NATIONAL UIC TECHNICAL WORKGROUP
FINAL WORK PRODUCT #5

Use of Annulus Additives to Address Leaks in Deep Injection Wells

ISSUE

Operators of wells sometimes request permission to attempt to stop leaks in injection wells by the use of additives to annulus liquid. Any leak preventative should be allowed if its ability to stop or slow leakage and allow for monitoring to detect future leakage has been effectively demonstrated. This guidance describes the assurances which the USEPA believes are appropriate when means which appear to be less substantial than oilfield tubulars are used to protect underground sources of drinking water (USDWs) from contamination by injected wastes.

BACKGROUND

Mechanical integrity (MI) is defined in 40 CFR §146.8(a) as: "(1) There is no significant leak in the casing, tubing or packer; and (2) There is no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore." The maintenance of MI is a very important part of the Underground Injection Control (UIC) program because MI allows real-time determinations that no significant amount of injectate is leaking through the well's tubing and packer, which are the first line of defense against contamination of USDWs by injected wastes. This report relates only to §146.8(a)(1), the internal portion of mechanical integrity.

Some leaks, particularly tubing and packer leaks in wells which maintain a greater pressure in the annulus than in the injection tubing (referred to as a positive pressure differential), cannot cause environmental contamination. However, they may have a significant impact on our ability to detect, in a timely manner, other leaks which can cause environmental contamination. Because of this, all leaks must be dealt with effectively.

Leaks in injection well components can be eliminated through a number of procedures including:

1. Resetting the packer;
2. Replacing the tubing;
3. Squeezing - cement may be forced through a casing leak;
4. Recasing - all or part of the well;
5. Cementing the tubing into the well
6. Setting mechanical casing patches of various kinds; or
7. Adding materials to the liquid in the annulus to change the properties of the liquid to prevent or diminish flow through the leak or to mechanically plug the leak.

The costs of using some of these procedures may be high both economically and operationally. Economic cost derives from the material and technology utilized, and operational costs derive from down time and possible reduced injection rates resulting from reduction in tubing size. In the past, the use of a particular liquid additive which can temporarily increase the viscosity of the annulus liquids to slow or stop small leaks which have caused a loss of MI has been denied. This was done because the particular additive was not designed for the use requested, the manufacturer made no claims for permanence, and stated that the effective life of the product is likely to be of short duration (i.e., no more than six months). Reliance on the use of additives to the annulus fluid to provide a permanent solution to leakage has been controversial because of the untested belief that additives to the annulus liquid will not provide long-term sealing properties.

However, several leak prevention products are now in development and their success with some unconventional applications has been reported. This being the case, it is important that the UIC program consider demonstrations of the use of these additives in preventing or permanently stopping leaks while allowing compliance with other UIC requirements.

CONSIDERATIONS

The critical issues in formulating a program policy regarding the use of chemical or mechanical sealants in well annuli which have lost MI are:

1. Does the sealant allow transmission of pressure throughout the annulus so that new and continuing leaks can be detected?
2. Does the additive offer a long-term solution to the problem?
3. If the sealant fails, is there an annulus monitoring system in place capable of timely detection of the loss of MI?
4. Will USDWs be protected from contamination in the event that there is failure to totally eliminate leaking or a failure of the sealant at a later time?
5. In the event the additive does not work and migrates out of the annulus, are its properties such that it cannot contaminate a USDW?
6. Will the additive remain suspended within the annulus fluid and not settle on the packer and inhibit its removal?

Positive answers to these questions assure that there will be no environmental impact resulting from the use of repair which may prove to be temporary.

RECOMMENDED APPROACH

A. Conditions Under which Additives to the Annulus Liquid may be Used

We recommend that injection well operators be permitted to attempt the elimination of leaks, at the UIC Program Director's discretion, by means of either:

1. Chemical additives which increase the viscosity of the annulus fluid; or
2. Materials which can mechanically plug small leaks when added to the annulus fluid

under the following conditions:

1. The leaking well component must be known (i.e., tubing and packer or casing) and, in the case of a casing leak, located;
2. Any leak in the outermost casing must be below the base of the lowermost USDW if leakage of injectate or annulus fluid may cause a violation of any national primary drinking water standard or may otherwise adversely affect the health of persons;
3. If the leak is in the outermost casing, the well must have part 2 of MI and it must be demonstrated periodically (e.g., that is, cementing records cannot be accepted as a demonstration of MI);
4. The additive will allow transmission of pressure throughout the entire tubing- casing annulus from the wellhead to the packer;
5. The annulus pressure and/or liquid level are frequently monitored and reported along with additions of liquid to the annulus system so that any increase in leak rate will be identified in a timely manner;
6. The potential for contamination of USDWs must not be increased as a result of any means used to restore MI.

If the additive should fail to prevent or decrease the leak as required and the well cannot demonstrate MI, the Director will request the operator to discontinue the use of the additive and repair the well mechanically, such that MI is achieved, or plug and abandon the well in accordance with prescribed plugging and abandonment practices.

B. Approval of Additives

Additives must be individually tested and demonstrate their effectiveness. An operator applying for approval of the use of any additive for restoring MI must provide documentation of tests that demonstrate the ability of the product to prevent annulus liquids from flowing through simulated leaks. Any additive used to restore MI must be marketed by its manufacturer for the purpose of stopping leaks for the long term. The manufacturer must stand behind the product and be willing to work with injection well operators and the USEPA to develop a testing and use history which will provide assurance that the product is effective.

Thus far, no additives have been approved for the purpose of restoring MI. The burden of demonstrating that a particular additive is appropriate for restoring MI must rest on the applicant. The USEPA may be able to assist with the testing of the additive through the availability of test wells located near Ada, Oklahoma. These test wells have been constructed so that leaks can be simulated, controlled, and evaluated.

When each additive is approved, an update will be added to this document in the form of an attachment which will describe the approved additive and its qualities.