

Turbine Mechanical Equipment Hydraulic Actuator Assembly

Major Components

- Cylinder
- Manifold
- Servo valve
- Linear variable differential transformer (LVDT)
- Quick close solenoid
- Logic valves
- Removable orifice



Hydraulic Actuator Assembly

The hydraulic actuator assembly uses hydraulic horsepower, generated at the hydraulic power unit, to position the steam control valves of the turbine. Some of the turbine valves are simply opened or closed depending on the state of a turbine status pressure header (“auto-stop header”, “emergency trip header” or “overspeed protection header”). Valves that are open-close type do not employ hydraulic servo valves to control their position. Generally, an orifice is used to meter the hydraulic fluid into the actuator, and therefore limit the rate at which the valve travels from full closed to full open.

Hydraulic actuators that modulate, to control speed or load, use high performance servo valves to regulate the position of the steam valves. Modulating actuators use linear variable differential transducers (LVDT’s) for position feedback to the control system.

All the valve actuators use a “quick close” circuit, designed into the manifold, to facilitate rapid valve closure when the turbine status pressure header depressurizes (turbine trip condition).

Cylinder

The hydraulic cylinder is designed to provide the correct stroke length for the steam valve that it controls. The piston diameter and rod diameter are selected to produce the proper extend and retract force at the system design pressure. Tie rods connect the cylinder head and cap, and produce the clamping force to hold the cylinder tube in place. Drilled passages in the head and cap allow fluid to pass from either side of the piston to the manifold.

Seals at the rod penetration prevent fluid from escaping along the piston rod. Double rod seals, a rod wiper, the rod bearing and a rod scraper are contained within the gland seal assembly. These seals can be replaced when the cylinder is overhauled. The hydraulic cylinders use various types of end connectors to interface to the existing steam valve operating mechanisms. These end connectors are custom designed for each application.

Manifold

Each valve actuator uses a custom designed hydraulic manifold. These manifolds use machined passages, within the manifold block, to form the proper hydraulic circuit. Using machined manifold blocks greatly reduces the number of potential leak points by eliminating the majority of the plumbing associated with a conventional hydraulic circuit. Logic valves, servo valves, flow control valves and solenoid valves are either mounted on the manifold surface or installed in machined cavities within the manifold body. These valves are combined in various ways to form the hydraulic circuit.

Servo Valve

The servo valve is the primary interface between the hydraulic system modulating steam valves and the turbine control system. The servo valve is used to port fluid to the top and/or bottom of the actuator piston to control the steam valve position. The servo valves have redundant torque motor coils driving the primary stage nozzle/flapper assembly. Individual output channels drive each of the torque motor coils from the Emerson servo driver module.

This redundancy ensures controlled motion of the valve actuator in the event of a single coil or output channel failure. The servo valve spool position is proportional to the torque motor input current and, with constant pressure drop across the valve; flow to the load is proportional to the spool position.

LVDT

The Emerson control system uses a linear variable differential transformer (LVDT) to indicate the position of hydraulic cylinder. This feedback signal is compared to the position demand and generates an error signal. The error signal controls the direction

and magnitude of the servo driver output signal. Emerson original equipment actuators are supplied with six wire AC LVDT's. The servo driver module provides the excitation signal and interprets the two feedback signals. The particular LVDT model is selected based on ambient conditions, electrical connection type and valve travel.

Quick Close Solenoid

Servo valves and control orifices are used during normal start-up and operational conditions to control the motion of the steam valves. There are instances when the steam valves are required to move faster than the normal control devices will permit. Examples of these conditions are turbine trip and overspeed actions. During these temporary conditions, actuator "quick close" solenoids are sometimes employed to allow the steam valves to travel from an open position to a closed position rapidly, without limiting the actuator speed to the travel velocity dictated by the maximum servo valve or orifice flow rate.

Logic Valves

Cartridge logic valves are used extensively in Emerson turbine hydraulic systems. These valves offer reduced system size, fast response, low leakage, improved contamination tolerance and controllability. In quick close circuits, the open/close state of a logic valve is controlled by one or more solenoid operated directional valves. In regenerative cylinder circuits logic valves provide a high flow path from the cap end of the cylinder to the head end of the cylinder, thereby reducing the volume of oil discharged into the main return line during turbine trips. Logic valves are sometimes used to provide a positive shut-off of the main hydraulic header pressure to the servo valve during turbine trips, eliminating the possibility of draining the main hydraulic header across the servo valves.

Removable Orifice

Simple orifices are used in turbine hydraulic systems to control flow at a given pressure. Removable orifice plugs are used in many Emerson manifold designs. Orifice plugs are used in branches from the main hydraulic header to produce a trip, or overspeed protection, header. During a turbine trip, these headers are dumped to tank pressure via logic

valves or solenoid valves. The installed orifice allows the trip header pressure to dump while the main hydraulic header pressure remains normal. The removable orifices used in Emerson hydraulic systems are made from NPT plugs with drilled holes. These removable plugs are located behind SAE straight thread plugs in the manifold. Removal of the SAE plug gives access to the NPT plug below. This simple, yet effective design permits easy orifice change-outs and orifice size modifications in the field

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