Authors’ Closure

Equipment Design Considerations for Lime and Ion Exchange Treatment of Produced Water in Heavy Oil Extraction
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We wish to thank John Fair for his discussion of our paper and for the additional information he has contributed to this subject and to respond to some issues raised.

It was not our intention to indicate that capital cost and intense sales efforts were the only factors in performance problems encountered in the “oil patch” of Alberta. There are many factors and John has broadened the list. As stated in his discussion, inexperience in the work force plays an important part and applies to every facet of projects built and in progress – from conceptual phases through engineering, procurement, construction to start-up and operation.

As many of us with experience know, water availability, quality and treatability are often the last things considered even though crucial for a successful and profitable operation.

We appreciate the addition of some of the basic descriptions and definitions that we were unable to include. Indeed, the selected topic was formidable and could fill several papers given time and a forum.

The suggestion that changing a chemical regime might help prevent oil passage into a lime softener is somewhat like closing the barn door after the horse is stolen. Without the proper equipment in place in which to employ a treatment chemical operating results may be inefficient, ineffectual and costly.

While externally regenerated ion exchange systems decrease potential for lining failures, they should not be considered as a substitute for efficient oil removal upstream of the water treatment processes.

We did not suggest that adding straight side to a hot lime softener was either practical or recommended practice to limit rise rates. Once a hot lime vessel reaches a certain diameter, it becomes tear drop shaped and straight side is not necessary unless extra volume is required. The basic volume is fixed by 60 minutes for treatment plus any required storage compartments. Rather, we expressed concern that some designs place internal compartments where they cause high rise rates in the settling zone. A suggestion we did not include is to use external storage to provide more storage of backwash water in storage tanks that need not be pressure vessels.

The total detention time provided in warm lime softeners is a function of the diameter required to attain a design rise rate and the depth of tank required to accommodate the internal draft tube and slow mix region with its required detention volume. At low flow rates diameters are smaller and detention time may be 60-90 minutes while higher flow rates result in detention times of 180-240 minutes. Our concern is that the unit be equipped with sample connections and/or monitoring provisions that allow the operators to see the results of changes in operation in a few minutes rather than in hours dictated by long detention times.

We would welcome publication of experimental results of filter backwash rates at the temperatures encountered in hot and warm lime treatment. However, the AWWA experiments are limited to temperatures usually encountered in potable water treatment. The data included in our paper is based on filter anthracite and media size is likely in the 1.0 mm range as used in potable water filtration. Higher density media such as siliceous sand might require even higher rates. However sand would leach silica into warm and hot lime effluent so will not be encountered in treating produced water.

Resin may be left behind in an externally regenerated ion exchange unit because of inefficient underdrain design as well as by clumping of resin due to oil fouling and other contributing causes. The underdrain must impart sufficient velocity to sweep the entire vessel bottom free of resin, moving it to the resin outlet, while not creating physical barriers to resin movement. Oil contamination makes this operation more difficult.

Once again, we wish to thank John Fair for commenting to our paper.