Pump passes flooding test

A steam-driven emergency water pump has been demonstrated when submerged in water. During two eight-hour flooding tests in February 2013, the ClydeUnion CUP-TWL was found to operate normally.

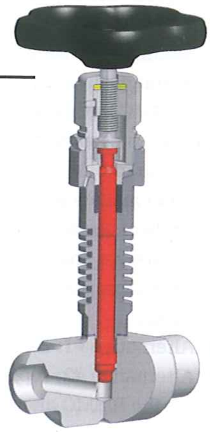
The pump, whose design dates back 50 years but has recently been updated, is used in key emergency reactor cooling systems in both PWRs and BWRs. In PWRs it is part of an auxiliary feedwater pump that moves water from an emergency feedwater tank to the steam generators to remove decay heat when the main feedwater system is unavailable, or during startup or shutdown. In BWRs it powers the reactor core isolation cooling system, providing water to the reactor for decay heat removal.

Inside the pump, NSSS steam turns a forged turbine wheel, which spins a central shaft and the attached impeller. It runs on water-lubricated bearings, and has self-contained governor and mechanical (centrifugal) and electrical overspeed indicators. It can pump up to 350 m³/hr with delivery head up to 1200m. Speeds are around 7500 rpm and temperature is around 120°C.

The pump was submerged several times over the tests, which were conducted in a purpose-built tank intended to simulate flooding conditions at ClydeUnion's Glasgow, UK factory. Representatives of five utilities were witnesses (but for safety observed the tests remotely). The test began with flooding the CUP-TWL with cold water, starting it with design steam conditions, and conducting a series of performance tests and an emergency stop/start while submerged. The test tank was then drained while the unit continued to run and the temperature of the unit was allowed to stabilise with the steam supply at 290°C (554°F) before rapidly flooding the tank with cold water. A second performance test was then conducted with a total of eight hours submerged running with no reduction in performance or integrity. ■

Valve design hots up

Some kinds of Gen-IV reactors planned for development over the next 20 years propose raising primary- and secondary-circuit temperatures and pressures beyond current PWR levels.



Raising steam parameters to temperatures up to 750°C and pressures up to 500 bar at the same time requires the qualification and optimisation of suitable materials and power plant components to meet these demands.

One research and development project was COMTES700 (July 2005-December 2011) at E.ON's Scholven coal-fired power plant in Gelsenkirchen, Germany. The insights gained shall be used in the development of components such as safety, control and needle-type globe valves, seals or coating systems, which can be employed even at temperatures above 700°C in a reliable and economic manner.

For that project, in June 2004 AS-Schneider received an order from ALSTOM Power Boiler GmbH to develop an isolation valve which is able to withstand temperatures up to 750°C at 400 bar.

The first issue is selecting the right materials. Normally steels with 9 to 12% chromium are used for temperatures up to 630°C (example: material 1.4901 or ASTM A182 grade F92). Only nickel-based alloys such as 2.4663 (Alloy 617) are used for temperatures above 700°C. These alloys are very expensive, and their difficult machining requires extremely great production knowledge.

When a power plant is started up and shut down the piping components as well as the fittings are subjected to large temperature variations, which strain the materials. Also, components' different degrees of thermal expansion may cause undesirable tensions or leaks. To prevent the valve tip from lifting off during temperature changes, the initiation of the closing force of the valve tip via a spring assembly, which compensates the thermal expansion differences, was included.

However, not only the metallic materials of a valve must withstand the extremely high pressures and temperatures but also the sealing elements, especially the packing, which seals the valve stem dynamically toward the atmosphere. Graphite packings are used here as a rule. However, since graphite begins to oxidise in the presence of oxygen in the air from 550°C, the stem seal was moved to an area where the temperatures are considerably lower and no more risk of oxidation is present. This was achieved by extending the bonnet and using additional cooling ribs. In addition, the valve was equipped with a metal back seat which supports the packing when the valve is fully opened. Also, a vent hole was installed above the packing through which the hot steam is directed away from the handwheel in the event of a packing leak.

Finally, the welding joints needed to be closely scrutinized. Especially high-temperature materials such as 1.4901 are very sensitive to the formation of heat cracks during welding. Particularly stringent requirements apply for so-called black-white connections which occur frequently at the process-to-instrument interface. To avoid having to make the welding joint on-site, this special connection is already made on the primary isolation valve, for example, by welding a short piece of pipe with the material 1.4952 to the valve body from 1.4901. ■