

Emissions

NO_x Reduction at a Vermont Ski Resort

Miratech SCR system used to reduce engine emissions from snowmaking activities

To a skier, there is nothing quite like the feel of fresh snow and the sound of cutting skis as one glides down picturesque mountains with perfect snow conditions. Each year from late November through early April, that feeling is replayed thousands of times at the Okemo Mountain Resort, located near the town of Ludlow in the mountains of south central Vermont, U.S.A.

For years, the best ski resorts have known that success depends on their ability to do one thing — create and consistently maintain the best possible snow conditions. And in Vermont, Okemo Mountain Resort is one of the best. In terms of snow quality and grooming, the resort is consistently ranked as the best in the state (SKI Magazine). Its snowmaking coverage capabilities are listed at 95%. Needless to say, The Okemo Mountain Resort takes its snow seriously.

One of the resort's primary engine-driven air compressors for snowmaking is powered by a 69 L displacement Caterpillar V-16 3516B diesel. The eight-year old engine operates approximately 1500 hours annually while driving an Ingersoll-Rand Centac centrifugal model 2ACII57D3 compressor. The compressor produces 2832 inlet m³/s of compressed air at 6.9 bar. While the compressor requires 935 kW of power, the engine can produce 1104 kW at 1550 r/min.

Due to the lack of extensive natural gas distribution in southern Vermont, most ski areas use #2 diesel fuel for snowmaking equipment purposes.

Three years ago, the State of Vermont approached the Okemo Mountain Re-



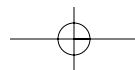
The Okemo Mountain Resort constructed a separate building (entered through doorway at left) to house the Miratech SCR system reactant storage tank, injection panel and all other components, next to the Cat 3516B engine-IR Centac compressor package enclosure (entered through doorway at right).

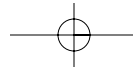
sort and asked it to develop and implement a comprehensive program to reduce NO_x emissions resulting from its large-scale snowmaking activities. The resort takes pride in its willingness and ability to improve ski industry methods and was eager to find an emissions solution that reduced NO_x levels, while maintaining engine use and optimum snow conditions. Further, it was vital to implement the emission solution during the summer shutdown period to insure the system could be fully operational before the start of ski season.

While searching for emissions control options for the Cat 3516B, the resort found that although selective catalytic reduction (SCR) technology for diesel engines was in widespread use in Europe, there were relatively few applications in the United States. The resort's



A closeup view of the urea injector wand location in the exhaust pipe. The exhaust piping was insulated to maintain exhaust temperatures for the catalytic reactions, and a straight run of pipe was necessary for proper mixing and urea hydrolysis.





Emissions



One of the Okemo Mountain Resort's primary engine-driven air compressors for snowmaking comprises a Caterpillar 3516B diesel similar to the unit pictured, driving an Ingersoll-Rand Centac 2ACII57D3 compressor. The Miratech SCR system reduced NO_x by 85% on the engine without any operational problems.

research eventually took it to the Miratech Corporation's website. Intrigued by the company's emissions technology and ability to deliver solutions in a timely and competitive manner, the resort began a dialog and ultimately a partnership with Miratech's emissions control experts.

To provide a viable emissions solution, Tulsa, Oklahoma, U.S.A.-based Miratech solicited the assistance of Southworth-Milton Power Systems, Milford, Massachusetts, U.S.A., the authorized Caterpillar dealer in Vermont and other New England states and upstate New York. The partnership with Southworth-Milton proved beneficial, because the Cat dealer already provided all the maintenance on the engine and lease rental generation for the mountain's electrical needs. Together, the companies designed a system-specific emissions control application.

Installation of the application proved to be a challenge. The Cat engine-IR Centac compressor package is located on a ski slope and therefore is exposed to an extreme and harsh environment throughout the year. Winter daytime temperatures average between -8 and -9°C, and summer daytime temperatures average between 20 and 21°C.

Also, Miratech and Southworth-Milton chose urea as the reductant for its ease of handling and storage. Urea must be stored at temperatures above 1.7°C to avoid crystallization, so the team installed an insulated tank and submersion heater as part of the system. The exhaust piping had to be insulated to maintain

exhaust temperatures for the catalytic reactions, and a straight run of pipe was necessary for proper mixing and urea hydrolysis (conversion of urea to ammonia after injection in the exhaust pipe). The resort constructed a separate building to house the storage tank, injection panel and all other components next to the engine-compressor enclosure.

The SCR system itself consists of three main components. The urea injection panel is a prepackaged unit containing the urea pump, air compressor and PLC for the proper metering of the aqueous urea reductant.

In this application, a higher degree of difficulty was encountered because unlike a base-loaded electrical generator, a compressor application has some engine load swings. The PLC component of this system must track load swings with an engine mapping procedure performed at start-up. The injector wand is placed in the exhaust pipe upstream of the converter, and the urea is sprayed with a very fine mist with the air compressor assisting in the process. The compressor also purges the urea lines during system shutdown to avoid urea crystallization when these lines are exposed to the elements.

Featuring an insulated housing, the converter also contains three layers of SCR catalyst and one layer of oxidation catalyst. Although the Vermont State Air Board requirements were for NO_x reduction only, the oxidation catalyst also provided an additional 90% reduction of carbon monoxide, hydro-

carbon reduction, hazardous air pollutant (HAPs) reductions and served as a failsafe device to avoid any potential of ammonia slip if the SCR catalyst becomes coated or damaged.

In the end, the three-week project was a success. "The system provided the resort an 85% reduction in NO_x on the Caterpillar 3516B without any operational problems," said Allen Fortier, manager of snowmaking at Okemo. "We are proud to be the first in the state to have taken the initiative to make such a step in the reduction of emissions and implement new ways to work in conjunction with our environment."

With Miratech and Southworth-Milton developing and implementing the system as a team, the resort received the benefit of a single-point guarantee on emissions. Miratech provided an emissions-conversion percentage guarantee and Southworth-Milton, through Caterpillar, guaranteed the engine's raw emissions levels.

Thanks to the foresight of The Okemo Mountain Resort and the partnership between Miratech Corporation and



The urea injection panel is a prepackaged unit containing the urea pump, air compressor and PLC for the proper metering of the aqueous urea reductant. Miratech sells, specifies and supports SCR catalytic systems from the Swiss company HUG Engineering.

Southworth-Milton Power Systems offering total emissions solutions, skiers will continue to enjoy excellent skiing conditions in an environmentally friendly setting for years to come. ♡

For more information visit
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