PERFORMANCE TESTING OF AERATED WASTEWATER TREATMENT SYSTEMS

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Abstract

This paper reports on the establishment of the site at Moss Vale, in the NSW Southern Highlands, by members of the AWTS Manufacturers Association (AWTSMA) to test their aerated wastewater treatment systems (AWTS) in order to be accredited for installation by NSW Health. It should be of interest to local government officers and others, who wish to know how the AWTS were tested.

It covers the reasons for re-testing AWTS and the design of the mechanisms at Moss Vale to ensure that the correct influent to the AWTS was achieved. It explains the role of the quality assurance organizations in the test, the sampling methods that were used and questions whether the tested AWTS are those now being installed in NSW.

A comparison is made between the results of similar samples sent to different NATA laboratories that questions the wisdom of manufacturers being allowed to test at different locations.

The testing increased the understanding of the operation of AWTS and suggestions are made on how future guidelines may be changed to improve the quality of AWTS.

Keywords

Accreditation, AWTS, BOD_5, Moss Vale, product testing, quality assurance.

1 Introduction

Aerated wastewater treatment systems (AWTS) have been a popular method of treating domestic wastewater from unsewered dwellings since the middle of the 1980s. By the middle of the 1990s there were various reports that showed that some AWTS were not producing effluent of the required standard.

In 1997 the Minister of Health was presented with a report of the shortcomings of some AWTS. The Minister replied that he was sure that the impending testing of all AWTS in accordance with a NSW Health guideline (AWTS Guideline 1997) and their re-accreditation would ensure the protection of public health.

NSW Health commenced the re-testing procedure by publishing a draft guideline in July 1995 (AWTS draft Guideline 1995). Initially, good interaction between the regulators and the industry took place to compile a guideline so that robust and effective systems could be tested under a credible protocol. Until the guideline was published in its final form, it was impossible for manufacturers to complete designs, fabricate moulds and performance test their systems.

Manufacturers objected to a prescriptive guideline, preferring the performance-based methods of Australian Standards in which the guideline presents the desired outcome and the manufacturers can meet that outcome with a design of their choice.

Testing could have finished by 1999 had the guideline accommodated three major criteria:

- no prescriptive design requirements;
- sampling from the discharge point not the clarifier; and
- all systems to be tested at one location.

At 30th November 1999 NSW Health refused to grant an extension to the existing accreditations for AWTS and manufacturers had to cease selling AWTS, even though the prescribed testing had commenced. One manufacturer had been granted accreditation under the new guideline on the 29th November 1999. This left the whole of NSW to be supplied by one accredited manufacturer, a feat that could not be achieved by much larger manufacturers.

Unfortunately there are no savings provisions to the regulation (Section 68, Local Government Act, 1993) that allow councils to approve AWTS. Thus, no applications previously submitted for approval to install an AWTS could be approved. This would have prevented householders installing their chosen system. Failure to complete contracts would have been the demise of probably all of the AWTS manufacturers, leaving owners of AWTS systems without service providers, without warranty and generally in a serious mess.

The NSW Chief Medical Officer arranged an extension to 17th December 2000. The previous decision not to grant an extension to the accreditations would have disadvantaged householders. NSW councils had until 28th February 2000 to complete the approval process of existing applications.

2 Quality Assurance and NATA Testing

Before publication of the guideline, NSW Health conducted the testing of AWTS and provided security by taking the samples and transporting them to a National Association of Testing Authorities (NATA) approved laboratory. By 1995, NSW Health had ceased conducting the testing and required each manufacturer to obtain the services of a third party quality management certification body accredited by the Joint Accreditation System of Australia and New Zealand (JAS - ANZ) to perform the task. Product approval to the Standards Mark Quality Assurance Program or equivalent (including accreditation to ISO 9000) is required.

The AWTSMA was encouraged by NSW Health to use the services of Quality Assurance Services (QAS), which had experience with the accreditation of septic tanks to AS/NZS 1546.1. QAS was duly appointed, offering efficient service and advice in establishing the test site and approving sampling protocols.

Microtech Laboratories (NSW) Pty Ltd was appointed to perform the work jointly with GM Laboratories Pty Ltd. During the testing weeks, a temporary site laboratory was set up in a marquee to house the necessary equipment including a deep freeze in which to temporarily store the samples.

3 The Moss Vale Test Site

Successful accreditation by NSW Health requires an AWTS be tested at a sewage treatment plant (STP) by receiving screened raw sewage of a specified strength, treating it and testing samples during three four-day periods over six months. Access to a STP was difficult with Sydney Water refusing access to the larger plants that had the required influent strength and offering access only to the Rouse Hill STP. The $150,000 cost required by Sydney Water was beyond the financial resources of the Association members. After more searching a licence was obtained to use Moss Vale STP, owned and operated by Wingecarribee Council.

The guideline does not specify a protocol for establishing a test site and it was up to the candidates to design their own method of supplying each AWTS with the required strength of influent. This latitude has led to the many different methods used at the various sites on the East Coast. It also amounts to setting your own examination paper. The AWTSMA members had agreed that their test was going to be conducted with a high degree of integrity.

Fortunately two members had attended a presentation in Melbourne by Mr Peter Beavers of the Queensland DNR on his visit to an American National Sanitation Foundation (NSF) test facility (Australian Standards committee meeting 1998). His many photographs showed in detail the elaborate metering system that was used to ensure each AWTS received the correct quality and quantity of influent. A design based on that presentation was commissioned and installed at Moss Vale.

Influent to the STP first passes through a rotating bar screen to remove rags and other material that will block pumps, then it flows to a grit chamber. Sewage was pumped from the grit chamber to a holding well at the test site. Seven positive displacement pumps supplied influent to each AWTS.

Although an AWTS can be accredited for eight, nine or 10 people, each of the Moss Vale AWTS were seeking accreditation for 10 persons. Therefore, this paper ignores the lesser flows for the smaller AWTS. Clause 10.3.1 of the guideline requires that, "the AWTS will receive sewage at the rate of 190 L/h for 10 persons… for eight hours per day being:

- between 6am and 11 am representing the morning peak flow of five hours,
- between 6pm and 9pm representing the evening peak flow of three hours."

The manufacturers and NSW Health had agreed to these periods to make the AWTS treat the peak loads, but neither party realised that at 6.00am the flow is only a trickle. The starting time was delayed until 8.00am when a continuous flow could be assured.

AWTS is supplied with sewage in this fashion for six months. During weeks 8, 16 and 26 samples were taken while AWTS were treating 2140 L/day. In weeks 12 and 24 the AWTS receive standard maintenance. Treated water from all AWTS was returned to the STP.

The metering system was commissioned in September 1999. A week later the STP's rotating bar screen failed and solid debris flowed into the grit chamber, causing both the primary pumps to clog and stop. After the bar screen was repaired the system continued to function without fail, and without any maintenance, until it was finally turned off in June 2001. AWTSMA members were extremely satisfied with the operation of the test site equipment.

4 Sampling and Testing

The AWTS guideline allows NSW Health to grant accreditation to an AWTS that complies with the criteria of clause 11.7, specifying that 90% of these samples have:

- a biochemical oxygen demand in five days (BOD_5) of < 20 mg/L, with no sample > 30 mg/L;
- total suspended solids (TSS) < 30mg/L, with no sample > 45mg/L;
- thermotolerant coliforms < 30 colony forming units/100mL (cfu/100/mL), with no daily sample > 100cfu/100mL;
- and that all these samples have:
- dissolved oxygen (DO) > 2mg/mL; and
- free residual chlorine > 0.2 mg/L and < 2.0 mg/L.

The DO and free chlorine measurements were performed on-site and the samples for bacteriological and chemical analysis were sent to a NATA registered laboratory for testing.

The guideline does not give a sampling protocol and sampling is not covered by a laboratory's NATA registration. If the guideline had required sampling at the first opportunity for human contact it would have been quite simple to provide a sampling tap on the pump outlet, but instead the BOD_5 and TSS were required to be sampled from the clarifier, part way through the process. Variation of the sampling point is at the discretion of the Manager, Environmental Health, NSW Health. Prior to the commencement of the test there were numerous applications from manufacturers testing at Moss Vale to sample at the end of the process, all to no avail.

The chlorine and bacteriological samples were to be taken from the final disinfection chamber. Dipping sampling vessels into the clarifier is unsatisfactory because disturb and dislodge biomass that will contaminate the sample. The use of a peristaltic pump to take the sample created other problems.

The guideline requires the clarifier sample to be taken at the outlet. However, if one considers that the purpose of a clarifier is to remove settled and floating biomass, it is impossible to obtain uncontaminated samples. The settled sludge, prior to being removed by the sludge return, would create gas that would be trapped in the settled floc, eventually the floc would rise to the surface of the clarifier and be collected in the sample. Sampling in the final chamber produced a more representative effluent sample.

Samples were taken from both the final chamber and the clarifier. Only one AWTS during the first test period just managed to achieve a pass result from the clarifier, however it subsequently failed on clarifier sampling. NSW Health granted accreditation on the effluent samples from the final chamber. NSW Health later successfully applied to have the sampling point changed to the discharge point in the soon to be published AWTS Australian Standard, AS/NZS 1547.2.

4.1 Variation In Tests from NATA Laboratories

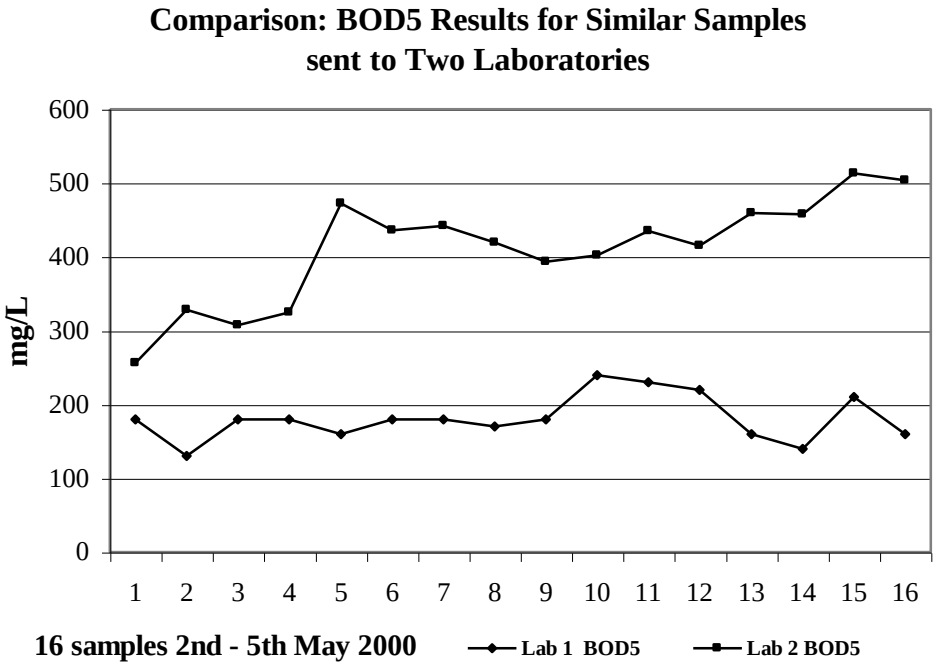
Unlike the American NSF system where testing can only be performed at three designated sites, the guideline allowed testing at any STP operated by a public corporation. So in the NSW case, it is impossible to say that all AWTS have passed the same test as not only were the test facilities set up differently, it is impossible to state that even the sewage strength was the same.

The test for BOD_5 is very unreliable, with an accepted variability of ± 25% (Irwin M, 2000). This means that 20 mg/L could be either 16 mg/L or 24 mg/L. Discussions with a member who was testing elsewhere and using a different NATA laboratory, revealed that much higher BOD_5 levels were being experienced. The influent was sampled to confirm that the minimum levels of >150 g/m^3 BOD_5 were being achieved. For comparative testing, double the number of samples were taken and randomly sent to GM Laboratories and the laboratory used by the lone member ('laboratory x'). Comparisons for TSS, TN and TP showed little variation between the laboratories, but the average BOD_5 results from the second laboratory were 2.3 times higher than those from GM Laboratories. The graph shows the variation in the results. This may have been caused partly from the difference in the bacteria that were used to seed the sample and the accuracy of the standard test sample that all laboratories have to perform each day. There is less variation in the effluent tests as the sample is already seeded with its own bacteria.

The only full test influent and effluent data that is published are from the Moss Vale site. Influent results from the manufacturer using 'laboratory x' reported an influent BOD_5 of >400g/L. If the GM Labs results are more accurate then the possible result is >173 mg/L; a result that is within the required range. The question needs to be asked, what if a manufacturer using laboratory x obtained BOD_5 results of <350mg/L? If there was the same difference

then the 'real' BOD_5 may be <150mg/L. The AWTS could then be regarded as being tested using influent that did not meet the minimum requirement of the guideline.

For these reasons it is not sufficient to just accept results from a NATA laboratory, their accuracy must also be scrutinized. Testing at one site using more than one laboratory would give the purchaser more confidence that all AWTS were tested to the same standard.



4.2 Test it at 35ºC, Operate it at 0ºC

AWTS tested under the JAS ANZ system anywhere in the World can gain accreditation in NSW. AWTSMA was concerned that an AWTS tested in Queensland could be installed in NSW in an area with freezing winter temperatures, such as the Southern Highlands. There has been vigorous debate among members of the AWTS Australian Standard committee regarding the need to test AWTS at their operating ambient temperature. As this is not a requirement for NSW accreditation, it appears that the NSW householder will have to rely on the AWTS annual testing to detect any that are unsuitable for colder climates. This is not helpful to householders who rely on the accreditation system to confirm that they are purchasing an AWTS that would perform to the required level anywhere in NSW.

Microorganisms have different temperature requirements and the bacteria acting upon the waste at 40ºC will be different from those at 10 ºC. Also their reaction rate will double with every 10 ºC increase in temperature, until an upper limit is reached (P. Greenfield 1996). The final test at Moss Vale was conducted 4 –7th August 2000 when the water temperature in the AWTS was 11-13^{0}C. A water tap at the test site had fractured because of freezing temperatures.

There are differences in design and specification between the Queensland and the Moss Vale tested AWTS. Time and experience will show whether AWTS tested in a warmer temperature will perform as well in colder temperatures.

The only data that show the effect of temperature on the Moss Vale systems was the decline in free residual chlorine (FRC) levels. The FRC declined over the three test periods as the temperature dropped. The chlorine potency was not affected, as the faecal coliform results were all within range at all times.

5 Accreditation of Systems Failing Critical Limits

A function of better-performing AWTS is that as well as reducing carbonaceous waste, they reduce the nitrogenous compounds. At Moss Vale some AWTS were able to reduce BOD_5 to <2.00 mg/L and ammonia (NH_3) to <0.2 mg/L. When this occurred the FRC exceeded the upper limit of 2.00 mg/L as there was no ammonia to combine with the free chlorine.

> "In the presence of ammonia, chlorine exists as combined chlorine (chloramine) and is measurable as total chlorine. A lesser quantity is therefore detectable as free chlorine. As the free chlorine is consumed it is replaced by more chlorine ions being released from the chloramine compound. As the ammonia level drops, the free chlorine level quickly rises as each milligram of ammonia consumed releases 4.17 mg of chlorine." (Irwin M, *et al*)

It was not a requirement to test for total chlorine (TC) and therefore no suitable reagents were on site. One manufacturer performed a subsequent test to discover the TC level of AWTS effluent, that the results were all >3.5 mg/L, because this was the limit of the test method and the exact concentration was never discovered. Expert opinion supplied to NSW Health about the high levels indicated there would be no deleterious effect on householder health or the environment and the high results were accepted. The proposed AWTS Australian Standard requires TC >0.5 g/m^3 with no upper limit. This will make it easier to achieve accreditation without the need to over-chlorinate.

6 Test Integrity

Did the tests have integrity? The answer is yes. NSW Health was questioned about the integrity of the Moss Vale test site. On the test days at Moss Vale there were between ten and twenty people on site to perform the work and to scrutinize the procedures. All samples were taken by Microtech employees to reduce sampling bias; the manufacturers were merely observers after they had prepared their AWTS for testing each day.

7 Product-Tested AWTS will be Installed in NSW

The object of the testing was to test the performance and construction of the AWTS. Part of the quality assurance process requires that the design of major and critical components and materials shall be frozen on the successful completion of type testing.

Each manufacturer is required to supply a set of detailed engineering drawings of the AWTS to each council in which they wish to install their AWTS so that the council officer can check dimensions of the installed AWTS against the accredited drawings. Already AWTS are being installed in tanks of totally different dimensions to the accredited design and there is documentary evidence of tanks of smaller capacity being offered for sale. Action by an AWTSMA member in notifying NSW Health ensured that the smaller tanks were withdrawn from sale, but it is suspected that a number of undersized tanks may have been installed before the discovery was made. Correspondence from NSW Health states that it is the responsibility of the local council to enforce the installation of accredited AWTS (O'Donoughue, 2001). If tanks were only allowed to be installed that complied with the accredited design, approving installations would be a simple matter for the council officer, and the householder could be assured that they were only installing tested AWTS.

Section 9.3.3 of the guideline states that, *"The (alarm) muting facility shall reset to audible after 24 hours*." This was the best benefit of the guideline. No longer did a householder turn off an alarm and then forget to phone for service. This made the serviceman's repair job more difficult as the AWTS was often flooded. Service managers applauded this cheap and simple device to make their job easier. By the middle of 2001, there were still at least two accredited AWTS that did not have a 24-hour reset device.

8 Conclusion

The important questions after the expensive testing and re-accreditation are: can a NSW householder purchase an AWTS and be sure that it will adequately and safely treat household wastewater; and is the installed AWTS of the same specification to the tested model? Has the testing made it easier for the cognitive buyer to make a valued comparison in order to buy the most appropriate AWTS for their circumstances? Finally is it easier for councils to recognise that the AWTS that has been installed is the same as the one that has been accredited?

The Moss Vale AWTS received the required minimum strength sewage and as the strength varied across the three test periods they were able to demonstrate their performance using both high and low strength sewage. However, many of the AWTS were the same design as the earlier models that were the subject of reports that sought to show that AWTS did not produce the required effluent quality, but now they have proved that they can perform. So were the reports correct? Or were those older systems not installed to their original tested specification? If so can we be sure that the newly accredited AWTS are installed to their accredited specification?

Were old AWTS not serviced correctly? Camden Council (1995) could not discover a performance difference when serviced by either a public utility (itself) or the manufacturer.

It appears that some AWTS are being manufactured in vessels that vary in dimensions to the vessels shown on the accredited drawing. So it is impossible for council officers to make a judgement of the accreditation compliance of a tank that is different in dimensions to the one shown on the certificate of accreditation.

Only two of the Moss Vale manufacturers publish the full set of influent and effluent results and present the percentage removal of the different pollutants for the cognitive buyer to make a valued judgement. The better AWTS managed to reduce BOD_5 by 97%, SS by 98% and FC by 99.99% (Martin R, 2001). There are no comprehensive data available from the AWTS that were tested elsewhere so it is not possible to decide the quality of their processes.

If the United States NSF can test on-site systems in three locations for a population of 65 million who require such systems, surely Australia or just the eastern states can provide one common site to test systems for the 500,000 or so people who require them in NSW and Queensland. No government funding would be required, as the testing is performed on a user-pays arrangement; it just needs to be established and controlled.

It is the Association's opinion that the test was worthwhile. Obtaining accreditation has given the author the confidence to send an AWTS to be tested by a competent third party testing organization, so long as it had the control mechanisms and integrity of the Moss Vale site.

Hopefully the data that is now available about the variation in test site design, sampling procedures and variation in results may find the regulators trying to persuade a third party testing authority such as QAS to set up an Australian or East Coast testing facility. Lastly the replacement of prescriptive design constraints with performance standards could see better and more innovative AWTS being designed, tested and installed.

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