



POWERPLANT SUFFERS EXTENDED DOWNTIMES & RECEIVES FAVORABLE SETTLEMENT AS FORCE MAJEURES

Two landfill gas process equipment failures at an electric powerplant cause significant unplanned downtimes and substantial repair procedures.

SITUATION

Landfill gas (LFG) must go through an extensive conditioning process before it can be used as a source of energy. Steps within this process include treating it to remove impurities like moisture and hydrogen sulfide (H₂S). To accomplish this, the LFG is filtered through large silo-like stainless steel tanks filled with sulfur-reducing media to lower the H₂S content. It then flows through a chiller heat exchanger to lower its humidity and temperature, and then continues on to be compressed.

An electric power station was treating LFG and then using the gas for combustion in its three power turbines. While it was treating the LFG, it experienced two significant unplanned downtimes.

One of the downtimes was due to the corrosion of four large 304 stainless steel pressure vessel tanks used to hold the H₂S removal media. The other downtime was caused by the failure of a dual path heat exchanger to further dehumidify the processed LFG.

The powerplant operators declared two long lasting Force Majeures (FMs) against the landfill operator. Within their purchase agreement, the FM definition included “equipment failures” and the need to use “best efforts” to remedy a party’s inability to perform its contractual duties.

ESi was retained by the powerplant operator to:

- Perform a root cause investigation of the failed equipment
- Evaluate repair procedures
- Assess the operator’s performance to resume service

Practice: Mechanical

Location: USA

ESi Consultant

Alfred Pettinger, Ph.D., P.E.
Principal

Mechanics Practice Group Director
ampettinger@engsys.com
949.336.9001

Services Utilized

- Metallurgical Engineering
- Microscope
- Scanning Electron Microscopy (SEM)
- Energy Dispersive Spectroscopy (EDS)
- Hydrostatic Testing
- Design Analysis
- Standard of Care
- Repair Evaluations
- Process Machinery

About ESi

For over 30 years, ESi has leveraged its multidisciplinary team of engineers, scientists, and professional technical staff to investigate many major accidents and disasters. Our technical expertise, hands-on experience and state-of-the-art facilities, combined with diagnostic, analytical and physical testing capabilities create an ideal environment for quickly identifying and interpreting the facts of a particular case.

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SOLUTION

H₂S Removal Tanks

ESi performed a non-destructive metallurgical investigation on sections of the steel treatment tank walls. Five samples were visually inspected and photographed. Microscopic examination of samples was performed using light microscopy and scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS).

The inner surfaces of the tanks exhibited severe localized corrosion and pitting. Pitting and general corrosion between the pits were observed on the surfaces of each sample. Regions of high sulfur concentration were detected on the surfaces of the cleaned and uncleaned samples. The EDS examination indicated that sulfur was the main corrosive species of the tanks. It was discovered that high concentrations of sulfur on the surface of the tanks led to the crevice corrosion by breaking down the passive layer of the 304 stainless steel. An analysis for fitness for service per API 579 determined that the tanks were structurally unsound and in need of extensive repair.

Chiller Heat Exchanger

The heat exchanger was found to be leaking internally. The ESi laboratory analysis of the heat exchanger's tubes found no significant corrosion on either the interior or exterior surfaces of the tubes. Further laboratory analysis identified a manufacturing defect in the tube's longitudinal welds that were likely responsible for the reported leaks.

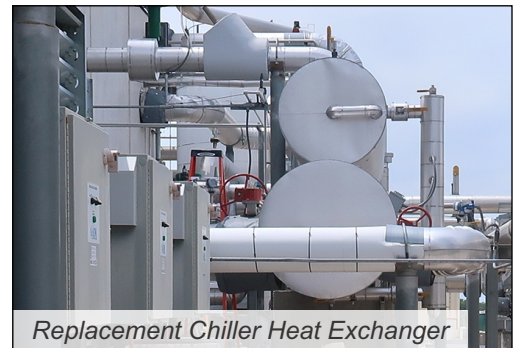
ESi also evaluated the design of the tube heat exchanger with alternative metals of carbon steel shells and stainless steel tubes as its composition was alleged to be the cause of the leakage. However, the original heat exchanger's construction is commonly used within the process heat transfer industry and is a recognized and generally accepted method of construction within the ASME BPVC.



Corrosion & Pitting Sample from H₂S Steel Tanks



Leaky Chiller Heat Exchanger



Replacement Chiller Heat Exchanger

RESULTS

Dr. Alfred Pettinger, ESi Practice Group Director, testified on the investigation and conclusions. The arbitration panel found both equipment failures to be Force Majeures and that the operator used best efforts to remedy their inability to accept LFG.

The ESi root cause analysis of the tanks established that they were damaged by the aqueous H₂S corrodent.

The heat exchanger was not damaged due to improper operation or H₂S, but leaked due to pre-existing longitudinal partial penetration welds that apparently grew over time into narrow longitudinal cracks. The cracks were only discoverable under operating conditions when pressure and temperature were applied, and did not appear with the commonly used isothermal pressure testing. A new heat exchanger was constructed as a replacement.



**Engineering Consulting
and Forensic Investigation**

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WHY ESi. The mechanical engineering practice group is comprised of consultants with backgrounds in:

- Code Compliance Analysis
- Control Systems
- Design Analysis
- Failure Analysis
- Finite Element Analysis
- Fluid Mechanics
- Fracture Mechanics
- Heat Transfer
- HVACR Analysis
- Risk & Reliability Analysis
- Safety Analysis
- Stress Analysis
- Testing & Instrumentation
- Thermodynamics
- Vibration & Modal Analysis