

# CATALYSTRAK®

CATALYST ACTIVITY AND MANAGEMENT

## CatalysTrak® - Activity\* In Situ Catalyst Activity Test System

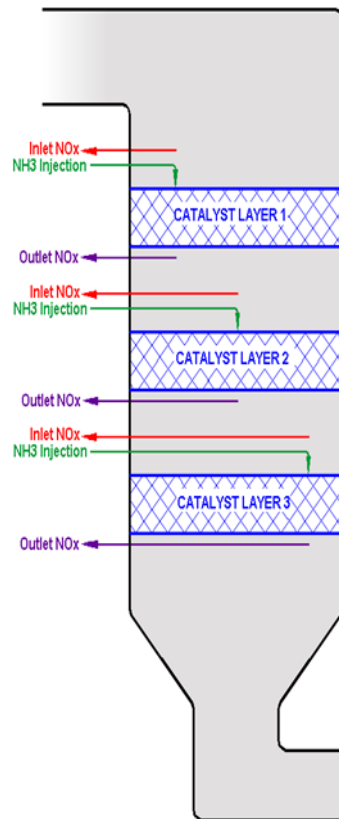
In response to the need for more frequent measurements of catalyst activity, Fossil Energy Research Corp. (FERCo) is offering the **CatalysTrak® - Activity In Situ Catalyst Activity Test System**, a proven technology that can determine SCR catalyst activity without requiring an outage to obtain catalyst samples.

The **CatalysTrak® - Activity** test system has provided on-demand measurements of catalyst deactivation since 2005 at Alabama Power's Plant Gorgas Unit 10, and on a combined cycle gas turbine at Clearwater Cogeneration since 2013. CatalysTrak® - Activity has also been implemented on two additional coal-boilers.

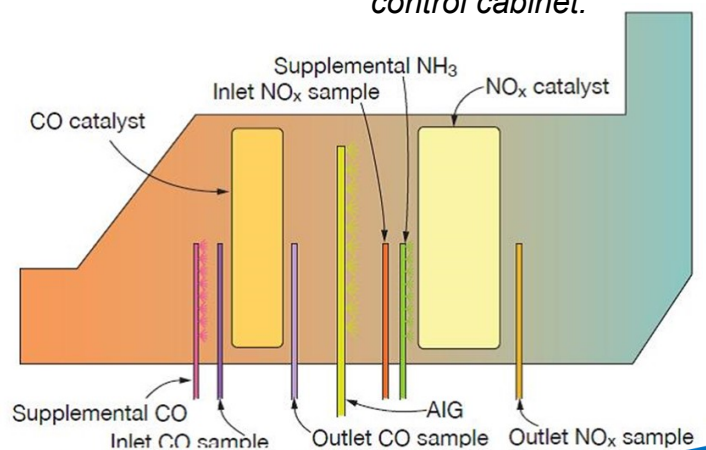
### CatalysTrak®- Activity features:

- Catalyst activity measurements anytime the SCR reactor is online
- Test individual layers independently
- Test multiple locations on each layer
- Monitor activity at low load (below MOT)
- Technique is the same as laboratory tests
- Larger data set than annual lab testing
- Avoid long lab turn around times
- Includes gas analyzers, sample probes, and mini-ammonia injection grids
- Easy to use interface allows calibration of analyzers, testing and data reduction
- Coal-fired, refinery, biomass and gas turbine applications

\* U.S. Patent No. 7,635,593



The **CatalysTrak® - Activity** test system is easy to install. Each typical test location requires only two standard 4" ports, one upstream and one downstream of the catalyst layer. Test as many locations per reactor as needed. All locations are managed by one control cabinet.



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FOSSIL ENERGY RESEARCH CORPORATION

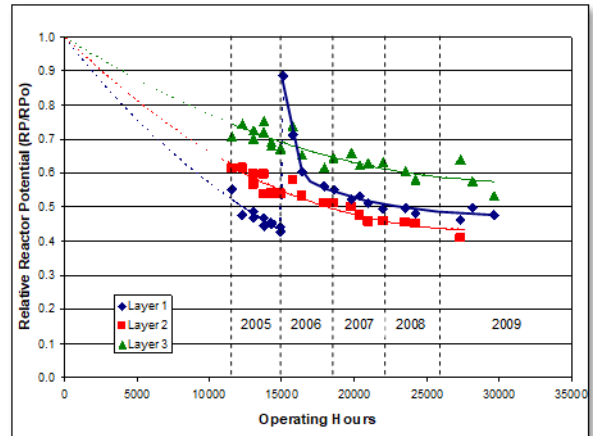
# KNOW YOUR POTENTIAL

## CatalysTraK® - Manage Catalyst Management Software

The goal of **CatalysTraK® - Manage Catalyst Management Software** is to take the guesswork out of catalyst replacement decisions. By entering data about your specific SCR reactor **CatalysTraK® - Manage** will determine when catalyst additions or replacements are necessary and can forecast the associated economics such that appropriate, cost effective strategies can be developed.

- Input SCR specific parameters, such as size, catalyst type, number of layers, desired NO<sub>x</sub> reduction, and NH<sub>3</sub> slip limit
- Catalyst activity data measured by FERCo's **CatalysTraK® - Activity** test system easily interfaces with the software to accurately predict Reactor Potential and catalyst life
- Can also be used with vendor specified deactivation data or one of several default deactivation rates
- Investigate various catalyst management scenarios, such as varying catalyst types, number of filled layers, new vs. regenerated catalyst, and the effect of deactivation rates
- Can be used to determine the effect of firing different coals, particularly biomass co-firing
- Forecast economics involved to determine the impact of reagent usage, outage, labor and NO<sub>x</sub> credit costs

**CatalysTraK®** products provide proactive, on demand data allowing better catalyst management decisions which will prevent unwanted costs associated with emissions credit purchases or reduced outputs.



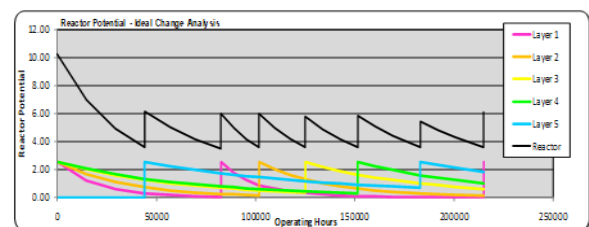
Actual data collected by CatalysTraK® - Activity

Catalyst Deactivation Worksheet						
Deactivation Rates		T Values				
		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
Default Low Arsenic		28000	40000	60000	80000	100000
Default High Arsenic		18000	23000	30000	30000	30000
Fit Vendor EOL Estimate		31578	45112	67698	67698	67698
User Supplied		21319	34756	62016	69854	104508
User Supplied, %/10K hours		44814	61531	94912	94912	94912
User	Used in the Calculations	21319	34756	62016	69854	104508

e-I/T Time %/10K hrs	Actual Deactivation Data or Vendor Curves (K/Kg)				
	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
0	1	1	1	1	1
2000	0.86	0.94	0.93	0.97	0.97
4000	0.84	0.84	0.94	0.92	0.98
6000	0.7	0.84	0.89	0.92	0.91
8000	0.7	0.75	0.9	0.88	0.93
10000	0.6	0.76	0.82	0.87	0.98
12000	0.66	0.67	0.81	0.84	0.91
14000	0.5	0.68	0.75	0.82	0.95
16000	0.48	0.6	0.76	0.78	0.96
18000	0.39	0.6	0.72	0.78	0.93
20000	0.4	0.55	0.75	0.74	0.83

Activity data can be entered into CatalysTraK® - Manage "Deactivation" worksheet



Deactivation and SCR specific data is used to predict the Reactor Potential for all layers

# FREQUENTLY ASKED QUESTIONS

## **What is associated with a typical *CatalysTraK® - Activity* system?**

A typical *CatalysTraK® - Activity* system includes both hardware and a Testing Services Agreement:

### ***CatalysTraK® - Activity* Hardware:**

- Equipment for each individual test location within the reactor which includes:
  - Mini ammonia injection grid (AIG)
  - Probe and filter assemblies for the inlet and outlet sampling locations
  - 4-inch port flanges with fittings to provide the tubing connections to the AIGs and sample probe assemblies within the reactor
- System control cabinet located external to the reactor which includes:
  - Valves or switching the inlet/outlet flue gas sampling lines and the AIG supply lines between the individual test locations
  - Filters and valves to provide plant service air for back-purging the sample probes
  - Anhydrous ammonia flow measurement and control
  - Flue gas conditioning and NO/O<sub>2</sub> analysis system
- Operating and data reduction software
- Utility responsible for some permanent equipment installation

### ***CatalysTraK® - Activity* Testing Services Agreement:**

- Testing services to be performed by plant engineer or FERCo personnel, as decided by an annual contract
- If tests are performed by plant personnel, FERCo provides remote support and guidance when planning and conduction the measurement
- FERCo performs all data analysis and provides a summary report after each set of activity measurements

## **How often are the catalyst activity tests performed? How long do the tests take?**

It is recommended that activity tests are run every three to four months. Once the analyzers have been turned on and calibrated, a complete activity test for each location takes approximately 2 hours. The test locations are tested one at a time through the use of manual valves in the control cabinet. Therefore, a system with 4 test locations would take about 10 hours from start to finish, including calibration.

## **How often do the analyzers need to be calibrated? What is the calibration procedure?**

The analyzers (NO and O<sub>2</sub>) are only turned on a calibrated when an activity test is being performed. The remainder of the time they are off. Before testing the analyzers are allowed to warm-up, which typically takes about an hour. Then, they are calibrated using known calibration gases, which takes about 15 minutes. We specify the calibration gases to be used (to be provided by the owner/utility) and they are typically stored adjacent to the control cabinet.

## **Are the test locations (injection grid and sample probes) fixed inside the reactor at all times or are they removable? If they do remain in the reactor, have they proven to withstand the harsh conditions (ash, acidity, temperature fluctuations) within the SCR for an extended period of time?**

The injection grids and sampling probes are permanent within the reactor. The current system at Plant Gorgas has operated through 4 ozone seasons **and ten full calendar years**, and has shown the basic ammonia injection and sampling hardware to be robust. To avoid acid corrosion near the 4-inch installation port we specify a corrosion resistant alloy for the tubing utilized in these areas.

**How are the injection grid and sampling probes kept from plugging?**

The sample probes (both inlet and outlet) are equipped with filters and backpurge capability. Typical procedure is to backpurge the filters both prior to and after each set of activity tests. Carrier air (filtered and dried plant-supplied service air) is used to transport the anhydrous ammonia to the injection grids. This carrier air is always on, even if the ammonia is not on, preventing the injection grids from plugging.

**Your literature states that one port is added before and after each layer. Is the system capable of having multiple test points associated with each port? If so, how many test points can be supported by each port?**

Our literature does state that one port is needed upstream of each layer for ammonia injection and measurement of inlet NO and O<sub>2</sub>, and then one port downstream for outlet NO and O<sub>2</sub>. However, these ports can be combined, depending on accessibility. For instance, at the Plant Gorgas installation, the outlet probe for layer 1 shares the same port as the inlet probe and AIG supply line for layer 2. Therefore, for a 4-layer system, it is possible to only need five ports in total. Additionally, you can have more than one test location per layer, as the Plant Gorgas system is configured (i.e., the port between layers 1 and 2 provides access for two outlet sampling locations on layer 1, as well as two inlet locations and two AIG supply lines on layer 2). The maximum for a 4-inch port is two outlet, two inlet, and two AIG connections. A larger port would be able to accommodate more than 2 test points per layer; or additional ports could be added.

**Are single test points mobile across the catalyst layer, creating a multitude of test locations?**

The test points are not mobile. However, multiple test points can be installed on each layer.

**How often is the anhydrous ammonia injected? How long does the cylinder gas typically last?**

Ammonia is injected through the mini-AIGs only during activity tests, which are typically performed on a quarterly basis. At the Plant Gorgas site with an "XG" size cylinder (150 lbs net NH<sub>3</sub>) and eight test locations, with tests being run quarterly, the cylinder lasts approximately three years. However, this will vary based upon the number of total test locations, the frequency of tests, and the inlet NO<sub>x</sub> level.

**Does running the in-situ tests at an NH<sub>3</sub>/NO<sub>x</sub> ratio of greater than 1.0 give a false sense of activity since real SCR operating conditions limit NH<sub>3</sub>/NO<sub>x</sub> ratios to the range of 0.8 to 0.95 (the reactor must be able to perform at lower injection ratios to avoid high NH<sub>3</sub> slip)?**

The test procedure for the device closely parallels that specified in the VGB Guidelines, as well as the EPRI Protocol for the laboratory analysis of SCR catalyst samples. Catalyst activity measurements in the laboratory (per the VGB and EPRI Protocols) are run at an NH<sub>3</sub>/NO<sub>x</sub> ratio of 1.0, not the "normal operating condition" of the full-scale reactor (usually NH<sub>3</sub>/NO<sub>x</sub> = 0.8 to 0.95). Catalyst activity is defined as a function of the maximum NO<sub>x</sub> removal achievable for the catalyst sample, not the NO<sub>x</sub> removal at the "normal operating condition". The laboratory tests are run at the higher injection rate in order to measure this maximum NO<sub>x</sub> removal (and hence, catalyst activity) for the catalyst sample. In the laboratory, near perfect mixing of NH<sub>3</sub> can be achieved upstream of the test sample, and the maximum NO<sub>x</sub> removal can be achieved at near perfect stoichiometry (NH<sub>3</sub>/NO<sub>x</sub>=1.0). For the **CatalysTraK® - Activity** in-situ device however, well-controlled laboratory conditions do not exist, and it is necessary to over-inject NH<sub>3</sub> to assure the maximum NO<sub>x</sub> removal is achieved over the test section. We compared our in-situ measurements of activity for a new catalyst layer installed at Plant Gorgas to both the catalyst vendor's value of activity, and a third-party laboratory determination and we were all in agreement within 3 to 6%. Once an "activity" is measured, there are calculation procedures to relate that activity to performance under normal conditions.