LNG & AIR FILTRATION

ACHIEVING HIGH RELIABILITY AND AVAILABILITY COMPRESSION SYSTEMS FOR LNG EXPORT SITES.

LNG

With the development of shale gas and the high gas prices overseas, LNG export projects are multiplying in North America. A large majority are planning to use gas turbines to power their compression trains and as such, require an air inlet filtration system.
Standard OEM supplied filtration systems do not always take into consideration the specific needs of LNG sites. Mainly located in coastal and industrial locations, they have to support the double burden of salt laden air and high dust load from their neighbouring industrial activities. LNG export requires continuous production, and as such, reliability and availability are highly critical.

GREENFIELD PLANT ON THE COAST

One company realized the challenges they were facing and decided to invest early on to ensure they limit potential operating issues. Their future LNG plant will be located on the coast of the Gulf of Mexico, in an industrial area with high particulate matter.

A STEP BY STEP EVALUATION

Camfil proposed a step-by-step evaluation. Air sampling was first performed to analyse the size and concentration of the dust. After that, multiple life-cycle cost analysis were performed to identify an optimzed inlet configuration.
Life-cycle cost analysis are in-depth computer generated analysis of all the variables relevant to the filtration system choice: the environment, the pollutants in the air, the turbine model, the airflow, the heat rate, the cost of fuel, the average value of each MW produced, the cost of lost production due to downtime for compressor wash, filter change or maintenance schedule, system and filter pressure drop cost, the filter disposal cost, how fouling or pressure drop affects power out as well as CAPEX consideration.

SELECTION AND ON-SITE TESTING

The software simulation helped narrow the selection down to a 3 stage system with a final E12 stage. Selecting the right efficiency was just the start. Efficiency is a laboratory measurement done under dry controlled conditions. However, power plants are not located in laboratories. Actual site conditions and particle types vary widely and actual filter construction also influences performance.
To finalize selection, it was decided to bring a Camlab - an onsite testing trailer - on the future site to monitor the performance of the different recommended filtration options during 3 months of operation.

Why are LNG sites so challenging?

- Salt-laden coastal or offshore sites
- Typically industrial settings with high dust level
- High value of continuous production, means reliability and availabity are highly critical
- Availability requirements highlight the importance of reducing compresssor washes, downtime for final filter change and lowering maintenance by preventing corrosion and erosion

CASE **STUDY**

Power Systems

The conditions at the site were hot and humid, with average dust mass concentrations of 30-40ug/m³ and spikes as high as 120ug/m³

Filtration data

	Standard OEM M6-F9[1]	Standard F7-E10	Camfil F9-E12 3V600[2]	Camfil M6-F9-E12 4V300
Average efficiency on 0.4 um	85.71%	**99.01%**	**99.99%**	**99.99%**
Initial final filter dP	0.65	0.90	0.7	1.40
Final filter dP after 3 months	0.66	0.95	0.79	1.42
Life Cycle Cost Estimation (20 years, incl. CAPEX)	30M USD	14M USD	11M USD	13M USD

1. Per En779:2012 / 2.The extended 3V600 has twice the depth as the 4V300 12" compact filter, thus offering a lower pressure drop at the same efficiency. LCC estimation with **3 stages and final filter 24" depth: 12MUSD.**

The Camlab test ran 4 filter combinations side-by-side:

- The OEM proposal: an M6 bag pre-filter and final F9 compact mini-pleat,
- an F7 prefilter with a compact final E10,
- a compact F9 with an extended depth 24" compact E12 and,
- Camfil recommended 3 stage system, an M6 prefilter followed by an F9 mini-pleat and an E12 mini-pleat as final.

Camfil recommendation was based on the LCC analyses and a successful LNG installation in Trinidad and Tobago - 26 units running for more than 4 years with no signs of power degradation (i.e. no improvement recorded after the washes that are performed based on the OEM recommended maintenance schedule).

ON-SITE MONITORING RESULTS

The Camlab's first test confirmed the harshness of the environment. 100% humidity days were frequent, spikes in dust concentration as high as 120 µg/m³, with a majority under a micron in size. To compare, 90% of US sites never see concentrations higher than 100 µg/m³.[1] The 3 month test confirmed the superior efficiency of the two systems with the final E12 filter (99.99% efficiency vs. 85.7% means 1400 times less particle penetration[2]).

With availability in mind and assuming the site would change pre-filters while online, the second factor to consider was the pressure drop increase on the final filter and what it meant for filter life. The pressure drop increase, on the OEM recommendation as well as the 3 stages E12, were minimal despite the lower efficiency for the OEM system that let small particles pass through the final filter. The test showed the 3 stage E12 design had a lower pressure drop rise of the final filter from contaminant loading, as compared to the 2 stage F9 system (0.02"w.g. compared to 0.09"w.g.).

Final selection was made for the 3 stage system, but with the extended 24" depth CamGT 3V600 for the final filter. Thanks to its lower initial pressure drop and larger media area leading to a longer life, expectations are that in baseload operations the final 24" deep E12 filters would last even longer than the 5 years life of the 12" depth.

Site data

Total run time	3 months / 1278 hours
Median relative humidity (RH)	96%
Median temperature	83 °F (28.3 °C)
Average dust concentration (g/m³)	30-40
Peak dust concentration (g/m³)	120

The small CAPEX increase for a 3 stage system with EPA grade final filter has proven its value in terms of performance during testing as well as in the field.

Main Benefits:

- **No shutdown for compressor washing**
- **Shutdown for final filter change extended to over 5 years - to be combined with maintenance activities**
- **Maximum power output (MW)**
- **Lowest life cycle cost estimation**

1. See EPA website. 2013 National Trends in PM10 Concentrations in 1990 - 2013. http://www.epa.gov/cgi-bin/broker?_service=data&_program=dataprog.aqplot_data_2013.sas&parm=81102&stat=MAX2V&styear=1990&endyear=2013&pre=val&region=99
2. Pentration rate of 0.01% versus 14.3%