New Excess Flow Valves for Preventing Side Slope Washouts

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Abstract

Newmont's Cripple Creek & Victor (CC&V) mine operates two valley fill heap leach pads. One of these, VLF1 (Valley Leach Fill), is a 372M ton leach pad that is over 700 feet (213 m) deep in some areas. As the leach pad was built, it has created over 12M square feet (1.11M m^2) of side slope area, which comprises nearly 80% of its leachable area. While these side slopes have been leached intermittently since 1995, they remain a potential contributor to CC&V's production.

There is limited access to VLF1's side slope areas, with most benches just wide enough to fit a pickup truck. This makes them difficult to leach. Moreover, there is a high potential for washouts caused by irrigation drip lines coming loose from adaptors. These washouts can affect multiple benches and access roads on the leach pad, creating safety and environmental concerns and generating costly remediation efforts and production loss.

To address this problem, leach pad metallurgist Zachary Felkey has developed two new excess flow valves (EFVs). EFVs isolate flow when the flowrate through a pipe increases beyond a specified set point. The "Check" and "Eddy" excess flow valves utilize two new mechanisms to achieve flow isolation. These EFVs allow for efficient operation by providing quick interconnections to drip line adaptors, while providing a reliable and robust safeguard to reduce the potential for washouts.

Introduction

Plumbing and installing drip line on the side slopes of heap leach pads presents many challenges, depending on the environmental and physical conditions surrounding the slopes. VLF1 is located at a 9,500 ft (2,900 m) to 10,400 feet (3,200 m) elevation in the Rocky Mountains of Colorado. It presents particular environmental challenges including high wind speeds, thunderstorms, snow, and freezing conditions. VLF1 was also stacked to maximum extents for many years, which has resulted in narrow benches at roughly 100 feet (30 m) elevational lifts.

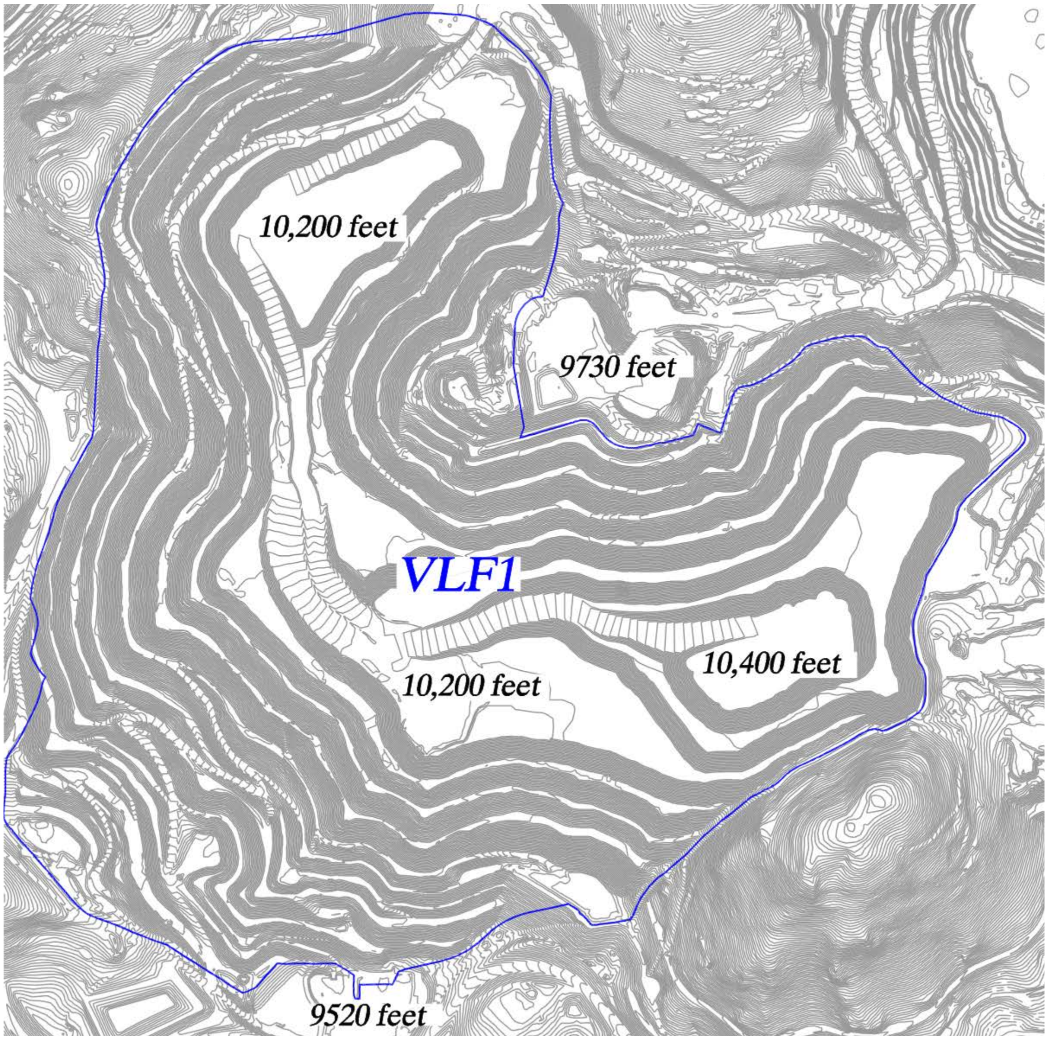


Figure 1: Plan view of VLF1

The process team at CC&V have developed many methods for laying out drip tube irrigation, including winch systems, remote-controlled skid steers, and rebar anchors. Each of these systems has advantages, but the end result is drip tubes on a slope that are exposed to high wind speeds or, if buried, strain from the weight of ore pulling down on the drip tubes. With this tension comes the possibility that drip tubes may be pulled off their adaptors (pop-off).

The resulting high flow rate from a pop-off on a narrow bench side slope panel can either cause a small washout directly below the adaptor, or build a large pond on the surface and result in a large washout. This may cause further pop-offs on either side of the adaptor as the moving ore pulls on additional drip tubes, or in some cases pulls the feed header to the point of breaking.

In either case the resulting damage could cause a geotechnical safety hazard or an environmental release off liner. Remediation including regrading the slope or access road is costly and time consuming, which in turn can cause delayed production.

While training pad crew members to be vigilant in their installation of the drip tube to the adaptors eliminates some of the hazard of pop-offs, inevitably, there will be a poorly installed drip tube that will result in a pop-off. The necessity to leach slide slopes despite these risks facilitated the development of alternative connections of the drip tube, such that pop-offs would not cause washouts. Two alternative connections were invented that act similarly to traditional excess flow valves, which isolate flow when the flowrate through a pipe increases beyond a specified set point.

The Check excess flow valve

The first EFV developed uses a swing check valve and a bushing, which is modified to accommodate a drip tube adaptor. The modified bushing is installed into the feed header in place of a typical adaptor using a close nipple. A coupling and swing check valve are attached to the bushing such that the drip line adaptor fits inside the coupling. For installation, the drip tube is fed into the swing check valve and coupling part while it is separated from the bushing. The drip tube displaces the flap of the swing check valve into an open position, thus holding the flap open when the drip tube is installed onto the drip line adaptor. The coupling and swing check valve part is then threaded onto the bushing, completing installation.

When the drip tube comes off the drip line adaptor due to pressure or stress, the drip tube is pushed past the flap in the swing check valve by the flow of solution, allowing the flap in the swing check valve to close and isolate the flow.

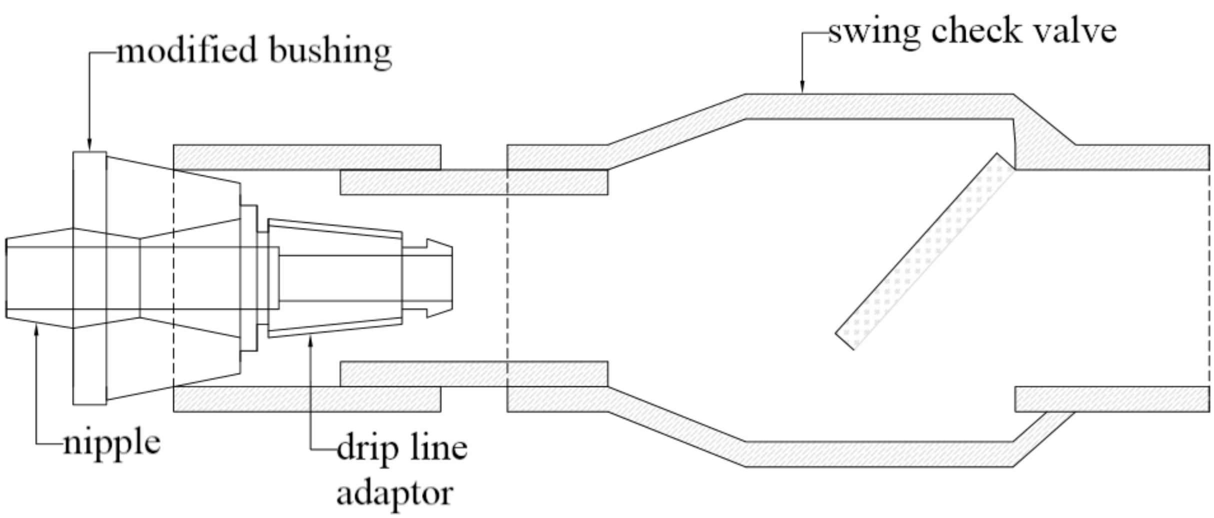


Figure 2: Design of Check excess flow valve

Figure 3: Photograph of the Check excess flow valve

Check EFV findings

The Check EFV is effective in its simplicity of design. In all trial cases, the drip tube would either entirely exit the swing check valve causing it to close, or be lodged in the swing check valve flap causing some solution to flow from the end at a low rate. Full implementation for all side slope panels was commenced in 2017 and continued for about two years before the use of injection wells and sprinklers for VLF1 production overcame the need to leach side slopes.

Before implementation of the Check EFV, side slope leaching required continuous monitoring for washouts from pop-offs that occurred almost daily. This was especially true for panels that were recently plumbed and needed to be subjected to fluctuations in plant feed pressure and settling of ore. After implementation, close monitoring of side slope panels continued, but the occurrence of washouts was reduced significantly. Over the two years in use, the Check EFVs prevented numerous washouts from occurring.

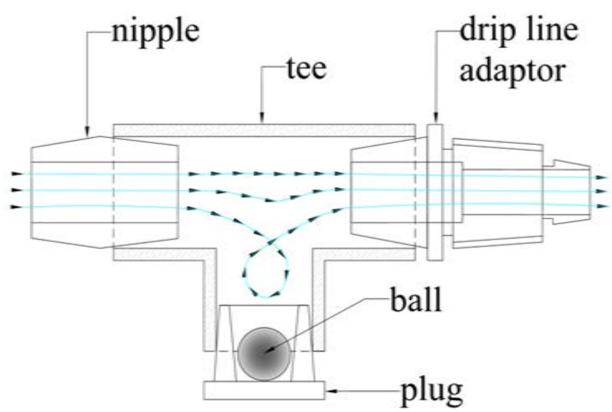
A design flaw was discovered in that the swing check valve would freeze if filled with solution after closing from a pop-off. The frozen swing check valve would crack and spray solution, requiring the swing check valve to be replaced. This was remedied by drilling a small hole in the swing check valve of each assembly. If the swing check valve filled because of a pop-off, the hole would allow solution to flow at a low rate and prevent freezing of the assembly.

Other disadvantages to the design include the necessity for modifying the bushing and assembling the device. A bushing tapped to accommodate an adaptor is not readily available on the market and a method for tapping bushings efficiently was required. A steel template that could hold 12 bushings securely was used to quickly tap them. The cost of each Check EFV is approximately $14. This EFV is considered optimal for plugging solutions since its mechanism is not affected by debris or scale.

The Eddy excess flow valve

The second EFV developed is a tee or wye fitting with a ball in the side outlet of the tee that is plugged off. The tee is installed into the feed header using a close nipple and an adaptor is threaded into the opposite end. When a pop-off of the drip line occurs, the velocity increases through the tee creating an eddy current, or swirling motion; this is sufficient to lift the ball into the straight section of the tee. The ball then lodges into the inlet side of the adaptor, isolating flow.

The size and material of the ball as well as the distance of the ball from the straight section of the tee can be changed for the desired maximum flow rate and solution being used. Upon activation of the Eddy EFV, the ball can be reset by isolating the feed header. If the EFV is faced slightly upward, the ball will roll back to its original position when the line pressure is removed. The Eddy EFV design is a departure from typical excess flow valves in that the flow path of the fluid is minimally affected. No directional change occurs, and no moving parts operate directly in the flow path. The design and operation of the Eddy EFV may be appropriate to other applications beyond drip tube plumbing.



Figures 4 and 5: Design and photograph of the Eddy excess flow valve

Eddy EFV findings

The Eddy EFV operated consistently in all trial cases. Due to the timing of development and testing, the Eddy EFV was never fully implemented at CC&V. However, the test panel on which they were installed operated for six months. During this time there were several successful activations of Eddy EFVs and upon testing of operability at this point, the EFVs were found to still be successful. The small amount of scale that had built up in the EFVs did not have any negative effect on their operation.

A concern that the EFVs may engage prematurely if the panel was turned on too fast was eliminated in testing as the eddy effect of the solution filling the drip tubes was not sufficient to lift the ball. The cost of each Eddy EFV is approximately $4. This design is considered an improvement from the Check EFV in that its size is considerably less, and they are easier to install. However, a concern remains that high scaling and plugging solutions could prevent the ball from lifting.

Conclusion

Washouts caused by drip tube lines separating from adaptors are a significant safety and environmental hazard that can require costly remediation and can delay production. At CC&V, these washouts were a near daily occurrence, requiring continuous monitoring. After implementation of the Check EFV, the occurrence of washouts was reduced drastically.

The Check and Eddy excess flow valves can provide the ability to safely leach side slopes that require feed headers to be near the crest of narrow benches. The Check EFV is advantageous in its simplicity of operation and its ability to operate independent of the plugging and scaling potential of the solution used.

The Eddy EFV is a low profile and cost-effective device for cleaner solution types. The Eddy EFV can also be adjusted in design to accommodate varying flow setpoints for operation and fluid types. It is the hope of the inventor that this design can be used for multiple excess flow valve applications beyond drip tube irrigation that require a simplistic and less flow-path-intrusive design.