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THE BIRTH OF A CATIONIC POND SEALANT*

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I want to thank the members of the American Fisheries Society for inviting us here to present our paper, "The Birth of a Cationic Pond Sealant." Having chosen this metaphor, I'd like to begin by reminding you that this was no simple birth. The gestation period, as you will discover, required nine years of hard labor.

In our paper we will attempt to give you a brief outline of the development of a cationic pond sealant which has been named POND-SEAL TM.

Nine years ago, Armour embarked upon a program to develop a chemical which would help to conserve one of our vital resources—water. As we all know, water is lost through seepage, evaporation, and useless transpiration. To give you some idea of the staggering sum of water lost through seepage each year from farm ponds in the United States alone, I would like to give you some figures. There are approximately 2.25 million farm ponds in the United States.[3] The farmer relies upon these ponds for irrigation, water supply for his animals, wildlife conservation, and fire protection. The average size of these ponds is one acre at a depth of three to four feet. One acre foot of water is equivalent to 325,851 gallons.[4] Thus, the average farm pond holds 1,300,000 gallons of water. If we multiply this figure by 2.25 million (the number of farm ponds in the United States), we arrive at a total of three trillion gallons of water contained in farm ponds of the United States. (For those of you who don't include this figure in your budgeting, this is the number three (3) followed by 12 zero's.) Now, if only two inches per day were lost from these ponds—two inches in some cases is a very minimal seepage loss—if only two inches were lost per day, this would amount to an annual water loss of forty-seven trillion, six hundred thirty-two billion, five hundred million gallons (47,632,500,000,000 gal-

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[2] Pennsalt Chemicals Corporation, Tacoma, Washington.

[3] E. L. Gambell, "Two Million Farm Ponds Backstop America's Streams," 1966 Annual Meeting, Soil Conservation Society of America.

[4] Calculated.

lons), or the equivalent of nine times the annual discharge of water from the Mississippi River into the Gulf of Mexico.[5]

Now, of course, all United States' farm ponds do not lose two inches of water per day through seepage. But even were they to lose only one millimeter of water per day, this would still amount to about one trillion gallons of water lost per year. With losses of this magnitude, water seepage from ponds represents a significant conservation problem.

In the past, water seepage in ponds has been controlled by bentonite, polyphosphates and other chemical sealants, butyl rubber, polyvinyl chloride (PVC), and polyethylene linings. These have all proved to be inadequate for various reasons. Bentonite has to be admixed or blanketed with the underlying soil of a dry pond or reservoir. Frequently, the effectiveness of bentonite cannot be guaranteed. In addition, bentonite is not always readily available and can be prohibitive in cost. Polyphosphates and other chemicals often react with minerals dissolved in the water and are limited to soil type.

Butyl rubber, polyvinyl chloride, and polyethylene must be applied to dry pond beds, freed from sharp objects, and also should be covered with a layer of fine textured soil to insure longevity. Obviously, this method is expensive and, in many instances, impractical. If a crack develops in the linings, the resultant seepage is equivalent to an unlined pond.

By analyzing the limitations of the available sealants on the market, Armour researchers established that the following parameters had to be met for a successful sealant:

1. Because the majority of soils are negatively charged, the preferred pond sealant would be cationic in nature, thereby having a built-in affinity for the underlying soil.
2. The research group wanted to develop a waterborne pond sealant, because of its ease of application and versatility. This meant that the sealant could be applied without first emptying the pond.
3. To facilitate application, the sealant had to be applied at ambient temperatures, effectively applied as low as 40°F.
4. The ideal chemical sealant would have to be nontoxic to humans and animals, and would have no adverse effect on water quality. Toxicity data was obtained from independent test laboratories.
5. In setting our durability and effectiveness standards, we decided upon a 70% reduction in seepage and effectiveness of three to five years.
6. Armour scientists wanted the pond sealant to be effective over a wide range of water and soil types.
7. The pond sealant under development would have to be competitive with those currently on the market and within the grasp of the average farmer.

Here are some selected slides from an actual field test at the Georgia Game and Fish Commission Hatchery located in Dawson, Georgia, which will illustrate how these parameters were met. The mechanism of PONDSEAL is one whereby positively charged PONDSEAL droplets are attracted to negatively charged soil. On contact with the underlying surfaces, they displace water and immediately adhere irrevocably to prevent stripping. They plate out and in the underlying soil. Here is an actual section of the sealant as taken from a sealed pond.

Here you can see that the sealant is easily added directly to the pond, so that there is no need to empty the pond before applying the sealant. In this way, the aim of ease of application was achieved.

For a slower rate of addition, PONDSEAL may be gravity fed through a garden hose as illustrated in this slide.

As you will note from this slide, the cationic pond sealant is self-

[5] Encyclopedia Britannica, 1966, XV, 585. (724,000,000,000 cubic feet of water is discharged from the Mississippi River into the Gulf of Mexico per year.)

dispersing, requiring no mechanical agitation. Thus, no auxiliary mixing equipment need be used.

The treated pond is safe to humans and animals immediately after treatment. As a matter of fact, even undiluted PONDSEAL presents no hazard to health under ordinary conditions of use.[6] Fish that are in the pond when PONDSEAL is applied, however, will suffocate from the suspended asphalt particles. Fish toxicity studies[7] have shown the LC_{50} for rainbow trout to be 30 ppm at 3 hours, 62.5 ppm at 24 hours, and 40.0 ppm at 96 hour exposures in 15-gallon jars having no seepage. These containers did not contain soil and were treated at a rate of ½ gallon per square yard of bottom surface. PONDSEAL is less toxic when applied to seepage reservoirs containing soil. When the water clears—usually within 72 hours, but in some instances as long as two weeks—a pond may be restocked with fish. This slide shows a dog swimming in a treated pond in Arizona without any adverse effects. Thus, the goal of a sealant which was safe to use was met.

As the technical problems of a cationic pond sealant were being solved, Armour began the commercial development program with extensive field tests, especially in the western part of the United States. At this point, Pennsalt, due to their concentration in aquatic chemicals, became interested in the pond seal project and teamed their commercial development activities with Armour's. Other field tests were then arranged under joint participation.

As part of the field tests at the State of Georgia Fish Hatchery, Armour and Pennsalt scientists, together with the Georgia Game and Fish Commission, will determine this November what effects, if any, the sealant may have on the reproductive processes of the fish population. According to fish biologists, no adverse effects on the spawning characteristics of the fish are expected. These results will be available in the near future.

Over the past five years, numerous tests were conducted of different formulations applied to varying soil types and in various parts of the country. At the test sites, water seepage was monitored before and after treatment. From these studies, we have concluded that we can obtain a seepage reduction of at least 70%, especially in cases of high seepage loss. A recent field trial in Arizona resulted in 99.2% reduction in seepage in a newly constructed pond with a pre-treatment seepage rate of 3.5 feet per day. At the Dawson, Georgia, hatchery, pre-treatment seepage was two inches per day. Preliminary data indicates a 55% reduction in seepage, probably due to extensive vegetation in the pond. But if the test pond follows past trends, seepage reduction should increase with time.

The commercial development program will continue in the direction of determining the long-term effect of PONDSEAL on fish and its effectiveness in various geographical soil types. Pennsalt Chemicals Corporation and Armour Industrial Chemical Company have jointly participated in the commercial development activities to date and will continue to do so in the future. Pennsalt Chemicals Corporation will be the sole marketer of the cationic pond sealant.

Ladies and gentlemen, we would not want to close without mentioning the vital assistance and encouragement given us by the United States Water Conservation Laboratory, United States Department of Agriculture, Phoenix, Arizona; the Bureau of Reclamation, United States Department of the Interior, Denver, Colorado; and the Georgia State Game and Fish authorities who aided us in developing a safe and effective pond sealant.

[6] Rosner-Hixon Laboratories, Chicago, Illinois.

[7] Conducted by the Bureau of Sports Fisheries and Wildlife, United States Department of the Interior, LaCrosse, Wisconsin.