditing, Economic and Commercial Committee brought the problem of high energy consumption of desuperheater. In order to solve this problem, Corporation achieves energy-saving through the transformation of low pressure feed water system. In the other word, in the situation of no increasing load to the boiler, add small back pressure steam turbine which drives the feed water pump. The steam source of small steam turbine takes use of the initial steam which enters desuperheater. On the one hand, this part of steam heat energy gradient is used fully, on the other hand the power consumption rate of the power plant is reduced through the reducing of electric pump. Then the target of energy-saving is achieved. The original desuperheater is function as a spare. Figure 3 shows the low pressure water feeding system before transformation

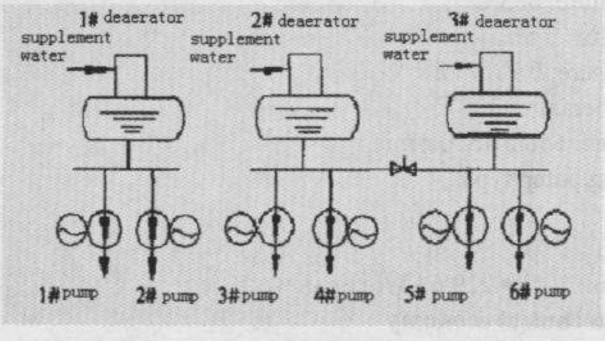

Figure 3. The low pressure water feeding system (before transformation)

Seen from figure 3, 1# deaerator in low pressure water feeding system of the power plant operates alone, 2# and 3# 1 may operate in parallel running with slightly transform. Now, every boiler is equipped with 2 electric pumps, so 6 pumps in all. The type of the pump is DG46-50×11, flow out is 46 m^3/h. rotation speed is 2900 rpm and outlet pressure is 5.5MPa. The power of 1# pump and 2# pump is 160 kW, which supplies 1# boiler alone. The power of 3#~6# pumps is 132 kW. So if 2# and 3# boiler is operating with full load, then 3 pumps should work together to meet the request. During regular production, the overall power of the pump electromotor achieves 556 kW.

Reconstructive plan

Reconstruct 2# and 3# deaerator to make these two deaerators work in parallel. After checking, the initial water balanced pipe can not satisfy the demanding of parallel operation, so the pipe diameter needs to enlarge and steam balanced pipe needs to be installed also. 3# and 4# electric pumps are cancelled and 5# and 6# pumps retain as spare. Additionally, small steam turbine which drives the feed water pump is added to provide the water for 2# and 3# boilers. The outlet steam from small steam turbine is used in drying and steam jet for salty production. Whenever there is a problem with heat user that they can not use the steam, the outlet steam can be changed to provide for deaerator or high-pressure heater as the heating steam. As a result the desuperheater can be eliminated and function as a spare. New modification pumps meets the demanding of 2 boilers with full load operation. After the transformation, the diagram of low pressure water feeding system can be seen in Figure 4.

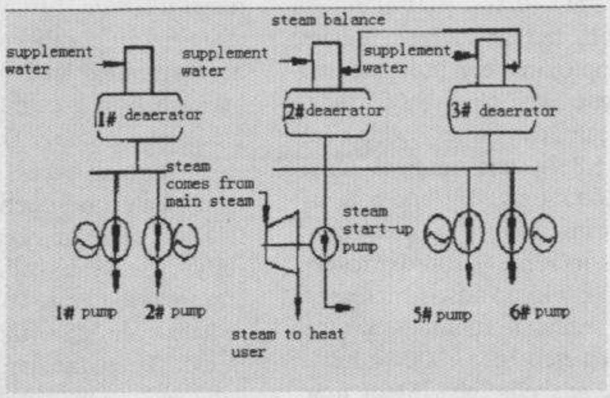

Figure 4. Diagram of low pressure water feeding system (after the transformation)

Small steam turbine type: B0.30-3.43/.98
Nominal power: 300 kW
Inlet pressure: 3.43 MPa
Inlet temperature: 435℃
Inlet steam flux: 9 t/h
Exhaust pressure: 0.98 MPa
Exhaust temperature: 305℃
Rotation speed: 6500~1500 r/min
Water feeding pump type:
DG85-67×9
Q = 100 m^3/h   p = 549 m
r = 2950 r/min   N = 229.6 kW(axle power)

The analyzes on technical economy

Table 1 The investment analysis of small steam turbine

Serial number	Name	Unit	Electric water feeding system	Steam start-up water feeding system
1	Steam quantity generated by boiler	t/h	105	105
2	Steam quantity provided from outside	t/h	96	96
3	Steam turbine inlet steam quantity	t/h	87	87
4	Electromotor power	kW	9000	9000
5	Other steam used	t/h	9 (steam to desuperheater)	9 (steam to small steam turbine)
6	Motor power of water feeding pump	kW	396	

Obviously can be seen that when the electric power is same as 3 boilers working together plus steam is provided from outside, the steam start-up water feeding pump reduce the motor power of 396 kW. And the steam quantity is not increased by the boiler. The electricity cost of each steam start-up water feeding pump saved is S_1, though the whole year (the equipment runs 7000 hours per year and the price of the electricity is 0.37 Yuan/kWh):

$$S_1 = 396 \times 7000 \times 0.37 = 1025640 Yuan \quad (3)$$

Equipment investment S_2: Every B0.30-3.5/0.98 steam turbine with co—production of heat and electricity is 400000 Yuan. Every DG85-67×9 water feeding pump is 20000 Yuan. Every 132kW electric motor is 21000 Yuan. Every DG46-50×11 water feeding pump is approximately 20000 Yuan. The transformation fee of pipeline, valve, deaerator, steam balance tube and water balanced tube, which equipped with steam start-up water feeding pump, is about 200000 Yuan. The added investment for the equipment is:

$$S_2=400000+200000+20000-2\times21000-2\times20000=538000 \text{ Yuan} \quad (4)$$

Compared the investment cost of electric water feeding pump with steam start-up water

$$\text{Profit} = S_1\text{-}S_2 = 1025640\text{-}538000 = 487640 \text{ Yuan} \quad (5)$$

Necessary condition of the using of steam start-up pump

① If steam start-up water feeding pump is adopted, the basic condition that the outlet steam needs to be fully used after work. At present, the range of inlet steam pressure of steam turbine with co—production of heat and electricity, which is produced in domestic,

③ decision of how many steam start-up water feeding pumps are needed have to base on the boiler water feeding condition. A certain amount of electric water feeding pump should be retained. Then the running in thermal power plant is very flexible.

CONCLUSION

From above calculations and analysis, it can be observed obviously that take use of desuperheater for inletting steam with steam start-up water feeding pump will save a lot of money. The economic efficiency is very remarkable, after half year the investment can

feeding pump, recoup the investment is as follows every half year:

0.5~3.5MPa and exhaust pressure is 0.2~1.6MPa. The range of inlet and outlet pressure is quite wide. The inlet steam can be connected with the boiler steam or pumped by steam turbine. The outlet steam can be used as the outer-supply steam or the heating steam for deaerator

② During actual operation, the water feeding to boiler by the electric water feeding pump is needed when the boiler starts at cold condition. Therefore, the

be recycled and from then on, the enterprise income will increase 1025640 Yuan every year. Therefore, if the salt making enterprises with co—production of heat and electricity use desuperh-

eater for a long time, the energy consumption will be very seriously. This reconstruction is feasible. The constructive method introduced in this paper is only an example; various enterprises may adopt their own method to save the energy according to the enterpris-

es' own characteristic.