Condensing, Extraction Turbine

INTRODUCTION

The steam turbine, like any other high grade machine, requires, for sustained efficiency and continuity of operation, a reasonable minimum of care and attention on the part of the operator. In order that the unit may receive such care and attention, it is necessary that the operators become familiar, not only with the mechanical structure of the various parts of the turbine, but also with their purpose, and, in a general way, with the reasons why they are so designed. The following brief instructions have been prepared as an aid to the attainment of this desired information and it is hoped that they may be found to be broad enough in scope for that purpose.

GENERAL DESCRIPTION

This is a combination impulse and reaction turbine designed for high operating efficiencies. It is arranged for automatically controlled extraction to supply steam at the desired pressure for heating or process work. The exact steam conditions with which it is intended to operate, the normal speed and the maximum load are given on the Title Page of the Instruction Book.

The construction of the entire turbine is shown in the longitudinal section photograph. It should be noted that this illustration shows a side view below the horizontal centerline and a longitudinal section above the centerline.

The blade path includes impulse elements (either Curtis, Rateau or both) and groups of reaction blading, the exact combination for each turbine being determined by the steam conditions and capacity required. The exact blade arrangement and the number of stages or rows of each type are given on the Title Page. Steam is admitted through the main nozzles and passes through the high pressure section of blading to the extraction zone where a part is led out of the cylinder to supply the extraction system. The remainder, which is not used in the extraction system, passes through the low pressure section of blading and exhausts into the condenser.

Depending on the size of the machine, one or more openings may be provided in the cylinder through which steam can be extracted non-automatically, if desired, for additional feed water heating or process work. The sizes of these openings, when provided, are given on the outline drawing. Since extraction at these points is not controlled automatically, the pressures and quantities available are determined by the load being carried by the turbine and the quantity of steam being extracted automatically.

CYLINDER

The cylinder is split in a horizontal plane through the axis so as to form a base and cover. A complete inspection can, therefore, be made by removing the cover only, and the base need not be disturbed after installation. This turbine has no bedplate. The cylinder is rigidly supported and anchored at the exhaust end by two pads which are either cast integrally with or bolted rigidly to the base.

At the inlet end, it is supported by two arms (or lugs) which are cast integrally at the top of the cylinder base, thus locating the point of support as closely as possible to the horizontal centerline. These arms rest on the thrust bearing pedestal which is a separate piece, and is free to slide axially on its base. Transverse keys, one attached to the bottom of each arm by a single sleeve type dowel and free to slide in its keyway cut in the pedestal, maintain the correct axial position of the cylinder with respect to the pedestal but allow free expansion in a transverse direction. A vertical key between the cylinder and the pedestal definitely locates the cylinder in a transverse direction but allows free expansion axially and vertically. The pedestal, in turn, is free to slide axially on its base but is held against transverse movement by an axial key, placed on the longitudinal centerline, between it and the base. Any tendency to tilt is limited by side gibs which are fitted with ample clearance to allow free movement axially. Any tendency of the cylinder to rise off the pedestal is limited by a stud bolt through each arm. These bolts are placed inside the sleeve type dowels and are fitted with ample clearance under the nut and around the bolt to allow free movement of the cylinder arms in response to temperature changes.

ROTOR

The turbine rotor is made from a solid steel forging. It is connected to the generator field by a rigid coupling, and the complete rotating element is carried in three bearings. That is, the exhaust end (or #2) turbine bearing carries also a portion of the generator field.

CONTROL

On a turbine of this type the control system is of utmost importance. The principal items of this system are:

1. Governor
2. Extraction (bleeder) valve servo-motor.
3. Extraction (bleeder) pressure regulator.

The control and oil system diagram shows the various parts of the control system and their relation to one another. The detail operation of each particular part is described in its respective leaflet.

The pressure in the extraction system is maintained constant, within reasonable close limits, automatically by an extraction valve, which is either located within the cylinder proper or cast integrally with it so as to control the flow of steam toward the exhaust, thus maintaining in the cylinder zone on the high pressure side of the extraction valve that pressure which is desired in the extraction system. This valve is opened or closed by an oil servo-motor which is actuated by the extraction pressure regulator.

When a turbine of this type is operated alone or in parallel with a small system where it can carry the total load swings, the extraction mechanism operates independently, and a speed variation regulator is used to maintain the frequency within close limits with any change in extracted steam demand or load.

When this turbine is operated in parallel with a large utility line, it will operate base load; or if it is operated in parallel with a number of other units, it will share load changes in proportion to its capacity. In such cases, the extraction pressure regulator is connected also to the main governor so as to control the main governing valves to compensate for changes in extraction demand, and thus carry the electrical load with approximately normal speed regulation. The oil system diagram shows which method of control is used.

The non-return valve in the extraction line is used to prevent any steam flow from the extraction system back into the turbine. It includes an automatic tripping feature which is connected to the turbine overspeed trip mechanism and closes the non return valve instantly and positively in case of overspeed.

Enough oil should be provided so that when the turbine is running at full speed the oil level in the reservoir, as shown by the gauge, is within the limits given on the indicator plate. Although there is a strainer in the oil system, it is desirable as a precaution to strain the oil through a fine mesh screen or cloth just before putting it into the reservoir.

The amount of water circulated through the oil cooler should be regulated to maintain the temperature of the oil leaving the cooler between 100 and 110°F. The correct criterion of oil cooler water supply is, of course, the temperature of the oil leaving the hottest bearing. This temperature will vary with different units and operating conditions. However, in general, oil return temperatures of 140 to 160°F. are considered good practice. When starting a turbine, the oil cooler water should not be turned on until the oil temperature has increased to the approximate limits given above.

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