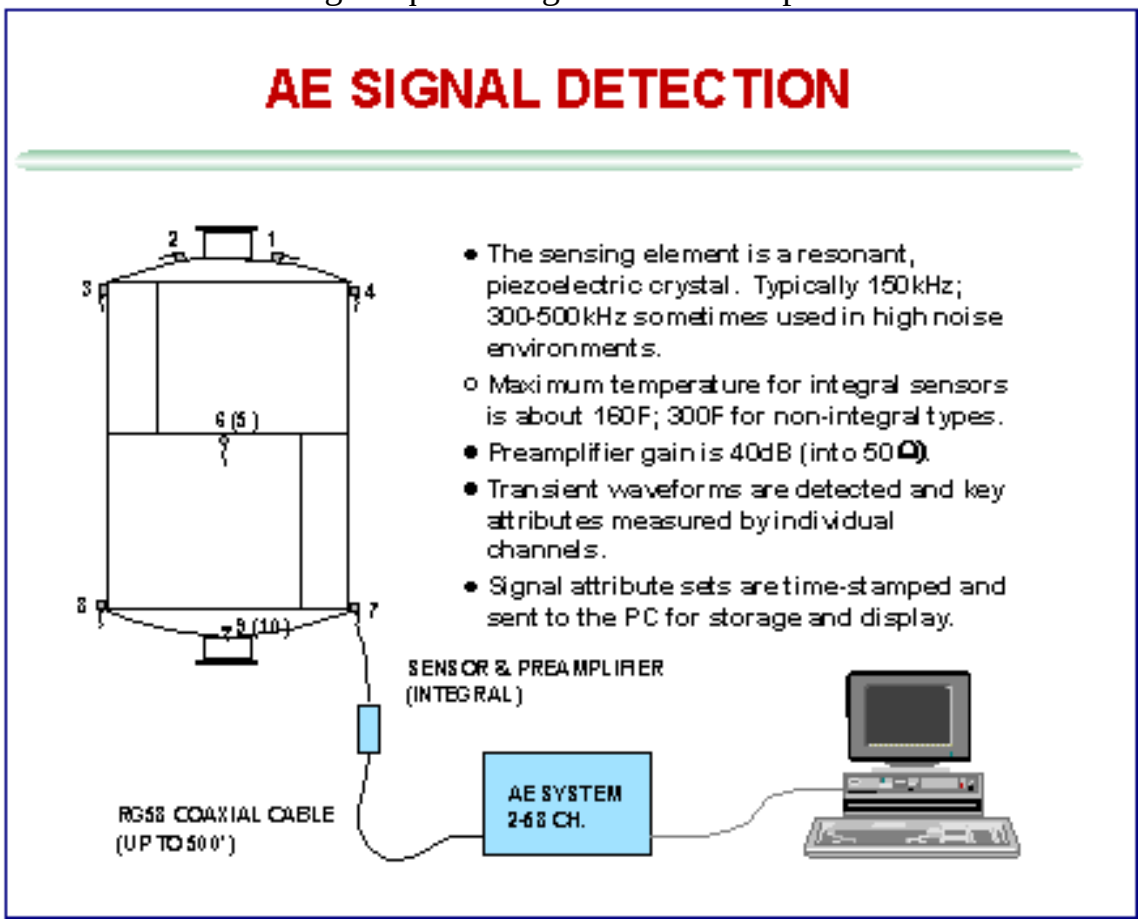
Matrix Inspection & Engineering, Inc.

Acoustic Emission Testing

Ammonia Tank Monitoring

Acoustic Emission testing detects cracking and other defects from the high frequency sounds generated by sharp discontinuities under stress. The method is most commonly used to detect service related damage (stress corrosion cracking, wet H2S damage, fatigue and so forth) in process equipment.

New or repaired vessels are also tested with this method for detection of fabrication defects or verification of repairs. The need to apply a load makes AE testing unique among the various inspection methods. AE testing is a dynamic method, relying on the applied load to reveal strain concentrations from cracks or other sharp discontinuities. This means the AE test method is sensitive to service related damage, especially cracking. Stable fabrication flaws and other blunt discontinuities are generally not active during an in-service test.



In other words, an AE test gives a measure of the response of a vessel to the applied load. Structurally significant defects produce relatively intense acoustic emission activity during the pressurization or filling of a vessel and this is the basis for detection of cracking or other damage.

Although an AE test can detect damage and give a measure of its severity, it cannot determine the type, size or exact position of any defects. The main purpose and benefit of an AE test is to determine if there is a structural problem, approximately where it is and give a measure of the severity of the problem. A complementary inspection method such as (shear wave) ultrasonics is needed to provide detailed information about the size and location of any flaws.

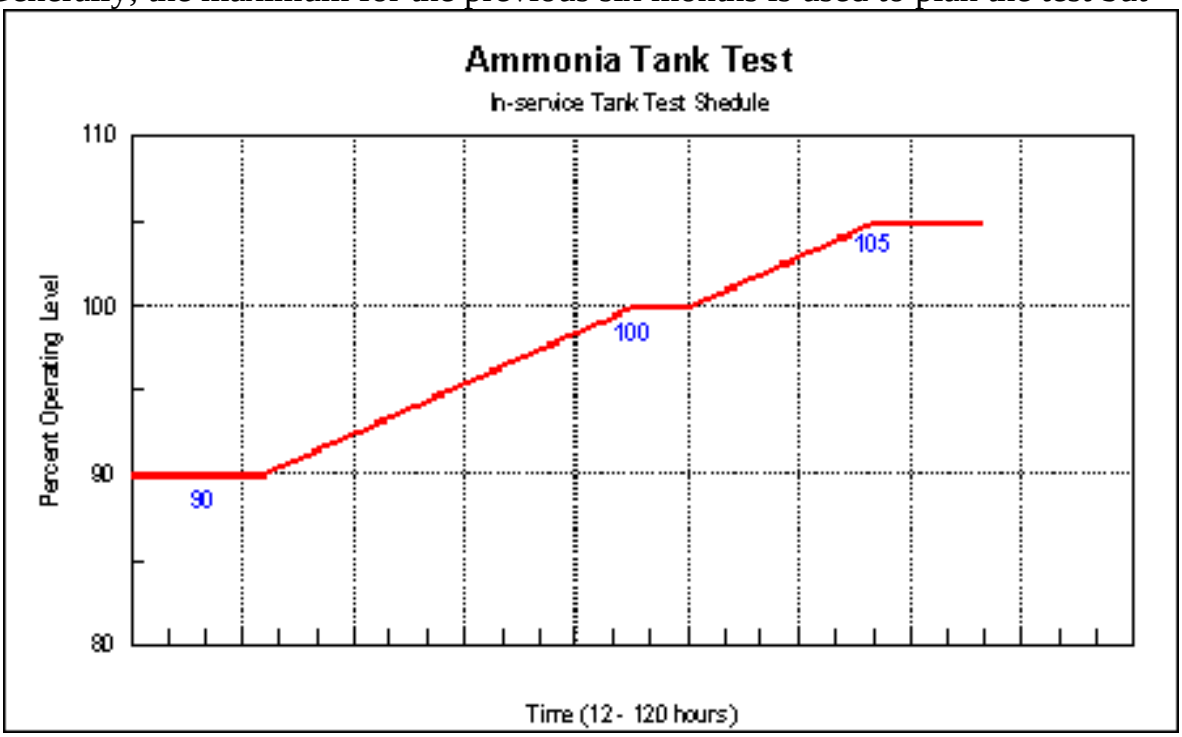
Ammonia tanks are normally tested to the Monpac Procedure. This was developed from a seven year test program including several hundred acoustic emission tests of process vessels performed by the Monsanto Company, a large chemical company headquartered in St. Louis, Missouri. The procedure is available by license to equipment owners, testing companies and Government bodies. A condition of the license is that testing personnel are required to attend a one-week training course and Inspectors must pass a written examination on the Monpac procedure and technology. Matrix has seven people qualified in this way.

Monpac licensees include chemical and petroleum companies, testing companies, and regulatory agencies. In addition to Matrix Inspection and Engineering, licenses are held by the Italian government, the South African Bureau of Standards and the National Aeronautics and Space Administration (NASA) in the United States. In the United Kingdom, the Monpac Procedure has been approved by the Health and Safety Executive for testing low temperature atmospheric ammonia storage tanks.

Sensitive acoustic sensors and specialized instrumentation are used to detect AE activity as a vessel or piping system is loaded. AE data is monitored during the test to identify any major problems as the load is applied and then analyzed to determine whether there are any areas needing follow-up inspection or evaluation.

For Monpac tests, AE sources are graded from the least to most severe ('A' to 'E') intensity levels. The intensity level is weighted with other factors such as the quality of the data and its correlation with load and time. This allows non-structural sources of AE activity such as pressurization noise to be screened out such that only AE sources showing a response to the applied load are reported.

In-service tanks are tested by filling with liquid to a level corresponding to a minimum of 5% over the maximum operating load. Generally, the maximum for the previous six months is used to plan the test but in the case of tanks having a wide operating range, historic and predicted maxima must be considered.



A successful acoustic emission test> relies on close cooperation between the testing company and the equipment owner. Planning and preparation are particularly important. These include collecting information about the equipment to be tested, especially operating conditions and history. Planning aspects for this work are covered elsewhere.

A typical AE test starts with positioning the test equipment, often in a trailer, near the tank and connecting to 110V power. The next step is to mark out the sensor positions and attach sensors to the vessel at each location using clamped waveguides or other suitable means. Coaxial cables are routed back to the instruments from each sensor. The final stage of the setup is to check the sensitivity of each sensor and

instrument channel.

Testing starts with monitoring of background noise at or below the starting level. Once noise levels have been minimized, the loading sequence begins and follows the planned sequence. Often it will be necessary to shut down recirculation or vapor recovery systems temporarily to reduce noise to acceptable levels during the test. AE data and level readings are monitored in real time to check for excessive noise or signs of a serious problem with the tank. However, because of high noise levels typical of ammonia tanks, it is not possible to determine the final result without extensive, off-line analysis.

Analysis of the test data includes filtering out any noise (frictional, flow or other non relevant acoustic activity) then applying the evaluation criteria and intensity analysis to determine whether and approximately where there are significant activity levels. Further analysis may be done to locate the sources of AE activity and narrow down the areas in need of follow-up inspection.

We plan to issue a site report containing a summary of the test and results. The results are reported in terms of follow-up actions needed (if any) and their location in terms of zones relative to the sensors.

Special Considerations for Ammonia Tanks

Cryogenic ammonia tanks as a group represent one of the most challenging applications for Monpac technology. Noise from the filling process, especially boiling ammonia as the liquid rises to the warmer upper region of the tank; recirculation or vapor recovery noise; thermal movement and ice can all contribute to a noisy data set. Evaluation of these data sets is invariably difficult. Matrix has developed some advanced filtering processes to aid in removal of noise but even this has limits and much emphasis is put on the relationship between the AE activity and level or time. This ‘trend’ analysis is used to supplement the Monpac evaluation criteria and intensity analysis assumes a lesser role. High intensity (noise) sources are normal for an ammonia tank and the AE versus level analysis is needed to separate ‘genuine’ AE activity displaying load dependent trends from fill and other noise.