WHITE PAPER: AC DRAGLINE CONVERSION

AC CONVERSION ENHANCES OUTDATED DRAGLINE TECH

MINE SEES MAJOR BOOST IN OUTPUT AND ENERGY SAVINGS

Two years of data confirms an AC system, known for safety advantages and low-cost maintenance, can produce double-digit returns on dragline productivity and efficiency.

TASK: Conversion of DC dragline to AC system
TIMELINE: Retrofit installed July 2019-September 2019; AC optimized July 2021
DATA: Collected September 2019-October 2021
LOCATION: Bowen Basin, Queensland, AUS

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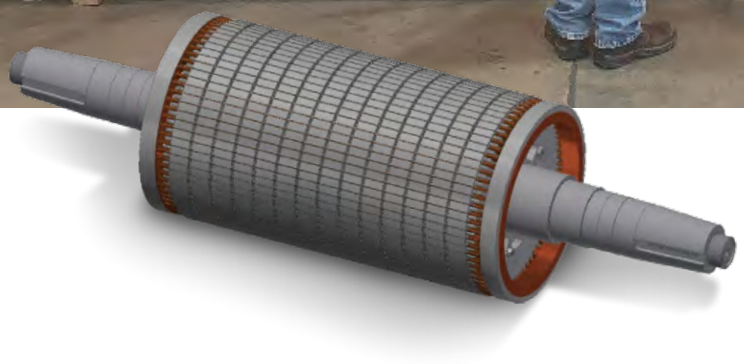


PROJECT OVERVIEW

After retrofitting an aged DC 8050 dragline with a safer AC power system, a multi-dragline coal mine operating in Queensland experienced a major boost in productivity and power efficiency, substantially diminished operating costs, and generated a return on the investment within 18 months.

The data presented here reflects two years of monitoring and includes preliminary results of a July 2021 AC optimization, implemented to increase peak power and reduce cycle time.

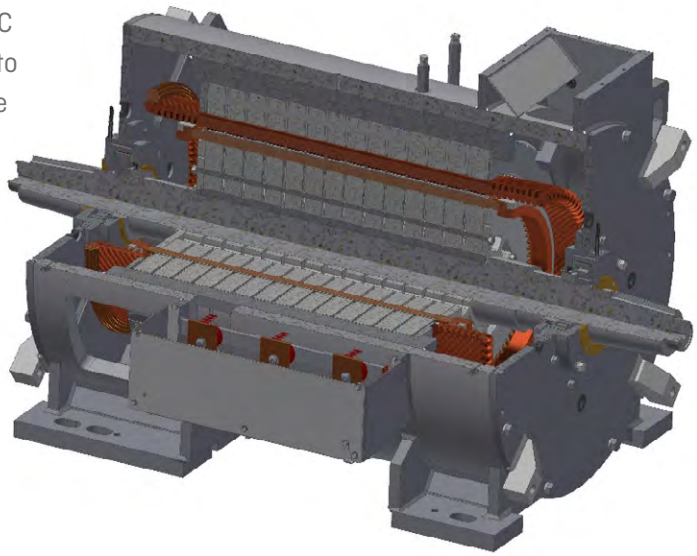
DC UPGRADE VS. AC RETROFIT

In 2018, senior management of a coal mine operating in Bowen Basin, Australia was developing a plan for the DRE28 DC 8050, a nearly 40-year-old dragline on which the DC rotating equipment and DC control system had reached the end of their operating service life. The dragline was still operating with the original Westinghouse DC motors and generators, which had also reached their end of service lifespan.

At a minimum, the DRE28 motors and generators needed to be replaced. They could upgrade to new DC equipment that would maintain productivity for another 25+ years with similar operating costs. However, the DC system required regular maintenance and was at a high risk of extended periods of machine downtime due to waiting for parts and maintenance techs, both of which were harder and harder to find.

Another option was to retrofit the DRE28 with an AC system. AC dragline systems were already known to have safety advantages and reduced maintenance costs compared to DC systems. They also had the same service life expectancy of 25+ years.

The team decided to move forward with an AC retrofit from FLANDERS. In July 2019, the boom was lowered on DRE28 DC 8050 and the on-site retrofit began.



After 90 days, the DRE28 AC 8050 was back online.

DISCOVERING THE AC ADVANTAGE

AC systems are designed with safety built in. Hardware compatibility, simpler and safer operating mechanisms, and scalability are benchmarks of FLANDERS' AC system design.

DRIVE CABINET

One of the key features of the AC system is the unique, easy-to-access drive cabinet designed to replace DC motor-generator (MG) sets. Water-cooled semiconductors remove heat so the cabinets keep parts protected from debris. This results in a substantial reduction in noise, dust, heat, and rotating parts, and reduced exposure of employees and maintenance technicians to these safety hazards associated with DC systems.

The drive cabinet also eliminates the need for on-site machining to blow out dust, balance parts, clean brushes, and other regular maintenance DC systems require.

AC HOIST/DRAG MOTORS

The 690V AC hoist/drag motors are designed to fit in the same size box as the DC motor, with the same footprint, allowing for easy drop-in installation. No modification to brakes, gearing, or coupling is necessary. Class H insulation and high-output blowers help the motors safely produce a 25% higher kilowattage than the DC motor can achieve.

ARC FLASH SAFETY SYSTEM

The FLANDERS AC system design mimicked the DC design in generating low- and medium-voltage interactions. The motors and drive cabinet have a category zero arc flash rating, requiring little intervention with specialists or the need to manually isolate systems within the machine.

There are several systems in place to ensure safety from arc flashes.

1. Metal doors safely hide high-power components, and all doors use Fortress Interlocks to ensure appropriate isolation of high-voltage before access is gained.
2. Electronic control boards can be separated into low voltage panels, nullifying the need to access high-powered areas.
3. Arc Flash optical relays installed in each drive cabinet monitor for arcs and trip high-voltage VCBs to reduce potential energy below arc venting requirements.
4. Fast-acting fuses are located on a) the secondary drive transformer, b) bridge cabinets feeding to drive lineups, and the DC bus in drive lineups.

GROUND FAULT DETECTION

The built-in Bender IRDH265 Ground Fault Monitor eliminates the risk of electric shock, providing a system shut down override at the sign of a catastrophic event. Each drive lineup has a manual ground fault test function to supplement the auto test function of the Bender. This allows electricians to manually verify functionality of the ground fault monitoring system.

The system is programmable logic controlled (PLC), which prevents the circuit from operating while the drive is in operation.

OPPORTUNITIES FOR OPTIMIZATION

Where the DC commutator is limited in output, AC capability is expanding and growing for draglines. There is still potential to be unlocked by analyzing machine data and implementing optimizing upgrades.

OUTCOMES

AC CONVERSION DELIVERS RESULTS

From September 2019 through June 2021, the DRE28 AC 8050 operated at the previous DC 8050 electrical, mechanical, and structural settings.

In July 2021, after system optimization, the AC 8050 surpassed the limits of DC 8050 machines, reaching output levels closer to the 8200 DC draglines models, and continued to bank gains in reduced maintenance costs, increased productivity, and improved energy efficiency.

The data herein represents a side-by-side comparison of DC and AC dragline operations over twelve months, and includes three months of data reported after the July 2021 upgrades as noted.

SAFETY

The DRE28 AC 8050 is, operationally and electrically, the safest dragline in its fleet. The drive cabinets and motors have maintained a category zero arc flash rating, providing consistently safe access for electricians.

"The overwhelming response from our client was related to the safe and easy operation of the AC system. Operators were vocal with management about the improved work conditions," said Owen Uebel, Strategic Business Development Manager for FLANDERS.

PRODUCTIVITY

The low-maintenance design of DRE28 AC system has resulted in reduced machine downtime and proportional gains in machine availability.

A twelve-month comparison study confirmed that, compared to the DC 8050, the AC 8050 moved an additional 2 million BCM.

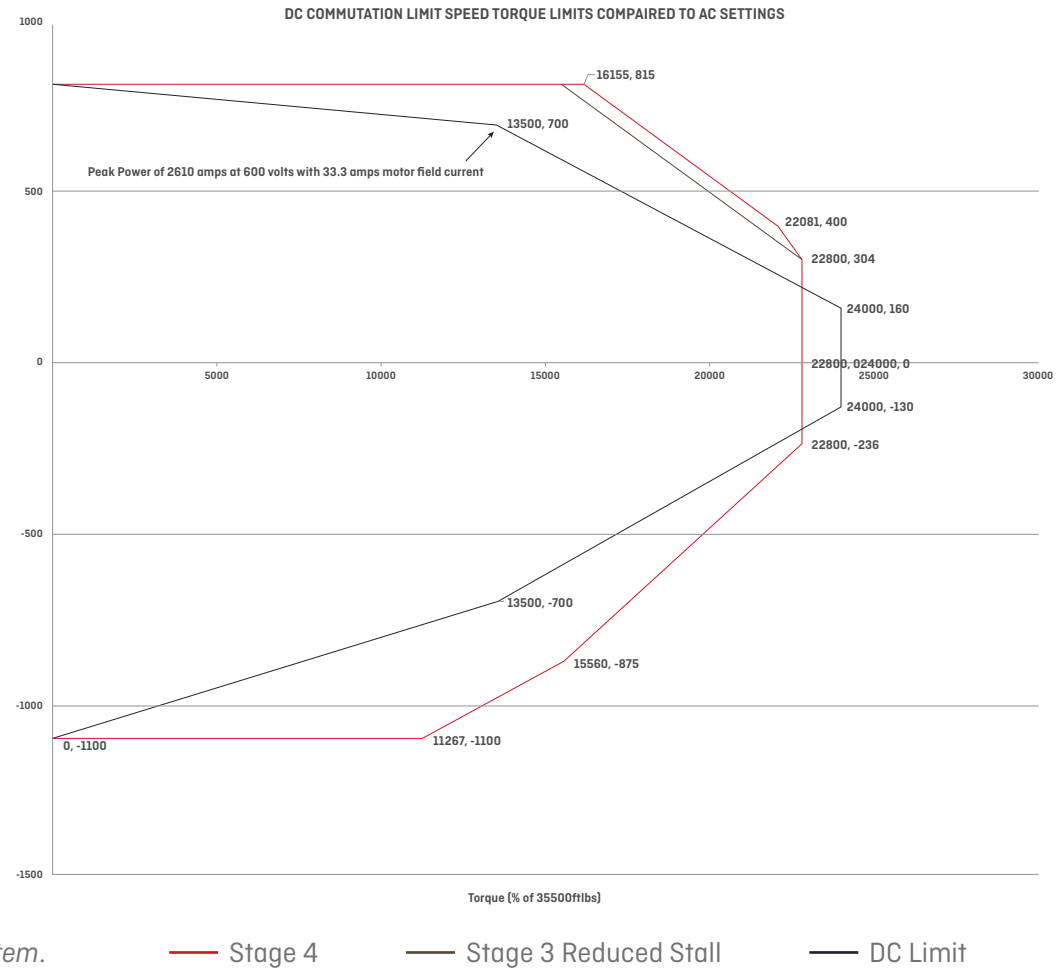
With the July 2021 optimization, the AC dragline is expected to reach a minimum of 15 million BCM annually in 2022, setting a record for this mine.

RESULTS OF AC CONVERSION

EFFICIENCY

An independent study confirmed an 1**1% boost in power efficiency** over the DC 8050 dragline over an operating period of January 1 to December 31, 2020.

As previously mentioned, one of the major benefits of the AC system is its scalability. The 2021 optimization increased the system's peak power, resulting in a **4.5 second reduction in cycle time with no additional structural or mechanical stress on the machine.** This finding was verified independently by MineWare reports and outside consultants.



The red line indicates the AC system's electrical limits, compared to the blue line, representing the DC system. The gap between the lines illustrates the boost in performance achieved by the AC system, resulting in an over 20% increase in production with the AC system.

RETURN ON INVESTMENT

The AC system's solid-state components have substantially reduced the amount of mechanical wear on dragline parts, extending savings across the lifecycle of the machine. Maintenance costs are down over 55% on average (and potentially upwards of 65% based on available data since July 2021 upgrades).

Additionally, the AC dragline's efficiency translates to 4.5 kilotons of CO2 offset, with major implications. To put that into perspective, at a global price of US$200 per ton, that's $450,000 annually and $900,000 over the two years of this study.

The AC retrofit achieved a return on investment within 18 months of being online, making it the lowest-cost pre-strip solution on the market.

As of October 2021, the mine's overall electrical and mechanical maintenance expenditures bottom line was decreased by 60%.

THE FUTURE OF AC DRAGLINES

In an age when efficient, energy-saving solutions are driving decisions in the mining industry, the future of AC draglines is bright. Based on verified data, FLANDERS' AC retrofit is the definitive way forward for cleaner and safer dragline work while raising the bar on productivity.

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