

# Hydra-Cell Pro Pumps for NOx Reduction Applications Inlet Fogging, Water Injection, SCR & SNCR, Wet FGD

By: Chris Pasquali, CEO Factory Direct Pipeline Products, Inc.

A common application for Wanner Engineering Hydra-Cell Pro pumps is power generation NOx reduction via high pressure water and reagent injection.

## What is NOx?

NOx is a general term mostly related to Nitric Oxide and Nitrogen Dioxide; gasses formed via combustion of fossil fuels (oil, gasoline, natural gas and coal). When the combustion process exceeds roughly 2800°F a chemical reaction takes place that accelerates NOx generation.

NOx emissions are regulated due to health and environmental concerns such as smog and acid rain.

California has the strictest regulations related to reduction of NOx emissions; Several states, including New York, New Jersey, Oregon, and Massachusetts, have adopted emission standards modeled after California's. These increasingly strict regulations limiting emissions increase the cost of power generation, either due to the excess costs levied by the government, the cost of equipment upgrades or converting to (or supplementing with) solar, wind, nuclear and other non-fossil fuel-based combustion power plants.

Cost effective methods of NOx control for power generation plants is to maximize the efficiency of their process and to control the combustion temperature.

## Inlet Fogging = Power Boost, NOx Control

This is a process where deionized (DI) water is sprayed at high pressure through spray nozzles, resulting in fine droplets; DI or highly filtered reverse osmosis (RO) water is required due to the fine orifices of the spray nozzles. DI water, a water without minerals, is aggressive to alloys such as iron, steel, brass and even 304 stainless steel; 316SS and duplex stainless steel are most commonly used alloys for piping systems. Wanner Hydra-Cell Pro pumps are available in all the aforementioned materials.

The droplets evaporate at the inlet of the compressor and it has an evaporative cooling effect resulting in cooler air which is denser, thus increases the capacity of the compressor. The increase in air-to-fuel ratio effectively results in a leaner mixture AND the air is cooler which corresponds to a lower peak combustion temperature.



D35 Hydra-Cell Pro Water Injection Pump  
Skid for Peaker Power Plant & Oil

The combination of a leaner mixture with reduced combustion temperature result in less NOx generation plus a power-boost.

Generation of fine droplets requires smooth pumping action at high pressures (typically within >1000 to 3000 PSIG). Evaporative cooling efficiency is lost when larger droplets are generated, the goal is for each spray nozzle to provide a relatively uniform pattern of droplets within the 10-20 micron

range. Such fine droplets evaporate efficiently, maximizing cooling. Larger droplets can pass into the compressor, reducing cooling efficiency and potentially causing blade erosion. Therefore smooth pumping action is critically important as pressure fluctuations contribute to coarser droplets.

Hydra-Cell Pro pumps output a smooth flow rate, evidenced by other applications they excel at such as spray dry flue gas desulphurization (FGD) and selective catalyst reduction or selective non-catalytic reduction (SCR/SNCR) which are other processes related to NOx and air pollution control applications.

## Water Injection = NOx Control

Injecting water directly into the combustion of fossil fuels is a more direct approach to combustion temperature control. This approach is primarily used by "peaker plants" (provide supplemental power to the grid to offset high demand periods; mostly related to air conditioning usage) and power plants burning distillate oil. Baseload plants and newer combined-cycle plants usually accomplish NOx reduction via selective catalyst injection (SCR). For baseload or combined-cycle plants, the large volumes of water required make direct injection impractical, so SCR is more common.

Injecting water into the fuel at combustion directly lowers the peak temperature of the combustion process and thus reduces NOx emissions.



D15 Hydra-Cell Pro Inlet Fogging Pump Skid

The flow rate required for water injection is proportional to the fuel flow (turbine load) and thus a positive displacement pump such as the Hydra-Cell Pro is required; they can operate within a 10:1 turndown ratio and their performance in terms of repeatability, steady-state accuracy and linearity satisfies API 675 standards for metering pumps. Repeatability and

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linearity are very important aspects of pump control for predictable and consistent results.

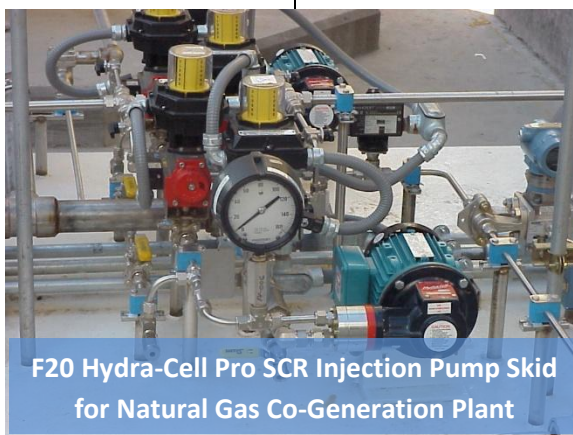
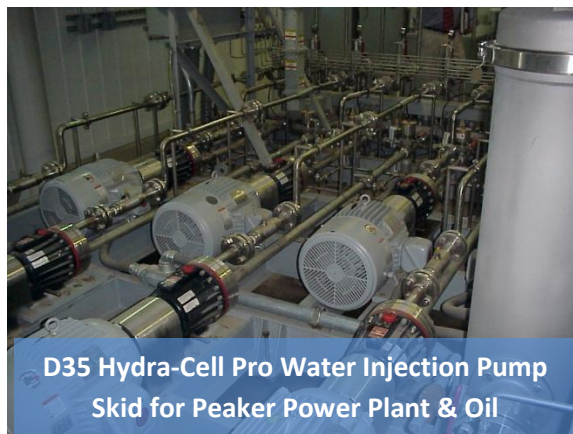
Unlike inlet fogging applications, mixing water with fuel does not require fine orifice atomizing nozzle, so the pump discharge pressures are in the 700-800 PSIG range. The smooth and repeatable flow rate is absolutely vital for combustion control.

The proportionality aspect is especially important for the "on-demand" or "peaker" power plants which are used to supplement power generation during heavy use periods, continuously ramping up and down, requiring precise control of both fuel and water flow rate.

Some power plants employ both approaches to NOx reduction, maximize efficiency of the compressor with cooler air for combustion AND inject steam or water directly into the combustion process to control combustion temperatures and NOx output.

## SCR & SNCR NOx Reduction

Selective catalytic and non-catalytic reduction refers to the process of injecting aqueous ammonia (SCR) or urea (SNCR) into the flue gas where it reacts with the NOx. The SCR applications are generally lower flow rate and lower pressure applications, a few gallons per minute at pressures up to 300 PSIG. Aqueous ammonia is quite corrosive and volatile, thus the sealless design of Hydra-Cell Pro Pumps is absolutely critical for SCR applications.



SNCR applications require higher flow rates and pressures, perhaps up to 2000 PSIG. SNCR requires injecting urea or ammonia into the flue gas at high temperature (typically 1600–2100°F). Fine atomization and even distribution are critical since there is no catalyst to promote the reaction. These droplets need to evaporate uniformly within a short residence time. This differs from SCR where the reagent is applied to the surface of the catalyst and atomization is less critical.

## Wet (FGD)

Wet Flue Gas Desulfurization is primarily employed for reducing SO<sub>2</sub> emissions (major contributor to acid rain and smog). Hydra-Cell Pro pumps are used to pump 20-25% concentrated lime slurry to air atomized injection spray nozzles. Since compressed air is assisting with atomization and the discharge pressures are not high, the primary design advantage Hydra-Cell Pro Pumps provide is their sealless design, replacing centrifugal pumps having leak prone shaft seals and packing.

Wet FGD can absorb some NO<sub>2</sub>, though it has little impact on NO. As a result, it provides only a minor polishing effect on total NOx. The wet FGD process is based upon a chemical reaction to convert the SO<sub>2</sub> gas into a solid byproduct (calcium sulfate) and during that chemical reaction some NO<sub>2</sub> will be absorbed further reducing NOx emissions.

Contact us today to learn more about Hydra-Cell Pro sealless pumps and how they will contribute to a less maintenance prone pump system which reduces both generated NOx and fugitive emissions.

## Pump Requirements for NOx Reduction Applications

Hydra-Cell Pump Characteristics	Inlet Fogging	Water Injection	SCR	SNCR	Wet FGD
316 and duplex SS materials of construction	✓	✓	✓	✓	
Accurate and repeatable flow rate across a 10:1 turndown ratio	✓	✓	✓	✓	✓
Smooth pumping action for fine spray atomization	✓	✓	✓	✓	✓
Low maintenance	✓	✓	✓	✓	✓
Capable of high pressures, up to 300 PSIG		✓	✓		✓
Capable of high pressures, up to 3000 PSIG	✓			✓	
Sealless design (reduces fugitive emissions)			✓	✓	✓