

## Is Your Vessel Really Empty?

An explosion and fire occurred in a 50,000-bbl/day fluid catalytic cracker (FCC) (Figure 1) that was being brought online after a seven-week maintenance shutdown. Six workers were killed and eight others were injured in the 1991 incident. Property damage was reported to be about \$23 million and business interruption loss was estimated to be \$44 million. This accident was not caused by a runaway reaction, leak of flammable material, or static ignition; it was caused by water.

The vertical pressure vessel (F7) that exploded was used to separate heavy oil from solid catalyst dust. During the shutdown, oil was drained from all process equipment, and the equipment was cleaned, inspected, and refurbished for service. As part of the startup procedure, steam was used to purge any air from the system before oil was fed to the pro-

cess. Operations personnel recognized that the temperature in the process equipment was low enough to condense some of the purge steam. Water that condensed was collected and pumped to the F7 vessel.

The normal startup procedure required the operating crew to drain the water from F7 before introducing any hot oil. However, a block valve incorrectly set to the closed position prevented the water from draining. The rapid expansion of the steam overpressurized F7, causing the vessel to violently rupture. The oil released during the explosion ignited, and the fire engulfed the FCC unit, burning for more than two hours before it was finally extinguished.

► **Figure 1.** Water in a vertical pressure vessel expanded, overpressurizing the vessel and causing it to explode. The fire engulfed this fluid catalytic cracker (FCC) (shown prior to the explosion).



### Did you know?

- Many reports of steam explosions involve unintentional contact between hot material and water. The October 2015 Beacon offers another example.
- When water vaporizes to steam, its volume expands by about 1,600 times. One U.S. pint of water can generate enough vapor to fill almost four 55-U.S.-gal drums!
- Water is often used to clean or flush equipment to prepare for maintenance activities. The water can collect in the low points of equipment and piping. If it is not completely removed before startup, it could contact hot or incompatible materials.

### What can you do?

- When returning equipment to service after maintenance, ensure that the equipment is completely clean and does not contain materials that may be incompatible with process materials or operating conditions.
- Do not deviate from the startup procedures, and use checklists and all procedures as written. Some process plants operate for years without a maintenance shutdown or other type of shutdown. Do not rely on your memory for this critical operation.
- If you find valves in the wrong position or other equipment in the incorrect status during startup, understand all the potential consequences before changing the valve position or equipment status.

**Liquid water + hot material = steam explosion danger!**

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