MSW Magazine Article Series
Part 1 of the series discusses design considerations for landfill gas collection and control systems (GCCS)
Part 2 takes into account construction quality assurance (CQA) measures during construction of GCCS; and
Part 3, "Designing for the Future," covers BMP's for GCCS Operation, Monitoring, and Maintenance (OMM) in the September/ October issue of MSW Magazine. SCS's David Fischer discusses Safety, Monitoring Plans, LFG Well Start-up, Wellfield Tuning and Maintenance, and Compliance.

Designing for the Future

Part 3 of a series on LFG collection focuses on operation, monitoring and maintenance

Ali Khatami, Srividhya Viswanathan, and David Fisher (https://foresternetwork.com/author/ali-khatami-srividhya-viswanathan/) • September 18, 2018

Credit: SCS Engineers
Onsite monitoring of LFG equipment

Landfill gas collection and control system (GCCS) optimization works well to achieve both compliance and maximum recovery since the practice focuses on understanding various elements affecting production and recovery of landfill gas (LFG) and conditions under which these activities take place. LFG extraction engineering best practices in landfill GCCS operation, maintenance, and monitoring (OMM) programs focus on implementing and maintaining durable solutions following a "beyond compliance OMM model." Developing and communicating the guiding principles of what beyond compliance means for your facilities is key to obtaining the right resources for ongoing OMM implementation and improvement. In Part 3, we emphasize how GCCS OMM works to increase realized value which will help fund comprehensive GCCS optimization programs. Using this model, OMM programs can focus on GCCS optimization, instead of merely complying with environmental regulation or gas recovery.

Safety First

Safety is first on the list. OMM contractors should arrive on the job with a complete written site-specific health and safety plan that aligns with their company Injury and Illness Program and the facility's safety plan. The plan should identify site-specific information such as a site evacuation map, notification procedures, nearest medical facilities, expected hazards, and detailed safe operating procedures. The first duty of all OMM personnel is to familiarize themselves with the content and acknowledge the plan. OMM subcontractors are also required to follow their plan and are often required to review and acknowledge the primary contractors' plan as well. In this manner, clear safety expectations and documentation are in place from the onset.

Once the site plan is in place, additional internal safety audits should be completed by the OMM team to identify and add additional hazard precautions to the plan, if necessary. Early on in operations, the OMM contractor should communicate to the facility owner if upgrades are needed. A typical collaboration: the OMM contractor completes the audit, and the facility owner pays for needed facility safety improvements. In cases where financial or leadership mechanism does exist to mitigate work hazards fully, the OMM contractor should be prepared to modify work scope to ensure the field team remains protected. For OMM contractors new to the facility, it may become challenging to understand hazards fully and communicate concerns effectively. Coaching OMM personnel in the process of “pause work authority” helps employees understand that pausing work to consider and address hazards is fundamental to evaluating safety and quality in OMM.

Putting safety first reduces the risk of injury and mirrors a fundamental OMM principle that there are “tried and true” methods established to complete OMM tasks successfully. It is not the slowness in implementing OMM procedures that causes project problems; it is the common missteps and poor communication of procedures that lead to a risk of injury, major budget overruns, and compliance deviations. Regularly recognizing OMM team safe working and operational excellence is a good way to maintain high operational efficiency and encourage early identification of the need for project improvements.

Monitoring Plan

Typically, GCCS systems components are a combination of equipment installed in phases over the years with varying construction techniques. Familiarization usually begins at the prime movers and reaches out to each field connection, and down into well casings, often revealing during the process that facility construction as-builts are incomplete and outdated. To fill in knowledge gaps, discussions with site engineers, facility operators, and other environmental contractors are critical. Ongoing formal collaboration is fundamental to successful OMM. The process allows timelines and procedures to be communicated and followed consistently. Once all lines of communication are open, organize-review-discuss the historical monitoring data.

Current permits, past reports, and manufacturer recommendations should be reviewed and compiled to generate a site-specific monitoring plan. Site monitoring plans are often either too informal or too detailed; either way can lead to misunderstanding and errors. Details such as tuning targets for each measured parameter, re-monitoring procedures, calibration frequency and procedure, data handling, and compliance timeliness should be clearly defined and summarized. A bullet item checklist of how and when to complete tasks should be readily available and used by technicians and team managers. Along with a review of the actual data measurement results, method checklist should be reviewed and discussed as well. Distilling procedures to their core elements promotes comprehensiveness and consistent repeatability. Office trailer posters of key program elements easily help reinforce the principle of “keeping the main thing the main thing.”

Within the first month of operation, identify a list of OMM questions and assumptions and hold a meeting with the facility owner and other site operators to describe observations and gather additional information. Regular formal meetings are valuable for team building, and building consensus for developing “to-do” items lists, technical approach, funding, and schedules. Meetings also set a process and expectation of formal documentation. Once efficient communication lines are developed, and general procedures are summarized, quality OMM service can commence.

Wellfield Tuning and Maintenance

Wellfield tuning encompasses more than just LFG wells. The first task is to stabilize the extraction energy (system vacuum) reaching each LFG well. Ongoing maintenance is required to accurately complete. Wellfield tuning commences when applying a relatively stable vacuum (i.e., variable frequency drive—see Part 1 of the series). By its nature, tuning requires monitoring, monitoring requires repeatable procedures, and repeatable procedures require communication, training, and adhering to schedules. Adhering to schedules necessitates a team who understands the scope of work and enjoys the challenge. LFG tuning applied in this manner makes compliance relatively simple, which assists in building strong relationships with the regulatory agency and other LFG end-users such as LFG to energy providers. Strong partner relationships assist the OMM contractor to craft an operational plan that focuses on system optimization to support compliance and quality LFG recovery.

Durable GCCS operation program aside, a typical wellfield tuning day begins in the early morning to devote as much time to the activity as possible. After inspecting and donning safety gear, proceed to the blower flare station (BFS). Ideally, the entire BFS and wellfield tuning event will occur in one day to achieve a “snapshot in time” of current conditions. If your GCCS is dynamic, it is more important to complete tuning during a consolidated timeframe. GCCS variation typically arises due to diurnal pressure swings, liquid blockages, multi-point vacuum sources, primary mover flow changes, and startup and shutdown of control devices. More fundamentally, LFG production is controlled by biological organisms which follow biological production cycles of their own, responding to moisture, temperature, and atmospheric conditions.

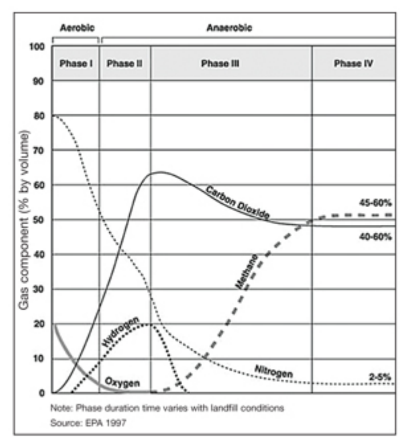
LFG well-tuning work begins by warming up (stabilizing) instrument sensors, calibrating instruments to manufacturers' recommendations, and documenting the calibration procedure. Start with a freshly CH_4-conditioned sample line carbon filter to keep non-methane hydrocarbons from artificially increasing measured CH_4. The BFS is the first and last stop of a successful tuning day. Confirm gas quality of the prime mover, and verify that components and combustion are stable and operating normally. Typically this means reviewing the data chart history of abnormal flow or temperature. Confirm that blower temperature is normal and whether rotation or servicing is due. If so, complete rotation or servicing before tuning begins. Check the liquid separators for clogging by measuring differential pressure across the separator, and also check that liquids are draining. Many tuning events quickly turn into a day of troubleshooting instead of tuning. Typical issues which take time to resolve are flow surging and elevated oxygen. If the prime mover and gas quality are stable, proceed to the furthest reaches (pneumatically speaking) of the wellfield. Along the way, test a few headers to detect maintenance issues. Walking is best to detect odors and to listen for line surging and air leaks.

Arriving at your first LFG well, use your detection skills to determine whether there are maintenance issues such as air leaks, surging, and odors. Pay special attention to the surface for crack formation; sometimes cover cracks are large enough at the well base to create an engulfment hazard. To mitigate the hazard, add a permanent well safety grate, as noted in Part 2 of this series. In general, air leaks in covers will significantly decrease LFG quality and increase the chance of offsite migration. Vertical wells should be in a vertical position to increase flow measurement accuracy. Well return lines should gravity flow to the GCCS lateral pipes to reduce liquid buildup. Ports and piping connectors should be sealed to prevent air leaks. If the LFG well was just returned to service after being extended, test the well for integrity using a camera. Well damage during extension is common. By identifying well casing damage before more waste is placed, repairs may be possible.

If the LFG well has a liquid pump, confirm that the pump is operational by waiting for or forcing a stroke. Confirm that the cycle counter advancement is in line with the pump historical values. Clean the pumps regularly. Although cleaning can be completed onsite by hand, new services exist to swap dirty pumps for factory cleaned and serviced replacements. This process gets pumps cleaner, saves field time, and eliminates onsite cleaning wastes. Force main pressures should be monitored to detect return line blockage. Compressed air pumps can impact gas readings and create foaming problems. Some air pump designs are prone to discharging compressed air into the well if the pump float freezes open. A quick bump to the pump exhaust line with the supply airline often frees the float; however, the sticking valve is an indication that pump maintenance is required.

To monitor the LFG well, select the pre-established unique well ID that contains the correct wellhead settings. To allow for freedom of movement to inspect the well for damage, hang your instrument on the wellhead without causing damage to the wellhead system. Purge your instrument, zero your pressure transducers, and connect sample hoses to the static and impact pressure ports. Instrument hoses should hang in such a manner that entrained liquid does not gravity flow toward the instrument. Stand upwind of the meter to avoid instrument exhaust fumes. Replace the sample line water trap if liquid buildup is visible. Differential pressure measurements take longer to stabilize if the water trap is saturated.

Follow the instrument manufacturer's procedures to determine gas composition and flow. Gas composition needs to be first evaluated to determine if there is an air leak in the wellhead or the sample line. Accomplish this by looking for a 4:1 ratio balance gas to O_2. Except in cases of a damaged well casing, or severe overpull, O_2 should not be present, since O_2 pulled through the waste mass is converted to CO_2 by aerobic bacteria.



Credit: Diane Samuels
Changes in the production and composition of landfill gas over time. Farquhar and Rovers, courtesy of EPA.

If differential pressures are too low (less than 0.5 inches water column) or too high (greater than 5 inches water column), wellhead modifications to the orifice plate or wellhead size may be needed to increase flow accuracy. Swings in the displayed flow indicate surging, usually due to liquids in the lateral conveyance system. When a localized blockage occurs, the vacuum is unequally redistributed, which can lead to localized overpull or underpull.

Make your tuning and maintenance decisions once initial gas temperature and flow are measured and compared to historical readings. Tuning should follow the same procedure as discussed above in the startup. Follow established tuning targets for each LFG well. Typically, the presence of O_2 in an LFG well indicates either a surface casing crack, over-pulling, or both. Except for LFG wells at the landfill perimeter, O_2 targets should be less than 1%. When elevated O_2 is detected, consider adding a well casing boot and cover improvements. If O_2 persists in large areas, additional LFG wells may be needed to allow for operating wells at lower vacuum, while still maintaining overall total flow. Balance gas is the best indicator of over-pull since it is an inert atmospheric gas. Balance gas targets should be around 5% to limit air infiltration. For perimeter LFG wells, CH_4 is often used as a tuning target (47 to 53 or lower). Problems such as CO_2 concentration greater than CH_4 concentration (inverted ratio), combined with sharp rises in temperature, are a sign that the well chemistry is either that of new waste that has not completely transitioned into the fourth phase of the gas composition (Figure 1) or is reverting to aerobic decomposition due to overpull. Inverted wells should be evaluated and repaired, or severely throttled back and observed closely to avoid impacting gas recovery.

After making a tuning decision, complete the adjustment and record the valve adjustment. Double check the adjusted value to confirm that the adjustment did not cause a compliance exceedance for pressure, temperature, or oxygen. Since an “adjusted” O_2 value is not typically a measured parameter on most field meters, a complete second adjusted reading is often required. Significant changes in O_2 directly following a minor adjustment are a sign that air is shortcutting down to the top well casing perforations. To improve gas quality, cover maintenance or well repair may be needed.

Following adjustments, enter a comment in the instrument comment field to document observations and any changes made. Written comments are excellent guides when reviewing data to determine well health, to document action to resolve compliance exceedances, or to document raising a well or completing other maintenance. Comments are critical for communicating conditions of each well. Also, add any follow-up compliance reading due dates to your field log and site monitoring schedule.

Continue to the next LFG well, maintain a consistent pace, and follow a routine set of procedures at each well. A routine route should also be established and followed. Test your instrument every few hours for accuracy by comparing reading values to calibration gas. When observing a discrepancy, recalibrate the meter. For NSPS sites, a 10% drift is allowed per 40CFR §60.753(c)(2)(v). When using atmospheric oxygen (20.9%) as a calibration standard, a drift of +/- 2.1% is allowed. However, it is common to use a lower 4% O_2 span gas to increase meter accuracy at the low end. If so, the allowable drift is tougher to achieve (+/- 0.4%). Additionally, NSPS Subpart WWW (40CFR §60.753(c)(2)(i)) requires calibration span gas to be between 20% and 50% of the regulatory limit, meaning that for a 5% O_2 limit, a calibration span gas of 10% to 25% should be used. (The current NSPS WWW accuracy and span gas requirement are consistent with the new NSPS XXX regulation.) NSPS Subpart XXX sites are not subject to an O_2 regulatory limit, but the regulation specifies that the O_2 span gas must be between 10% to 12% (40CFR §60.766).

Compliance

In maintaining compliance, all too often the tail wags the dog. A common misconception is that achieving compliance means wellfield optimization. As discussed above, an LFG extraction well can comply but is not optimized. The previously described LFG well evaluations help OMM contractors define baseline conditions and the most efficient responses when observing a departure from baseline readings. Use the site-specific Shutdown, Startup, and Malfunction (SSM) Plan (40CFR § 63.6(e)(3)) to develop detailed procedures to respond to compliance requirements, and to document best management actions. Developed procedures and observation findings are useful to advocate site-specific compliance limits as allowed in both NSPS Subpart WWW and Subpart XXX (40CFR §60.753(c) and 40CFR § 60.767(c), respectively). Take time to read, and ask regulatory agencies to help summarize compliance requirements down to plain language before compliance concerns arise. Time spent customizing site OMM procedures increases operational flexibility and staff understanding of approved procedures.

Place a high level of importance on accurately tracking and responding to compliance exceedance resolution and reporting time clocks. Compliance resolution timeframe requirements often do not align with project procurement and site mobilization lead times. For NSPS sites, missed deadlines are reported as compliance deviations. Deviations reflect poorly on the OMM contractor service and can result in fines, additional operational restrictions, and public health and safety concerns. Scheduled compliance monitoring and re-monitoring event calendars should be highly visible to the OMM team at all times. Compliance due-date tracking mechanisms should be duplicated to help avoid missing OMM and reporting dates.