AD 101

Mark Moser, RCM Digesters

My name is Mark Moser. I'm with RCM Digesters, out of Berkeley, California. Chad asked me to address the status of RCM Digesters on the market today and give you a little benefit of our experience. The message of my talk is going to be that anaerobic digesters are not a risky technology. For somebody who knows what they're doing, they're going to give you a reproducible result, something that will operate as expected and something that will be of benefit to the farm.

I've had a few questions already this morning about affordability or it's not going to make any money. My answer is, if it's not going to make any money, why do it? There are plenty of places around where digesters provide economic benefits to the farm. The worst thing you could do is force a digester into a situation where somebody is going to hate it or lose money and then hate it. So we work with willing clients and we develop solutions to their problems.

Thanks, Phil, for giving such a great introduction. As Phil said, you put the more digestible portion of the total solids (the soluble solids) in the digester and the bacteria eat those and fart methane. Our company does only anaerobic digesters and that's all we've been doing for about 20 years. We have 40 digesters running today with about 25 in the U.S. We have four digesters running in Japan, seven running in Chile, had one running in Ireland, and did a demo in South Korea. We don't have just one type of digester—we'll do what's appropriate. All of our digesters are developed for farms. We're not an industrial process trying to backfit itself.

I came out of Cornell University with a master's degree in agricultural engineering and had the opportunity very early on in the development of anaerobic digestion to do basic research. I thought it was pretty cool. That's actually how I ended up doing this. I could have gotten a job, but then I had an opportunity to work on the Mason-Dixon Dairy Farm which was the first large dairy digester in the country, and I got hired because I knew just a little bit and it turned out I knew a little bit more than the people who were working on it, so I ended up being the site engineer and got the system going and the rest is history. We started out building one at a time, figuring out what worked, what didn't work. Twenty-four or 25 years ago when Mason-Dixon was going on, basically it was just a concept at that point. Sanitary engineers got together with some ag engineers and strung together a bunch of things and we were just darned lucky it worked. Not everything worked, but that was what we spent the next five years working on.

One thing I did learn is that you need profitable solutions. You don't need another anchor on your farm and I'm sure you have a few places to bury money already. So the objective of RCM Digesters is to develop a solution to meet your need. We have four different basic classes of digesters and we can deploy them in different situations to solve different problems and come up with a reasonable solution. In terms of flush dairies, we favor covered lagoon digesters. It is just, simply stated, a big dumb hole in the ground with a floating cover on it. Fairly easy to build, unbelievably simple to operate—if it's done right.

We're located mostly on dairy farms with less than 2% solids where flush collection is the technique that's being used. We have two dairy flush lagoon digesters in California, one at Cal Poly San Luis Obispo and one at Larry Castonelli's. We have six or seven operating in the hog industry, one in North Carolina, three or four in Chile. So we've had a lot of opportunity to work with the system. It's simple, it's reliable. Very simply, you're flushing your manure, taking the floatable solids out with a screen-type separator, putting the remaining liquid with the fines into a digesting lagoon. It's sized and configured to optimize gas production. It will actually work in any climate, it just won't work as well. We favor them in warm climates because we get continuous gas production.

I have that same slide from Oklahoma that Phil had on gas production. The colder the climate, the colder the lagoon gets in the winter and the less gas it produces. So if you go to Wisconsin in a place like Emerald Dairy and the other one, two dairies owned by the same guy, and throw a cover on a lagoon—he makes a burnable gas from probably April to October and then it gets cold enough and the system goes to sleep. So if you were going to invest all that money in a covered lagoon in a climate where it's going to go to sleep, there has to be a real advantage to just making seasonal electricity. In some cases it might work, in some areas it might be very favorable. Around here I don't think you have an extremely high electric rate that would justify it, so the reason for a covered lagoon in some places might be simply for odor control.

This is one of our more recent projects. It's Castonelli Dairy in Lodi, California. I was there yesterday with a little tour group. We've been running since March 2004. One thing that has changed over the years is that covered lagoon startups are not a one- to two-year proposition. We can generally bring them online in three months or less. This is a very complete system and in this area you don't have to worry so much about rainfall but in Lodi they get 20 to 24 inches of rain. This year they've gotten a lot more than that, so what we're seeing here and you'll see in the

next slide is a precipitation removal system, we're sealed at the edges, all the water is conducted to the center and then pumped off. It's clean water so it just goes out in a ditch and is not a problem. There has been a lot of consideration of this in the wetter climates.

This happens to be a covered lagoon for a hog farm in North Carolina where, if you get four feet of rain, you don't have to worry about the space in your lagoon. He just pumps it off.

Julian Berryman is running since 1997 and I'll talk a little bit more about him later because he was a victim of his utility. It's a great project and makes lots of gas. The utility learned to change rules.

That's what we do right now with our thin flush manures. For thicker manures, that would be a 3 to 8% total solids, and in the dairy industry that would be a scrape system where you're mixing your scrape manure with your parlor flush, parlor wash water, you'll get down around 3 to 8% solids. It also is a situation where if you were take a flush and concentrate the solids you would have a digestible mix in this 3 to 8% solids range.

Now, once you get down to that range with dairy cow manure, it doesn’t hang together. If you leave it in a tank without mixing of some sort, it's going to separate into floatables and into settleables. Anybody who has a dairy lagoon that they threw solids into knows that. So we stir it mainly to keep it from filling up with solids.

This is a heated type of digester. Once you get to 3 to 8% solids, you're going to have to maintain it hot because if you don't it's going to go acid on you and die. Heating a digester is what we do, we're very good at that. You're going to want to run it around 100°F; it's called mesophilic digestion. There are some thoughts and considerations and there are some people out there talking about thermophilic digesters.

I'm going to digress from what I had planned to say here. We’ll talk just a second about thermophilic digesters because it's a concept, it's a technology, it's demonstrated in Europe. Most everyone who runs one is wearing a white lab coat, carrying a beeper, and may have their control module with them so they can dial in and adjust the digester. They are highly developed in Europe, they're touchy compared to a mesophilic digester or heated digester where you have 20 or 25 different methane bacteria that participate in actually producing the methane. In a thermophilic digester, you're down to 4 to 5 different types. If you have 20 bugs and you happen to lack something that kills one or suppresses it, you still have 19 others that are going to take

over. If you get into a thermophilic situation, you have four different bugs, you suppress one, well, 25% of your potential (good guys, bacteria working making gas for you) just left.

The principal reason for thermophilic digestion in Europe has nothing to do with performance in terms of biogas production. I was on a trip in Denmark and on a panel with the head of the Danish Veterinary Service, and had a little talk; the Danes promoted thermophilic digestion primarily because most of their digesters are combined digesters where they are receiving waste from a multitude of farms, cattle, pigs, chickens, meat-packing, sludge, so they went thermophilic for sanitary reasons, for pathogen kill. Thermophilic does make more gas in the first 12 days. If you run it out to a certain point, heat makes gas faster, so if it's thermophilic you can make more gas faster than mesophilic. But at 20-25 days, the two systems got about the same results. I think the literature gives you 9-10% at 15 days as far as an advantage, but European literature doesn't go out 20 days because they don't operate that way.

That's a little bit of a sideline on complete mix digesters. Complete mix digesters or the 3-8% total sludge digester is your most flexible unit. They are usually designed and promoted because you can throw virtually anything in them that will digest, and as long as you know how to control the process, you're going to get your results. So, as I just mentioned, the Europeans throw everything in them. Basically if you have a high price for power, you make as much gas as you can, so you throw everything you can get your hands on into it.

I prefer mesophilic. They are much more forgiving on farms, they can take a lot of abuse, they are very robust. By abuse, I mean, we went on vacation for a week, I left it with somebody to run, he fed it every third day. We came back, it wasn't running quite right, but we straightened it out in a day. If you did that to a thermophilic digester, you'd have big problems. All of our farm systems have been designed for farm operation. I know who's going to run the digester, so we're designing for that person who will run the digester. We've taken most of the thinking out of it—minimum controls—only a few things you can adjust; if you have dials, we'll even mark a spot, "match the arrow to this," because the owner may not be out there doing all the operations and inspections, so the guy who needs an explanation, all you say is, "match the marks." That's a key issue in keeping digesters running.

For complete mix digesters, this is one of ours in Clybourn, New York, at a 900-cow plus dairy that takes all the parlor water plus everything you can possibly imagine for 20 miles around. We're getting Mrs. Paul's fish sticks and we're getting ice cream waste, waste milk and

some whey, and the bottoms of Welch's grape juice. Gas production ranges from a minimum of 100,000 cubic feet of gas to typically 200,000 to 250,000 cubic feet per day, depending on the waste deliveries. It was designed for about 225,000. The farmer is making about 130 to 150 kilowatts per hour, the rest of the gas is being used in an experimental food dryer.

I should mention a similar system, the RCM Digester, which is a tank in the ground. This is gas collection. Those bubbles are full of gas, serves as both the gas collection and roof structure. They are removable. They give you flexibility for variation in gas production, you can take them up or take them down. We have an owner in California who spent the last 15 years doing peach shavings by storing gas in the bag, so when power is worth more he would use more gas and suck his bag down. And then he'd use less gas overnight and let his bag fill back up.

Sooner or later, all digesters will have to be cleaned out. These tops can be removed in 8 hours, exposing it to the air, making it a safe—once you pump it out, you're going to pump it out for the reason that there will be something on the bottom, usually sand. Even in a mixed unit, big particles of sand aren't going to be resuspended and pumped out and, I'm sure in this area, you're aware of this. A long time ago I did a solid separation system down at the Boardman feedlot and learned an awful lot about blow sand. So, if you're going to have that issue, which happens in many places in the country, you'd need to have a way to get into your unit.

The first thing you're going to do, of course, is keep as much sand out as possible. That which you can't keep out, you're going to have to get it and take care of. So if you put a solid top on one of these things, I think by definition you have a confined hazardous space, so when it comes time to clean it out, you're going to be working in a basement in the dark. We've cleaned one of our units out, actually two already, and it becomes very easy, very simple. Pull it apart, pull the top off, mix it, stir it, pull it down to the sand, wash the sand out, pump it out, and then refill, restart.

There is a variation on the theme of mixed, heated digesters—we developed a system in Chile for 238,000 pigs. It may be one of the larger units in the world, but it is seven hog farms spread over 7 miles with a central collection point. We're right now at Farm 4. All the manure goes to Farm 4 where the digester is. And this is a variation on the theme. It's a heated, mixed covered lagoon. She's making around a million, million and a half cubic feet of gas per day. It's just an awful lot of gas. This was put in simply for odor control. If you can project what a quarter of a million hogs smell like, they can smell them forever. This was number two in a series of

seven that we've done down there. Again, this combines both the covered lagoon with the heating system, and I'll show you the heating system for this later.

We've done a variety of things with digesters. We've mentioned Matlings in New York where we're combining all kinds of organic waste. Here's another one in California where we're throwing in cow manure and other organics; he's got a 350-cow dairy. In order to top up his engine, he was able to get a regular source of organics from some of the food processors in the area added daily to top up gas for his engine.

Here's an older project, this is Chip Seal Farm in Lancaster, Pennsylvania, Harland Keener, and it's a pigs and whey project. He's been running pigs and whey for 15 years. It actually serves as the whey disposal system for one of the local cheese plants. It was not our original design, we got hired after the company that designed it went out of business. A new owner came in and wanted to expand, and they had a problem with the original heat design. We redesigned the heat and expanded the system, so he's been running happily ever since. This guy actually had an engine that went 65,000 hours before they rolled new bearings into the bottom end and the guy rolled the bearings and said he didn't really need to.

If you put a digester in, you're not going to need daily advice. Once a year, once every other year, you're going to need to call somebody and go, "Well, this is this," and somebody has to be able to say, "It's that." That's what we're good at. I don't go out and visit farms. Someone calls me and says, "It's probably . . ." and most often what problems turn out to be are adjustments. I try to keep it to a minimum the adjustments that you can do. Turns out, someone adjusted something and did not tell someone else. About three weeks later they find out, and they call up, and I go through four questions and tell them, "Go look at this dial, put it back where it belongs."

I'll talk a little bit about plug-flow digesters. If you are scrape collecting your manure and keeping it at 11% solids or more, we recommend plug-flow digesters. Plug-flow digesters are long, rectangular tanks in the ground as we build them. We have bent them into horseshoes before and I know that GHD bends them into horseshoes. Basically you put thick manure in one end so it's long and narrow, and thick manure travels down the digester. As it travels, it's getting thinner because it is digesting. You're going to lose about a third of your solids to gas. So thick pushes thin, it works like a piston. It's unique to cow manure because raw cow manure is sticky

and has enough solids that it will hang together without mixing to travel down the length of the digester.

I'll show you pictures of a few. This is a dairy in Visalia; we'll get to one; this is a complete digester system; this is Meadowbrook Dairy near Victorville, California. It's a dry lot scrape dairy; they are milking 2400 cows; we're picking up only the manure off the feed lanes, no corral manure because there's too much sand in it. So the long, narrow digester is here; the vacuum truck delivers to a tank here; manure flows out, goes up to the solids separator; this is our generator room, very nice compact little unit—works like a champ. And just to mention again, we've been in business for a while.

This is Langendorf Dairy in Durham, California, milking 350 cows. He's been running since 1983. Engines run something like 170,000 hours, averaging 40,000 to 50,000 hours between overhauls, with about a 4-year payback. His payback comes from electricity, from heat which he uses in his parlor and in his home, as the house is right next to the dairy. Since 1984, all the digested solids off the separator have been sold out the gate, and he did not truck a drop of it. It's actually a good cash business and he's up to $15 per yard. Again, that's site specific, market specific, and somebody has to be responsible for it. Marketing digested solids does not happen as an accident.

Some of our newer and larger jobs—we have about 15 of these so I'll just show you a few. This is a 2000 cow unit in New Verizons Dairy in Elmwood, Illinois. I was at a meeting earlier this morning where the issue of odors came up here in the State of Washington. This is a good project that pays really well but it wasn't put in because it was a good project that pays really well. It was put in because mistakes were made in manure handling and the neighborhood right across the tree line from the dairy had an issue with the manure smells. We mitigated this and the problem is over. Actually a lot of our work over the years, for example in Japan, was driven by the same thing—odor control. Japan is pretty tightly packed and so when the little town is two kilometers away and you have a stinky pig farm, they had to do something about it.

Another example of the work we do—you've all heard about the Tillamook System. This is a regional system. As you all know, the Tillamook dairies are relatively small, relatively tightly packed on a coastal plain where it rains a lot. They are also in an area where their land is pretty heavily loaded with nutrients. The goal of this system was to remove nutrients from the watershed. So the Port of Tillamook Bay received grant money to build this system. It is built at

the port site, eight dairies are having manure trucked in, the port handles the truck and the trucker. The dairies are contributing to the truck haul. There is 1,000, 2,000, 3,000, 4,000 cows worth of digesters; the 2,000 are in operation. There is adequate demand for the buildout. It's a public works project, so it has a public works grant. It functions by selling its electricity, separating the solids and selling those solids.

The goal was nutrient removal from the basin. Nutrient removal from the basin and then the dairies that are there can expand. Because if they can't remove nutrients from the basin, they can't expand. Another major issue and one of the benefits of this, and it's being looked at very heavily, is the pathogen reduction. Everything in Tillamook washed into Tillamook Bay and every time it rains, for the next week you couldn't harvest oysters. Of course, it was nothing to do with the dairies. But dairies in order to help out with the situation are looking at this and there has been an awful lot of study. We're looking at 99.6 to 99.9% reduction in the pathogens in the manure. Not a complete kill but it's pretty darned good. Washington State has participated with Oregon State University and documented that.

Next I'm going to go through gases. Digesters are always used to make gas. The key to digesters is to make gas continuously and easily. So we make gas. All of our systems have an emergency flare on them. We do not want to release unburned gas around the farm because who knows who will go by and have a spark from a cigarette or end up having bad things.

Once we get the gas, first we build an engine room and then we manufacture some equipment, dam the gas, this happens to be a filter-meter-pump, skidded unit, comes in and gets bolted in. On heated digesters we have a water handling unit. This one is from Meadowbrook Dairy where we mix, pressurize, it's a fresh water system and it goes over to an engine generator where the heat is recovered.

Sometimes but not often in this country, we will put in a boiler and this is a little unit that we put in down in Chile. That's about an 800 horsepower boiler that we used to keep that heated mixed covered lagoon digester running. Another interesting thing about the Chile project is it qualifies for greenhouse gas reduction credits. I think we were the first in the world on the international panel on climate change to get our digesters qualified as installed and as running without any extraneous baloney to recover, burn the gas. Credits were purchased by TransAlta Canadian Utility and they pretty much paid for the digester or all seven of them.

This shows a boiler in combination with an engine generator set. This is installed in North Carolina, the hog farm, and again this is a fairly cold place. Gas production drops in the winter and he would overnight with the boiler and run the engine during the day.

This is a fairly typical one of our engine generator sets and I show it because it's fairly easy to see in a slide. It's a CAT 3406 spark ignited engine. We always use spark ignited engines. Methane itself will not diesel so, when people start talking about dieseling, well, you need diesel fuel as a pilot fuel to actually run the engine. We have focused pretty much on Caterpillars. We have done Cummins, CAT, Waukesha, Ford, Chrysler through the years and we're working pretty much all the time with Caterpillar for the very simple reason that there is Caterpillar service in every town and that's a key to operational success. If you want to buy a Deutsch engine, you don't want to have to call Germany and say, "Where's that part?" It's a very key issue. In terms of economics, you make money only when the engine runs. If the engine is not running, you're losing money two ways: 1) it's not making electricity; and 2) you're paying to fix it. We know this, we've designed this, all these have been built to our specs, and they're designed for long-term service with as little personal attention as possible. Like anything else, you're going to have to look at it, but you're not going to spend your life with it.

Turbines—people start talking about small micro-turbines. I can't say that I recommend them for any of my customers. I said that four years ago, I say it today. There have been turbines on three of our projects. The operational experience is poor. They didn't know how to handle gas to begin with, they've gotten better at that now, but I wouldn't leave a single one of my customers with one of these because I don't want them calling me.

Bonus section on digester effluent—I think Phil has probably said everything that should be said.

A few things about digested solids—they make good bedding and they can be sold. I've heard some things that need to be straightened out here. The question, can digested solids be used for bedding off the separator? The answer is yes. Not a problem with that. Langendorf Dairy has been doing it now for 22 years and so have a lot of our units. If you compost it, is it better? That depends on how you compost it. In theory, if you run it up to temperature, you'll have more pathogen kill. The question is, does it make it wetter or drier because you get a volume reduction. Some people compost because they want to. We have a big herd in Minnesota

that put in their own composting facility for the digested solids and that was at the herdsmen's instigation.

Other than that, post-digestion—you have your solids and liquids, you've separated your solids, you go to your liquids—this is Langendorf Dairy—they've been mixing it in irrigation like most dairymen for the past 22 or 23 years now and irrigating without a problem, making very good corn crops.

I think that's all I have for today. If someone has some questions, I'll be happy to answer them.

Question—

Answer: Depends how much sand got in the digester. We had a guy bedded with sand, about 2 years, had to get into it. That was even with some work with the sand to keep it out, but the worst possible case for me is someone bedding with sand. Now with a plug-flow-type digester, in Castonelli's case in Lodi, he's bedding with sand, and we're just trapping it out and then going to the digester. If you're going to clean the digester out, shut it down and empty it out, you're going to be down for about a month. If it's a heated mix digester, you've got to take the liquid out, put the liquid back in after you're done cleaning it, reheat it, start feeding it again.

Question—

Answer: I'd love to have it 80° all the time, but in Lodi our low temperature last year in the digester was 47°, our high in the summer was 78°, so the temperature fluctuates with the season. Our wintertime low over the winter so far in California in that system we're producing about 3,200 cubic feet of gas per hour; summer high it was 5,500 cubic feet of gas per hour. That's the range of variation you'll find.