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Water-cooled check valves boost reliability of 7FA liquid fuel system

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Reliable starts on distillate oil and reliable transfers from gas to backup liquid fuel are critical for plants having ancillary services agreements with grid operators requiring dual-fuel capability. Owners who get a premium for assuring standby generation must run when called.

There has been significant discussion over the years at meetings of several user groups regarding the coking problem many owner/operators of dual-fuel engines experience with standard liquid-fuel check valves. After switching from oil to gas, the oil remaining in check valves, which are located close to the combustors, is exposed to high temperature.

Above about 250F, that relatively small amount of oil oxidizes. The resulting coke coats check-valve internal surfaces (and fuel lines as well) and restricts the movement of valve parts. Once this occurs, a check valve will not open and close properly until it is overhauled.

The most common trip during fuel transfer is on high exhaust-temperature spread—caused almost exclusively by check valves "hung-up" on coked fuel. Startups on oil when fuel-system components are fouled can be challenging as well—sometimes impossible.

Starting reliability and reliable fuel transfers are particularly important to Tampa Electric Co's Polk Power Station where distillate is the backup fuel for syngas produced by the facility's coal-gasification system. Yesterday afternoon, Maintenance Specialist Brian Hall discussed the check-valve challenges Polk faced, the corrective alternatives considered, and five years of experience with the solution selected.

Hall told the 7F users that Polk has five 7FAs. The unit coupled to the gasification system is capable of burning only syngas and distillate, two other units are natural-gas only, and the remaining two natural gas/distillate.

The operating paradigm for the FA operating on syngas is particularly challenging, he said. Key points included these:

* The unit must start on distillate and then transfer to syngas when output exceeds about 100 MW.

* When the syngas supply is lost, the GT transfers to oil to enable an orderly shutdown—one that doesn't adversely impact the lives of hot-gas-path parts.

* If power is required when the gasifier is out of service, the unit must operate on distillate oil to fulfill the grid commitment.

* The liquid fuel system cannot be exercised regularly because of permit limits and the gasifier run schedule. The GT operates at base load when the gasifier is in service.

Hall discussed the four alternatives considered to mitigate the coking problem and improve reliability:

* Retrofit air cooling, which the plant selected to prevent coking in the two natural gas/distillate dual-fuel engines.

* Lay-up the liquid fuel system after use and purge it with nitrogen.

* Convert to a recirculating or return-flow liquid-fuel system to keep the oil moving and prevent coking.

* Change-out the conventional liquid-fuel check valves with water-cooled valves.

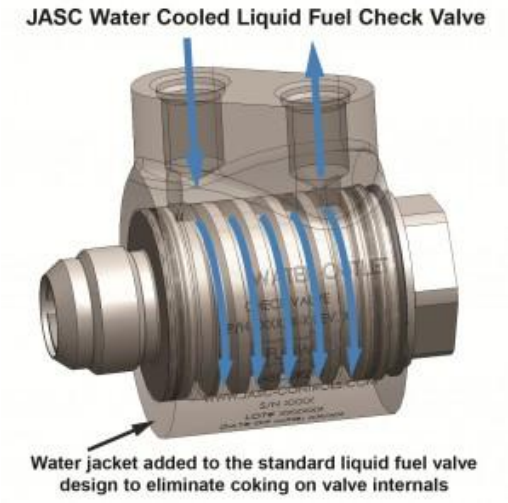
Hall said coking was most problematic in the upper half of the casing of the two natural gas/distillate GTs and that air cooling was adequate for that application. However, it was not feasible for the syngas unit because of space limitations and because coking impacted the operation of all combustors.

The lay-up alternative was not feasible because it limited operational flexibility: Up to a day might be required to prepare the fuel system for restart.

The recirc system didn't pass the financial litmus test. Plus, the Mark V control system had no spare I/Os to accommodate that upgrade.

The most practical option was water-cooled check valves for the liquid-fuel circuit—one valve per can. Hall said the new valve, manufactured by JASC-Jansen's Aircraft Systems Controls Inc, Tempe, Ariz, was a direct drop in for the original. The only extra step was getting water for jacket cooling.

But since these units already had a closed-loop cooling-water header within reach, installation was relatively simple. The first and only issue encountered, inadequate cooling, was solved by removing a downstream restriction in the cooling-water discharge line.



The water-cooled valves have been in service for about five years and there have been no forced outages related to coking during that time, Hall said. Transfer and startup reliability prior to installing the JASC valves was less than 60%. Startup issues were almost all check-valve related; transfer reliability was affected by controls problems as well as coking.

Today, the maintenance specialist continued, startup reliability is north of 95% and fuel-transfer reliability is more than 90%.

The plant purchased two sets of water-cooled valves. They are swapped-out during the annual combustion inspection and the valves removed are sent to JASC for overhaul. Refurbishment costs about half of what it used to cost to replace the standard valves annually. Hall has not yet seen wear and tear that would justify annual overhauls, but the cost of a failed start or transfer is so much greater than refurbishment it doesn't make sense at this time to stretch out the maintenance interval.

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