

Everyone needs megawatts! Throughout America and the world, power demands are rising due to data centers which sometimes steal power from residential and commercial grids. Unfortunately, the gas turbine original equipment manufacturers (OEM's) are booked solid for 2-3 years and installation of a new engine is fraught with greenfield permitting and financial risks. Besides, maybe a new power plant is not needed, rather, just a strong power increase? So how do you increase gas turbine power output this year and not years in the future? Inlet water augmentation will provide up to 15% increase in gas turbine power and is deliverable within 40 weeks of purchase.

Caldwell Energy is a well-established manufacturing company hidden in the bourbon belt of Louisville, Kentucky USA. Don Shepherd began its operations in 1995 and the company quickly found its niche building and installing gas turbine power augmentation equipment by using Wet Compression and Fogging.

Water Mechanisms: When air is cooler, it is denser, and when it is hotter, it is less dense. Accordingly, in hot weather, gas turbine power is reduced and much of this lost power can be recovered by installing fogging and/or wet compression.

Fogging works by introducing a fine mist of water into the inlet airstream far enough upstream of the engine that the water has

time to evaporate into the incoming air. The humidified air is now full of water and the evaporation has made it cooler, so, to the denser air, more fuel can be added increasing the power output of the gas turbine. Fogging power increases depend on the relative humidity of the ambient air, but in dry locations, up to 6% increase in power can be had.

Inlet humidity for fogging must be tightly controlled. Too much water, using techniques labeled "overspray" or "high fogging" oversaturates the air turning the fine droplets into large slugs of water that either stick to inlet ductwork and run, wasted, out the drain, or enter the compressor as large slugs and erode the compressor blades. Inlet Fogging increases power by up to 6% depending on ambient relative humidity.

But if more power is needed, *Wet Compression* can deliver. Wet compression works by *intentionally* introducing *liquid* water, in very fine drops, into the compressor of the engine. When this water evaporates, the latent heat of vaporization cools the air which reduces its volume. The evaporative cooling (also known as compressor intercooling) helps the compressor do its job and the saved work is then available to turn the generator. Also, the extra mass flow through the engine is combusted with more fuel to make additional power. In

total, wet compression increases gas turbine output by up to 15%.

Benefits: Wet Compression generally increases power output by up to 15% depending on the engine and ambient conditions.

Scope: The main component of fogging and/or wet compression equipment consists of a skid which mounts the long-lasting, smooth running, easily maintained, axial positive displacement pumps, (no belts or vibration) AC motors, filters, valves, variable frequency drives, and programmable logic controller. The skid itself is made of painted structural steel and mounted on a customer-supplied concrete pad outside the enclosure. The other main component is the nozzle spray rack which is mounted inside the gas turbine inlet duct. Water delivery happens through these nozzles.

To generate a firm proposal, Caldwell typically arranges a site visit to perform a 3D scan of the inlet ductwork. This scan is used along with engine air mass flow to create computational fluid dynamics (CFD) models which determine nozzle quantity and locations in the inlet duct. Next, finite element analysis (FEA) is used to perform stress analysis on the modeled spray rack structure to ensure integrity and long life. Components are ordered and assembled, and complete unit operational wet testing happens at

Caldwell's factory before delivery. Specialized crews perform the installation in little more than a week, then commissioning and testing is supported.

Notes on Operation: Wet compression is only operated above 50°F with the engine at base load. There are usually two stages of flow and they are ramped up to the maximum water flow. Also, the engine OEM may recommend specific actions after a turbine trip, and there may be hours limitations per service interval. Always consult your engine OEM when applying water augmentation.

Risks: But water augmentation is not without risks! Demineralized (demin) water must be used to maintain clean compressor surfaces, otherwise corrosion starts and will not only cause pitting on blades and vanes but could also impede disassembly on some engines. Demin water also keeps the spray nozzles free of deposits that would spoil the fine droplet size and turn the mist into large slugs of water that will either stick to inlet ductwork and run, wasted, out the drain, or impact the compressor blades and quickly cause severe erosion.

Things to look out for:

- It is well known that CO emissions will go up if WetC is used at the same time as duct firing, so permitting actions for CO emissions may need to be addressed.

- Plant water usage will increase, and permitting actions may be necessary for that, also.
- Using demineralized water is mandatory, so holding tanks will need to be constructed.
- Inspections must be conducted on the spray rack to ensure there are no dirty or loose nozzles or structure.
- In some applications, the engine OEM may restrict hours and/or require coatings or replacement of the early stages of the compressor or outright replacement of these blades and vanes at each major. Consult your engine manufacturer for those specific recommendations.

Case studies: In 2025, Caldwell Energy completed installation of wet compression on a Mitsubishi JAC frame, achieving 38MW added at 156 gpm of injected demineralized water. Caldwell Energy also achieved first time application Siemens frames with 60Hz F5 MW added, F5EE MW added, G MW added in 202, 4000F MW added, 2000E MW added and soon to be HL anticipating MW added.

Looking forward: To accommodate increasing business and stretch our legs, Caldwell Energy is currently constructing a new 40,000 ft² manufacturing plant in Shelbyville, KY. Plant opening and operation startup is forecasted to be early 2026.

Conclusion: In hot and/or dry areas, water augmentation has proven itself. And since 1995, Caldwell Energy has installed over 6.2GW of increased capacity between fogging and wet compression.

When contemplating pricing, it's instructive to put the benefits of wet compression into perspective in dollars per kilowatt (\$/kW). Prices for a new plant are around 1,500-2,000 \$/kW, which, many times, is too much and takes too long, so most power providers go to the OEM for a traditional blade and vane gas turbine modernization. These generally are on the order of 500-600 \$/kW. This would put the price of a 22MW GT Modernization from the OEM at around \$13,000,000 and it would still require an 18-month leadtime, and a rotor-out major to implement. Additionally, at last check, OEM's generally sell wet compression at around \$125/kW. Compare those figures with the current proposal pricing and see that Caldwell wet compression is the single most cost-effective way to add power to gas turbines.

Also, compared to blade, vane, and combustor upgrades, water augmentation has multiple advantages. An engine cover lift is not required. Unlike a firing temperature increase, water augmentation does not burn up hot parts, change service intervals, or increase NOx. The install time is about 2 weeks including commissioning and testing. Installed cost



is far lower than turbine modernizations
and has a much shorter leadtime.

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