ature and/or pressure).
On the other hand, the study found that the mechanical bridge plugs usually have good compressive strength, corrosion resistance, and elastoplasticity [5]. In particular, after the stress is eliminated, the properties can be restored to its original state in a short time. The high strength characteristics of the cement plug can form a floor protection for the wellbore. Mechanical plugs are used in some wells to reduce the amount of cement required to plug a well or to provide additional protection from formation pressure in the well. Bridge plugs are typically made of cast iron with duel slips with a sealing element between the slips. Therefore, the main characteristics of using cement plugs and mechanical bridge plugs can not only improve the sealing quality, but also greatly improve the safety of the implementation of squeeze measures and achieve permanent well closure. By plugging wells correctly, future environmental issues, related to fluid or gas leakage, can be avoided and thereby preserve savings otherwise eroded by remediation or litigation costs.

Best Practices / Tangible Project Outcomes

The plugging and abandoning (P&A) of oil and gas wells that are no longer economically viable for production, or which have wellbore issues that require closure, has historically been conducted as an afterthought in the oil and gas production business. By plugging production wells that can no longer be used to prevent the oil and gas reservoir fluids from migrating uphole over time and possibly contaminating other formations and or freshwater aquifers. A well is plugged by setting mechanical or cement plugs in the wellbore at specific intervals to prevent fluid flow and provide a great environmental benefit by protecting the environment from potential contamination from oil and gas.
Abandoned wells generally have complex downhole technical conditions, and some wells cannot be implemented with conventional well closure methods. According to different downhole technical conditions, corresponding well closure treatment methods are used to implement well closure to ensure the permanent well closure effect. The sealing materials used for well plugging and abandonment must be adapted to the downhole condition changes that take place after well abandonment. Research has lagged on materials and methods for plugging wells although advances in technologies for drilling and completion should be applicable to practices in plugging and abandonment. As a result, many wells are poorly plugged and over time these poor plugging jobs may result in significant environmental problems. For instance, in the gas well area, the cementing of gas wells is a constant issue due to gas channeling. If operators plan poorly for the cementing of a gas well and try to cut costs by using cheaper materials and methods, those gas wells could potentially become a hazard due to gas leaking through the plugs. Actually, if the plug wells are located in a field for which pressure, thermal, and stress state are not in equilibrium at the beginning of abandonment, the downhole condition changes during abandonment can lead to plugging failure or micro-annulus formation inducing fluid leak-

age along the well.

In Alberta, Companies must follow the Well Abandonment requirements in Directive 020 of Alberta Energy Regulator to ensure that the public and environment are protected. First of all, designing an abandonment program to identify any issues within the well that could lead to potential leaks (e.g., cracks) and to identify all oil or gas formations and all groundwater zones that the well passes through. In addition, the company must also evaluate the cement that holds the well in place to ensure that it remains strong and intact. Next, the company must clean the inside of the wellbore to remove any oil or gas that could cause it to corrode or could cause the cement plugs that will be inserted into the well to leak. Any issues identified with the wellbore during the planning phase must be repaired. In addition, all oil or gas formations must be isolated from one another with cement plugs, and any groundwater zones must be isolated from the wellbore to make sure that no oil, gas, or water can travel up the wellbore and contaminate soil or groundwater. The company must then fill the well with freshwater or other noncorrosive fluid and assess the well to ensure there are no leaks.

Combining the consideration of this work, the best practice outcomes for permanent abandon of oil & gas wells is to apply cement plugs and mechanical bridge plug and ensure that plugged well is not exposed to the high pressure and/or high-temperature variations which might induce the fatigue and plug failure. If normal operating conditions are ensured the cementing the well is recommended practice that provides certainty in ensuring the proper sealing of the well. In general, setting a permanent bridge plug within 15 m above the liner top and the cement top behind the casing extends above the top of the formation and the depth is below the BGWP. Once the bridge plug has been set, it must be pressure tested at a stabilized pressure of 7000 kPa for 10 minutes. The plug must be capped with either a minimum of 8 vertical meters of class “G” cement or with a minimum of 3 vertical meters of resin-based, low-permeability gypsum cement.