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DESIGN AND INSTALLATION OF A CONDENSATE RECOVERY SYSTEM

By
NCB (IEA Grimethorpe) LTD.

December 1980

Work Performed Under International Agreement No.: ET10393

For
U. S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
NCB (IEA Grimethorpe) LTD.
Grimethorpe,
Barnsley,
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1. INTRODUCTION

The Grimethorpe Experimental Facility was designed to use steam from the Grimethorpe Power Station to drive the turbo-compressor during start-up. During this period, it was intended that steam produced in the Facility Steam/Water Circuit would be vented to atmosphere and the required condensate make-up would be supplied from storage tanks. Once start-up had been completed, Power Station quality steam produced in the Steam/Water Circuit would take over the duty of supplying the turbo-compressor.

During the construction of the Facility and the planning of the Experimental Programme, two problems were revealed. First, the capacity of the condensate storage tanks was only sufficient to supply make-up for the period of a text-book start. Any extension of the start-up time due to e.g. operational problems would introduce the risk that the plant would run out of condensate. Second, and more important, under a number of planned operating conditions with Tube Bank 'A' it became clear that the Steam/Water Circuit would not produce Power Station quality steam and there would be insufficient make-up capacity to keep the plant running.

Two systems were considered to remedy the problem - additional condensate storage tanks or a condensate recovery system. Storage tanks would have solved the start-up problem but not the problem of make-up when low quality steam was being produced during normal operation. Thus the provision of a condensate recovery system was preferred. In discussion with the Power Station, the turbo generator manufacturer (NEI Parsons), the Steam/Water Circuit manufacturer (VKW) and Cornhill Insurance Co., it was established that a condensate recovery system was technically feasible and could be designed to handle the full output of the Steam/Water Circuit even when Power Station quality steam was being produced.

NEI Parsons indicated that they were unable to undertake the work due to the pressure of other contracts but offered full assistance in terms of providing drawings and technical data. VKW were selected to design and install the pipework systems because of their knowledge of the plant and their presence on site. For similar reasons, Babcock Controls were selected to design and install the control and instrumentation system.

Following Executive Committee approval in December, 1979, VKW started site erection in April, 1980 and the system was available on hand control for the start of hot commissioning in September 1980. Commissioning on hand control was carried out in September and October 1980. The final automatic control system has been delayed by priorities on other work but will be completed during the planned shut-down in January 1981.

2. DESCRIPTION

The Condensate Recovery System (CRS) and its interconnection with the FACility is shown in the P. & I. Diagram, IEA CRS 1005 Rev.5 Sheet 1. The resulting changes of the thermodynamic conditions of

the steam are shown in the Mollier Diagram, Sheet 2. The system is capable of receiving the full output of the Steam/Water Circuit at design conditions of 440°C, 30.3 bar abs.

Low quality steam produced in the Facility is diverted through line SH5112 to the pressure reducing valve SH9506. Downstream of that valve the steam is attemperated and then enters the flash tank. The main pipeline of the CRS is connected to the vent line from the flash tank to atmosphere. The hydraulically actuated butterfly valve SH9619, installed downstream of the connection, serves to cut off the vent and divert the steam into the CRS. The system is designed for a steam pressure of 4 bar abs. to keep the pipe dimensions within reasonable limits. The pressurisation did not require any alteration to the existing vessels (flash tank, start-up vessel) which are designed for a pressure of 10 bar although initially being used at atmospheric pressure.

The main steam pipeline (NB400) breaks through the wall between the Facility and Power Station and runs to the condenser of the turbo-alternator set no. 3 of the Power Station. Before entering the condenser the steam is reduced in pressure and temperature by passing it through the pressure reducing valve SL9623 and a desuperheater. In the condenser the steam is dispersed by an arrangement of two perforated pipes which allows continued use of the turbo-alternator set. The condensate is delivered to the condensate surge header by the existing extraction pumps which also supply the spray water for the desuperheater.

Emergency spray water supply from the surge tank of the Power Station is provided by the spray water pump when the extraction pumps trip out due to low level in the condenser.

Sets of pressure switches on the main steam pipeline and on the condenser operate various interlocks which prevent any part of the system to over pressurise. In addition to that a safety valve is installed on the main steam pipeline and a rupture disc for the condenser is on order. This ensures safe operation of the system according to good engineering practice and the requirements of the insurance company.

An additional benefit of the CRS is that waste steam from the Research Instrumentation system can be recovered in the CRS, thus eliminating losses from this source and any requirement for a separate recovery system for the Research Instrumentation.

3. TESTING AND COMMISSIONING

After installation the steam pipeline was pressure tested and 20% X-rayed. The interlocks and the safety valve were tested under design conditions during commissioning on 3rd September and performed satisfactory. The only problems which occurred during

commissioning were minor operating problems due to the temporary hand control and mechanical problems with the pressure reducing valve SL9623. The valve manufacturer overcame these latter difficulties by carrying out modifications to the valve. The final commissioning will take place after turning over from the temporary hand control to the final control and instrumentation, which will be available by January, 1981.

4. CONCLUSION

1. The CRS was installed and has operated satisfactorily during the hot commissioning runs.
2. Waste steam from the Research Instrumentation can now be recovered by the CRS thus eliminating the costs of a separate Research Instrumentation condensate recovery system.
3. The CRS represents a reliable long term solution to the condensate problems of the plant. It is capable of accepting the full steam output from the Facility even at design steam conditions.

Mollier h,s-Diagram

PRESSURE	bar abs
TEMPERATURE	°C
MASS FLOW	kg/s

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Fluidised Bed Combustion Project.

Grimethorpe Experimental Facility.

Condensate Recovery System

Mollier h,s-Diagram.

Sheet 2

Date	Drawn By	Drawing Number	Revision
11/1/80	SMP	CRS.1011	

SHEET. 2 .