Regenerative power units save energy

Spindle drives, decanter centrifuges, hoists, cranes, elevators, and torque dynamometer test rigs can save energy from frequent run and stop, deceleration with high inertia load, and overhauling torque by using a regenerative power unit. One application saves 54% of the power used, $1017 per year.

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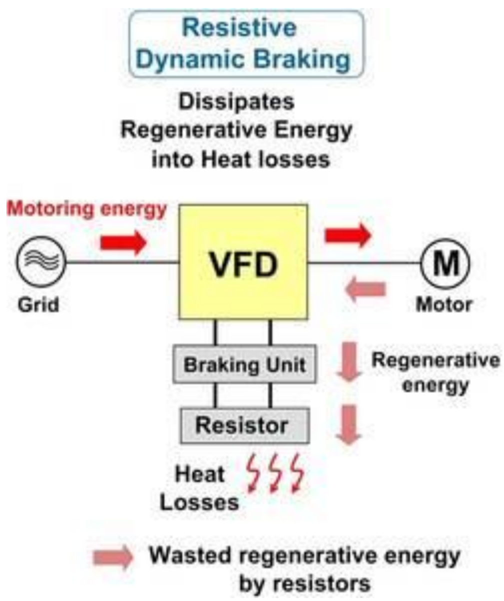
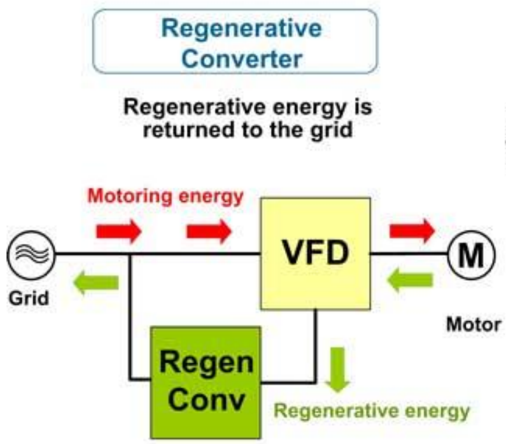
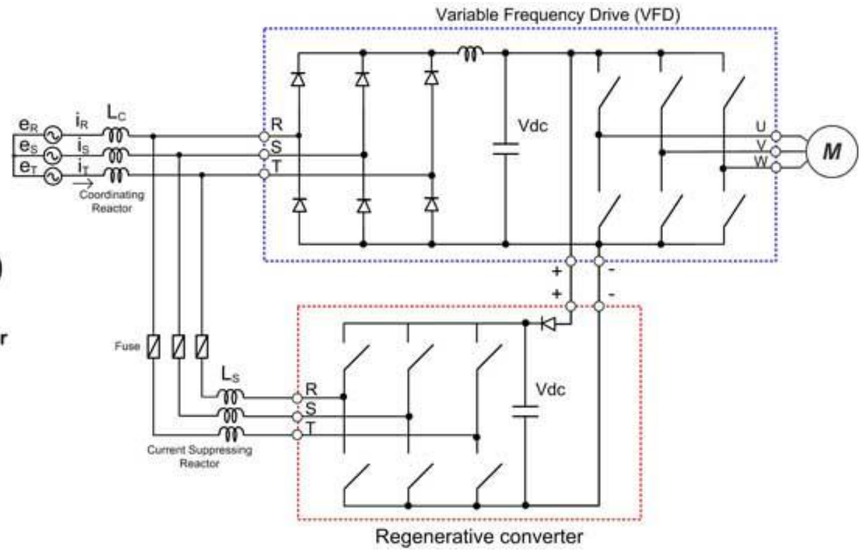


When an electric motor is driven by a variable frequency drive (VFD), electric power delivered to the motor is regenerated while the motor decelerates by applying negative torque to the motor shaft. Usually energy storage capacity inside the VFD is very limited so regenerative energy should be returned to the grid or quickly dissipated by a braking resistor. Otherwise, the dc bus will be overcharged and an over-voltage fault can occur. Dynamic braking resistors have been widely used to convert regenerated energy into heat loss because of simplicity and low installation cost, as illustrated in Figure 1. But a regenerative power unit provides a significant energy cost saving opportunity, especially in applications that require frequent run and stop, deceleration with high inertia load, and overhauling torque. Such applications include spindle drives, decanter centrifuges, hoists, cranes, elevators, and torque dynamometer test rigs. Electricity cost per kilowatt hour is getting more expensive. So it will be worthwhile to review the basics of regenerative units and understand estimated energy cost saving. Three types of regenerative power units are available in the U.S. market. Basic features and power topologies are explained and compared.

1. Regenerative converter

The regenerative converter is a cost-effective solution that can replace the dynamic braking transistor and resistor network. It absorbs excess regenerative energy from the VFD and returns it to the ac power source. Figure 2 illustrates the regenerative energy flow from a motor to the grid using a regenerative converter on the left, and detailed power circuit schematic with power switches on the right. During motoring, the VFD delivers power without the regenerative converter in the main power flow. So there is no conduction loss in the regenerative converter during motoring. The regenerative converter is activated when regenerative energy charges dc link capacitors of the VFD. The regenerative converter returns stored energy in the dc capacitors to the grid.

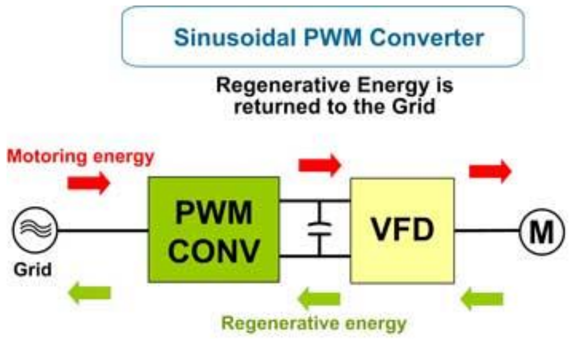


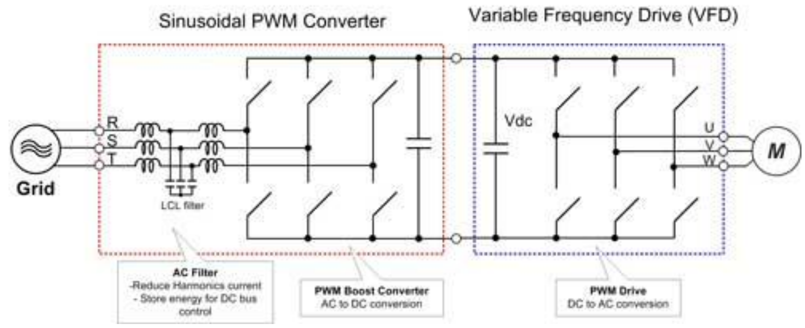


The size of the regenerative converter is determined by the size of the VFD, regen power, and duty cycle. The 6-step pulse control method is used to keep the switching loss of power devices very low. For applications that require high duty cycle braking, the regenerative converter can significantly improve the system operating efficiency and reduce the cost of electricity [1-2].

2. Sinusoidal PWM converter

The sinusoidal pulse-width modulation (PWM) converter is a high-performance solution designed to regulate dc bus voltage under both motoring and regenerative power conditions. The grid side current waveform of the sinusoidal PWM converter is sinusoidal with very low PWM harmonic distortion, approximately 5% total harmonic distortion (THD). It is designed to meet the IEEE-519 standard. Input current is also controlled to synchronize with input grid voltage, which enables achieving unity input power factor. It is connected in series between the incoming power line and the VFD. An ac filter, such as an LCL filter [inductor (L)-capacitor (C)-inductor (L)], is used as an external component to reduce ac current harmonics.





The sinusoidal PWM converter in Figure 3 is ideal for applications that require very low current harmonic distortion to meet the IEEE-519 Harmonic Limits standard and have large overhauling loads or those that make frequent stops such as elevators, centrifuges, test stands, and winders. This can result in significantly reduced system operating costs of machinery by “re-cycling” the excess energy back to the power grid. The sinusoidal PWM converter package is highly efficient without the heat loss and mounting location problems associated with braking resistors. For reference, the unidirectional regenerative converter is a lower cost solution with a six-step waveform that does not provide IEEE-519 compliant current waveform.

Source: http://www.controleng.com/media-library/case-studies/single-article/regenerative-power-units-save-energy/2bd419645e681aeb6b637d1e50bd41c5.html