

**VIRGIN GRADE ACTIVATED CARBON WILL OFTEN
CAUSE A pH RISE IN INITIAL EFFLUENT
IN A WATER TREATMENT SYSTEM**

by Mike Mullaney

I. What causes this problem?

Traditionally, the presence of soluble ash material in virgin grade activated carbon was offered as a possible proximate cause of the observed pH spike in the effluent of water treatment systems. The decay of this pH spike (Figure 1), and its return to original levels was thought to result primarily from reducing the ash constituents in the carbon through washing of the bed over time. Recent studies show, however, that carbon de-ashed to 0.2% ash content still exhibits a large initial pH spike (R. Farmer, personal communication). Obviously, the traditional "ash explanation" is flawed.

A relatively new and stronger explanation for the "pH spike" problem is that an ion exchange mechanism occurs at the carbon surface (Figure 2). In water treatment systems using virgin grade activated carbon, a three-way interaction occurs between 1) naturally occurring anions (SO_4^{2-} , NO_3^- , Cl^- , PO_4^{3-} , and F^- in order of decreasing strength); 2) natural cations (H_3O^+ and Ca^{2+}); and 3) the surface groups on the carbon. Sulfate, typically the strongest anion, is removed from the influent upon interacting with hydronium (H_3O^+) at the heterogenous carbon surface (Fig. 2). As a result, $(\text{OH})_2$ is freed as a titrated base, causing an increase in pH. This pH spike levels off and returns to normal as adsorption sites become saturated.

II. What is the degree of this pH rise and how long will it last?

The duration of the pH rise depends on the ion composition of the influent water. Typically, the lower the influent pH, the higher the effluent spike will be, and vice versa. The pH rise reaches 8.5 to 9.0 typically, but spikes as high as 11 have been reported, well in excess of the Safe Drinking Water Act upper limit of 8.5. As for duration of the pH rise, previous pH levels may not return to the effluent until after 800 bed volumes have passed through a Model 10 system. This is roughly equivalent to 4 million gallons.

III. What can the customer do if this is a problem?

The simplest solution to pH problems is to add acid or base to the effluent in order to reach the desired pH level. Another solution would be to de-ionize the water before carbon treatment. De-ionization, however, is often not a very economical solution.

IV. What can we do for the customer?

The primary help we can be to the customer is to let them know what to expect in terms of the extent and duration of the pH rise. For instance, the customer needs to know they may have to allow 400 to 800 bed volumes of effluent to pass through the system before the pH