Digester at OSU is Up and Running after a Successful "Cold Start"

In August 2008, manure began flowing into the Anaerobic Sequencing Batch Reactor (ASBR) located at the OSU Swine Research and Education Center. A year later, we are very happy with the results. Organic Matter loading on down-stream lagoons has been reduced 75%, and we are producing 8.8 btu's per day of heat energy per pound of liveweight housed on the farm.

An ASBR is a type of anaerobic digester designed specifically for the dilute manure flushed from pull-plug swine barns. An ASBR gets around the problem most digesters have treating dilute manure –size. Normally, the length of time liquid has to stay in a digester, the Hydraulic Retention Time (HRT), needs to be long enough for methane producing bacteria to grow and multiply, and that can be up to 30 days. With an ASBR, we can cut HRT down to about 5 days because bacteria are trapped in the reactor through a sequence of settling solids and draining liquid from the top (Figure 1). As long as the average age of the settled solids remaining in the ASBR is more than 30 days old, the bacteria settling with them will continue to produce biogas.

Usually, we would like to start an ASBR with a full charge of methane producing solids. This is done by taking active sludge from a lagoon or a sewage treatment plant's digester and adding it to digester so that the solids content of the mixed digester is about 1% by mass. Charging with a bacterial culture is called a "Hot Start". We didn't have this luxury when we started the digester at OSU. First, Dr. Penn removed most of the sludge from our covered lagoon on the swine farm to test tree growth in sludge amended soils. You read about his experiments in the March 2009 issue of *Pork Pages*. Second, we could not find a sewage treatment plant

willing to give us 6,000 gallons of sludge without causing a headache with their permit. So, we decided to use a method known as a "Cold Start".

To cold start the digester, we first filled it with water, and then slowly began adding manure until the reactor began to produce gas. The ASBR produced enough gas to inflate its cover within a week. Once we were satisfied with the gas production, we began operating the ASBR with one fill-react-settle-decant cycle per day. By December 2008, total solids concentration in the reactor reached 0.5%, enough to say we had a viable mass of methane formers. We then shut the digester down for two months.

On February 2, 2009 we re-started the digester, passing all of the manure produced on the farm through the ASBR, feeding one cycle per day, with an HRT of 20 days. At first we had some trouble with scum formation and poor settling, but once accumulated solids reached the ideal 1.0% in mid June, things shaped up and the reactor has been running like a charm ever since.

Figure 2 shows how well the ASBR is performing.

Solids Retention Time (SRT) is a measure of how long methane forming bacteria remain the reactor. It is calculated by dividing the total mass of solids in the digester by the average mass leaving each day. Since we have not removed any sludge yet, the only way for solids to leave is when liquid is decanted. SRT steadily increased as solids accumulated in the ASBR until about day 80. Solids were still accumulating after day 80, but we could not measure them because of the floating scum. On day 120, we gave the ASBR a good mix, and SRT began increasing rapidly.

One reason SRT increased so quickly after day 120 was because solids were settling better; therefore, less solids left with the decanted liquid. This can be seen in the Organic Matter Removal Efficiency (OMRE) data given in Figure 2.

OMRE is the daily mass of organic matter -- measured as Volatile Solids (VS) -- removed by the reactor, divided by the mass entering the digester every day. VS are removed by conversion to biogas and settling. The OMRE has been slowly increasing, with a few ups and downs, since we restarted the ASBR. We are expecting the Volatile Solids OMRE to level off between 70 and 80% as we continue operation.

Figure 3 shows the amount of biogas produced per mass of volatile solids added to the reactor. The amount of gas produced in the ASBR has steadily increased throughout the start-up period. We expect the average value to level off to 0.8 cubic meters per kg VS fed. This is a good result. For finishers, this could produce about 170 kwh/day of electrical energy per 1,000 hogs at 50 pounds liveweight, and 430 kwh/day at 275 pounds.

Overall, we have had a successful cold start of the ASBR. We would expect the same results with a hot start, only we should have arrived at this point quicker – 6 months instead of a year. Between now and December, we will slowly transition to optimal performance: decreasing HRT to 5 or 6 days, wasting sludge to maintain SRT around 60 days, and increasing to 2 or 3 cycles per day. We are expecting gas production and organic matter removal to remain as high as they have been through the start-up period.

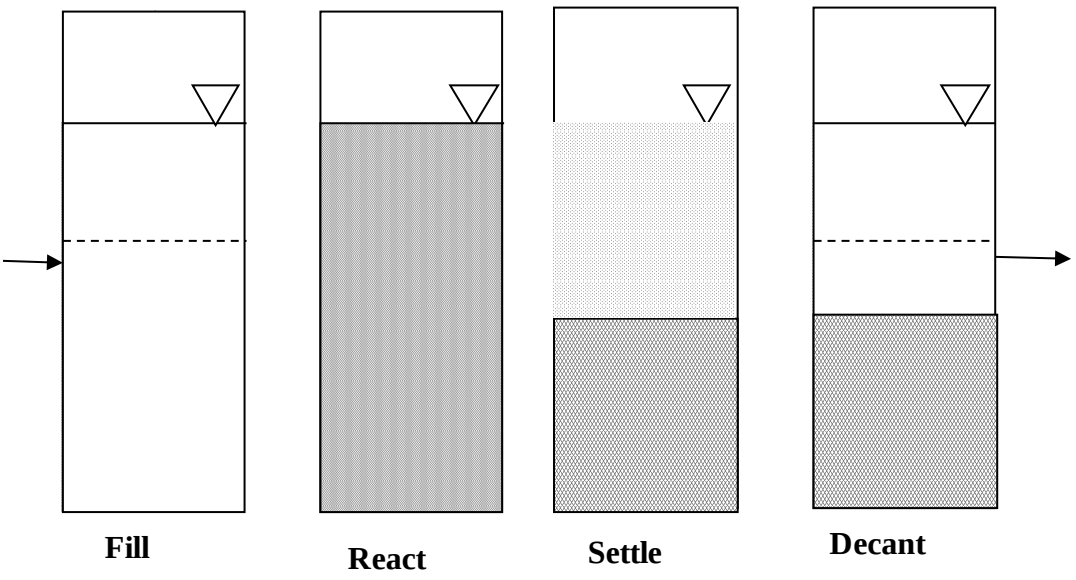

Figure 1. Four Steps in One ASBR Cycle.

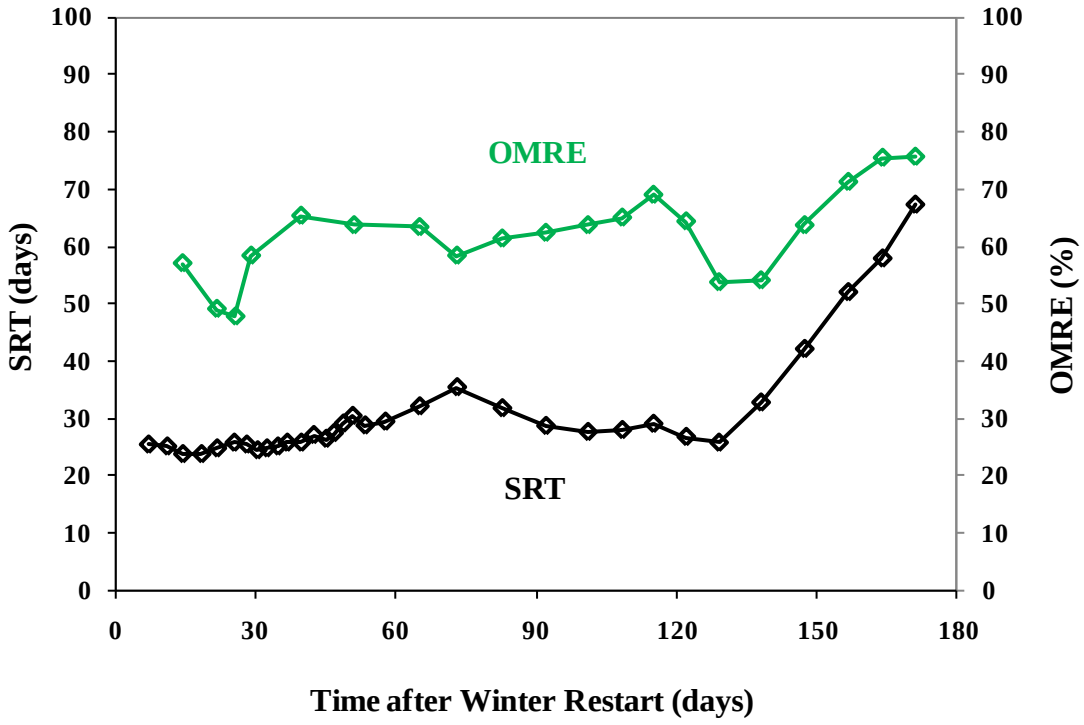

Figure 2. Solids Retention Time and Organic Removal Efficiency during Restart of the ASBR at Oklahoma State University.

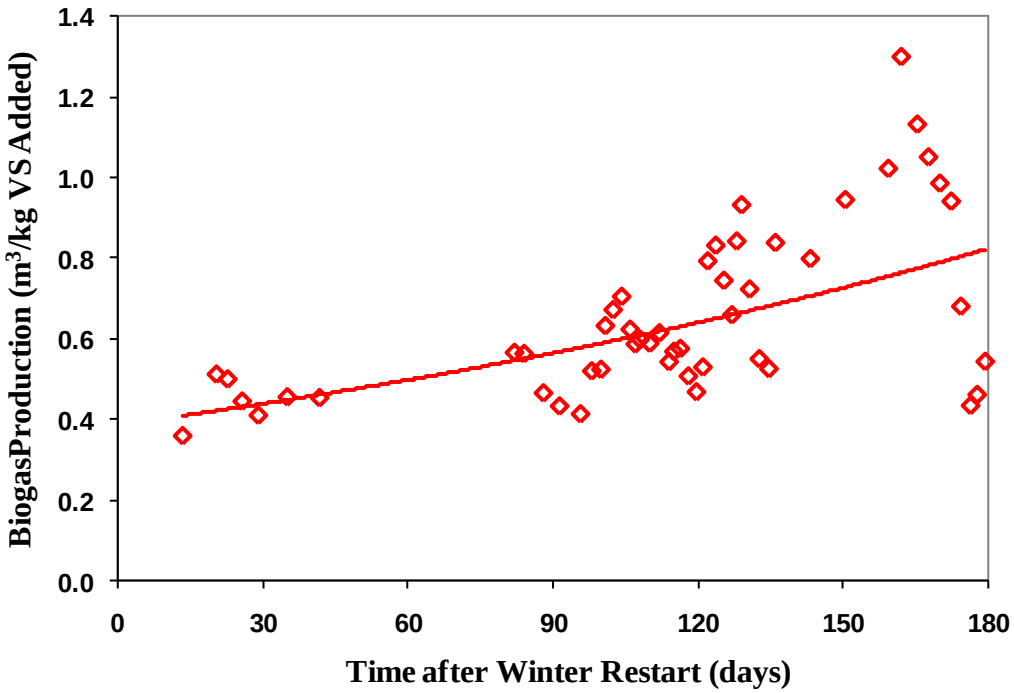

Figure 3. Biogas Production per Mass of Organic Matter Fed to the ASBR at Oklahoma State University during Start-up.