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Pardon Your Elbows

All drilling programs try to avoid or minimize any flows from the wellbore to the environment or rig floor. If pressure control is required, every effort is made to ensure that it is conducted in as safe a manner as possible. Erosion of pipe can be a serious issue, especially during well control operations, and certain measures should be taken to prevent such erosion and the resulting premature failure in diverter and choke/kill lines. Some might ask, "Isn't this an old problem; why discuss it now?" It's true that this issue has been around since shipboard piping was first installed. Unfortunately, WEST still frequently sees rigs with original work or modifications to the diverter and choke and kill lines that were done without considering erosion issues. This can lead to piping failure and potential loss of drilling time and money, not to mention the exposure to an environmental or safety incident. Figure 1 shows an example of work that at first glance looks quite suitable. Work like this, on newbuilds and retrofits, is often the result of designers and/or fitters who are new to the drilling industry. The failure to follow good design practices can have serious consequences, including loss of life. Figure 2 shows piping similar to piping which failed in less than 10 minutes during a well control operation, resulting in a fire and major damage to a rig. Even if there are no injuries or loss of life, the cost can still be enormous. Punitive damages for a single incident have run into billions of U.S. dollars. In the past, there have been documented flows to the environment of 10 thousand to 30 thousand *barrels per day*. A flow of that magnitude today could easily bankrupt even a large company if it continued for very long.

Figure 1 – Short-sweep ells downstream of choke

Figure 2 - Port diverter vent line (the identical starboard line failed in less than 10 minutes; the elbow wall thickness was ¾ in.)

Description of Issue

Diverter and choke and kill piping systems require components that can stand up to potentially high flows and pressures while safely transporting mud and abrasive cuttings. The turns and elbows required in these piping systems create localized areas of very high erosion. This erosion, especially during well control operations, can be a serious issue, and both API (American Petroleum Institute) and MMS (Minerals

Management Service) require certain measures be taken (see below for more details). For directional changes in piping, common measures include long-sweep ells and targeted elbows and tees.

For those reviewing the available solutions, one consideration is the space requirements of the different options. Long-sweep ells are very effective in most circumstances and create less restriction in the flow, but they don't always fit the allotted space or piping plan. Targeted turns and elbows allow sharp direction changes in smaller spaces and are available in a variety of options.

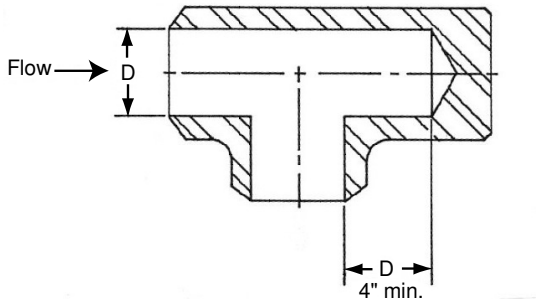

Figure 3 – Quiet zone elbow (weld neck style shown for simplicity; flanged style usually preferred for field inspection and reparability)

The design of targeted turns and elbows varies substantially depending on the manufacturer. Most use either lead-filled targets or "quiet zone" targets. For years the industry standard was lead-filled targets. The soft, malleable lead absorbs the energy of the flow and abrades slowly away to minimize local erosion of the piping itself. However, there is a real risk of a lead plug working loose and taking an unplanned trip to the nearest restriction in your piping, often blocking a valve in the worst possible place.

As a result, the industry is turning more and more to quiet zone targets (figure 3). A quiet zone target is basically a plugged tee, and the theory is that the pocket creates a dead space which, due to the nature of the fluid, deforms with the flow velocity to absorb the forces applied against it. This allows the turbulence to be lower and therefore, the erosion to be less. Based on practical experience with a variety of installations, we have found that quiet zone targets can work well, but their effectiveness varies depending on the design and the circumstances.

Solutions

Consider the application before installing an elbow or targeted turn. For example, it's pretty straightforward to isolate flow through a choke line if a washout occurs, but it's not as simple to isolate flow through a diverter overboard line, therefore that application would be considered more critical.

API RP 53, 3rd edition, sections 10.2.1.h.1 and 11.3.i.1 on choke and kill systems state that large radius bends should have the bend radius equal to more than 10 times the nominal pipe diameter. API RP 64, 1st edition, section 3.5.2 on diverter lines states that the large bend radius should be 20 times the inside diameter of the pipe. Also, keep in mind that the actual process used to make these bends can reduce the thickness of the pipe wall on the vulnerable outside of the curve.

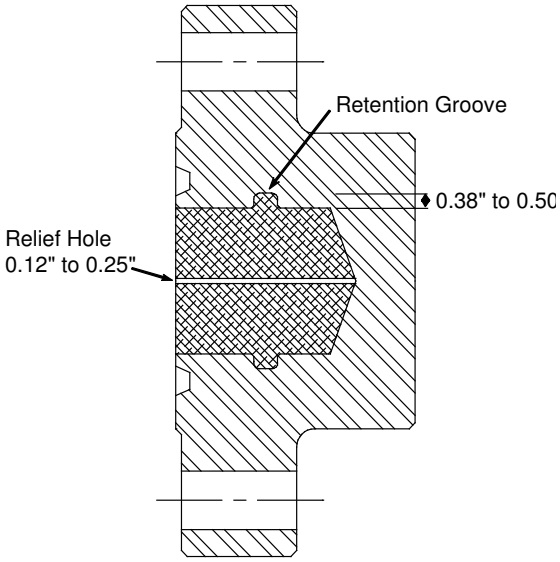

Figure 4 – Lead target with pressure-relief hole

For lead targets, WEST recommends that a hole be drilled through the target to relieve any pressure build-up at the back of the plug (figure 4). We have seen very good success with minimal risk with this modification. Just remember that the lead targets are perishable

and, based on usage, need to be regularly removed and visually examined, especially after a well control operation.

There has been relatively little research into the design of quiet zone targets, and thus there is little consensus on an optimum target configuration. Based on research at Texas A&M University and practical experience, WEST recommends that the still length of the target should be at least equal to the diameter of the pipe, with a minimum length of 4 inches (figure 3). As with all these options, regular inspections should be done to check for erosion and, if found, determining the magnitude and rate of erosion.

For more information or technical questions, please contact WEST Engineering, west@westengineer.com, or call 281-375-5515, or visit our website at westengineer.com.