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A Novel Wind Energy Based Hybrid Power Conditioner for the Distribution Power System


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Abstract:

The global electrical energy consumption is still rising and there is a steady demand to increase the power capacity. Deregulation of energy has lowered the investment in larger power plants, which means the need for new electrical power sources may be increased in the near future. In general, this paper discusses role of modern power electronics in small size wind energy and hybrid generating systems. A new and simple control method for maximum power tracking by employing a step-up dc-dc boost converter in a variable speed wind turbine system, using permanent magnet machine as its generator, is introduced. Output voltage of the generator is connected to a fixed dc-link voltage through a three-phase diode rectifier and the dc-dc boost converter.

A maximum power-tracking algorithm calculates the reference speed, corresponds to maximum output power of the turbine, as the control signal for the dc-dc converter.A new hybrid power conditioner for solving the problems of harmonic currents and neutral-line current in three-phase four wire distribution power systems is proposed in this paper. This hybrid power conditioner is configured by a neutral-line current attenuator and a hybrid power filter. The hybrid power filter, configured by a three-phase power converter and a threephase tuned power filter, is utilized to filter the nonzero-sequence harmonic currents in the three-phase four-wire distribution power system. The neutral-line current suppressor is connected between the power capacitors of the three-phase tuned power filter and the neutral line to attenuate the neutral-line current in the three-phase four-wire distribution power system. The proposed hybrid power conditioner can effectively reduce the power rating of passive and active elements.
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Keywords:

Wind Power Systems, Hybrid power Conditioner, Grid Integration, Power Converter, Filters, Control.

I.INTRODUCTION:

THREE-PHASE four-wire distribution power systems have been widely applied in office buildings and manufacturing- office buildings to supply single-phase or three-phase loads. The third harmonic is very serious in single-phase nonlinear loads. The third-order harmonic current of each phase is synchronous and regarded as the zero-sequence current. Therefore, the zero-sequence currents of each phase are summed up and flow into the neutral line of three-phase four-wiredistribution power systems. Furthermore, single-phase loads may result in serious load unbalance, and the unbalanced.

II.PROPOSED SYSTEM:

Fig. 1 shows the system configuration of the proposed hybrid power conditioner. In comparison with the conventional hybrid power filter, a neutral-line current attenuator is integrated into the hybrid power filter in the proposed hybrid power conditioner. The integrated neutral-line current attenuator can advance the filter performance of the hybrid power filter under the unbalanced load. Hence, the proposed hybrid power conditioner can simultaneously and effectively solve the problems of harmonic currents and neutral-line current in three-phase four-wire distribution power systems. To further reduce the power rating of the power converter, the advanced hybrid power filter is used with the three-phase power converter connected to the inductors of the three-phase tuned power filter in parallel.

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By incorporating the neutral-line current attenuator, the hybrid power filter is utilized to suppress only the nonzero-sequence harmonic currents in three-phase four-wire distribution power systems. Hence, the three-phase power converter is configured by a three-arm bridge structure and the tuned frequency of three-phase tuned power filter is set at the fifth harmonic frequency. With an increase in tuned frequency of the tuned power filters, the inductance of inductors can bereduced. Consequently, the volume and weight of the three phase tuned power filter are reduced. The neutral-line current attenuator of the hybrid power conditioner is employed to suppress the neutral-line current. Conventionally, the neutral-line current attenuator is connected between three-phase lines and the neutral line of the three-phase four-wire utility [6].

Hence, the voltage rating of the zig-zag transformer used in the conventional neutral-line current attenuator is the phase voltage ofthe three-phase four-wire utility, thus enlarging the volume and weight of the zig-zag transformer. As can be seen in Fig. 3, the neutral-line current attenuator is connected to the capacitors of tuned power filters in series, and the fundamental component of phase voltage will drop on these capacitors. The voltage rating of the zig-zag transformer is almost equal to the voltage of inductors in the tuned power filters, and its voltage is very small compared with the zig-zag transformer used in the conventional neutral-line current attenuator.

Hence, the volume and weight of the zig-zag transformer used in the proposed neutral-line current attenuator are reduced. The single phase power converter is connected to the zig-zag transformer in series to advance the performance of the zig-zag transformer. As seen in Fig.1the neutral line of the load is directly connected to that of the utility, and the fluctuation in ground voltage of the load can thus be avoided. Owing to power loss caused by the operation of the single-phase power converter, the dc bus voltage of the power converter is decreased. However, the power loss is low because the dc bus voltage of the single-phase power converter is low.

A simple single-phase diode rectifier is employed to supply power to the dc bus of the single-phase power converter to sustain the dc bus voltage at an acceptable range. A transformer is employed to step down the line-to-line voltage. The input current of the single-phase diode rectifier is small.

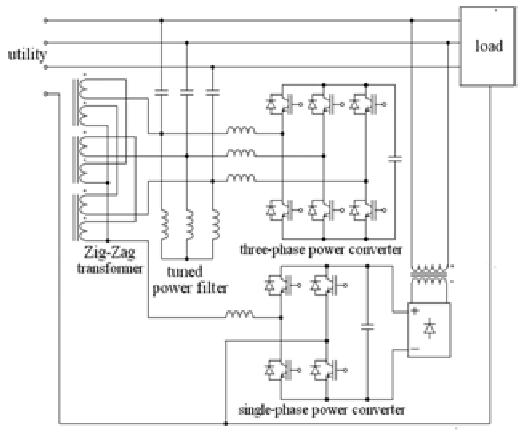

Fig. 1. System configuration of the proposed hybrid power conditioner.

WIND ENERGY CONVERSION:

Wind turbines capture power from the wind by means of aerodynamically designed blades and convert it to rotating mechanical power. The number of blades is three in a modern wind turbine. For multi-MW wind turbines the rotational speed is typically 10-15 rpm. The most weight efficient way to convert the low-speed, high-torque power to electrical power is to use a gear-box and a standard generator including a power electronic interface as illustrated in Figure 1.

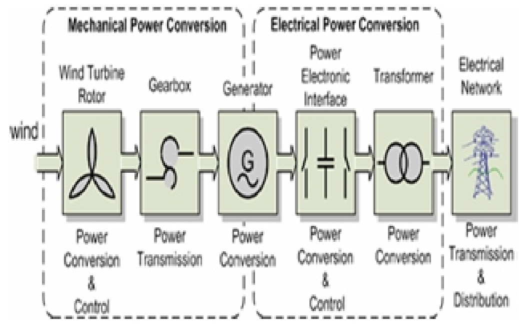

Figure 2. Power conversion stages in a modern wind turbine (based on [14]).

The gear-box is optional as multi-pole generator systems are also possible solutions. Between the grid and the generator a power converter can be inserted. The electrical output can either be AC or DC.

III.CONTROL STRATEGY:

Fig. 3shows the control block diagram of three-phase and single-phase power converters.

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The three-phase power converter adopts the current-mode control. The current referencesshould be calculated first. The current references should beequal to (1)–(3), and they contain a fundamental signal and a harmonic signal. The detected three-phase utility currents are sent to the bandstop filters to extract their harmonic components. The outputs of the bandstop filters are sent to theamplifier with gain , and the harmonic signals of the currentreferences are then obtained. The detected dc bus voltage ofthe three-phase power converter is compared with the setting-voltage, and the compared result is sent to a proportional-integral(PI) controller. The output of the PI controller is . Boththe outputs of the PI controller and the detected three-phaseutility voltages are sent to the multipliers so that the fundamental signals of the current references are obtained.

Thecurrent references are obtained by summing up the harmonicsignals and the fundamental signals. The detected output currentsof the three-phase power converter are compared with thecurrent references, and the compared results are then sent to thecontrollers. The outputs of the controllers are sent to the PWM circuits to generate the driver signals of the power-electronic switches for the three-phase power converter.The feedforward control is employed to control the singlephase power converter. The neutral-line current of the utility can be obtained by summing up the detected three-phase utility currents and is then sent to an amplifier of gain . The output of the amplifier is sent to the PWM circuit to serve as the modulation signal. The PWM circuit adopts unipolar PWM to generate four PWMsignals for the power-electronic switches of the single-phase power converter. The control blocks of three-phase.

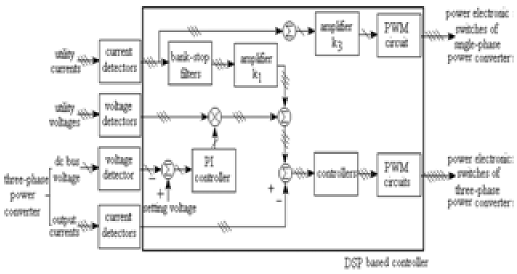

Fig.3. Control block diagram of the three-phase and single-phase power converters.

IV.SIMULATION RESULTS

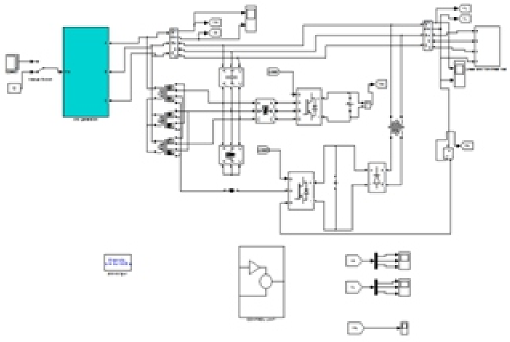

Fig.5Wind energy Extension circuit

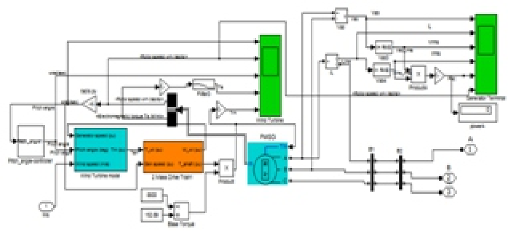

Fig.6 Wind energy block

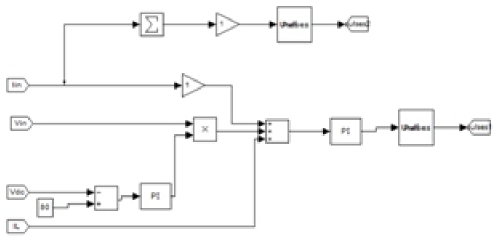

Fig.7 control block

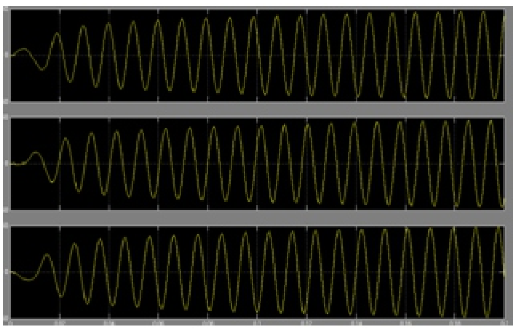

Fig.8 Unity current

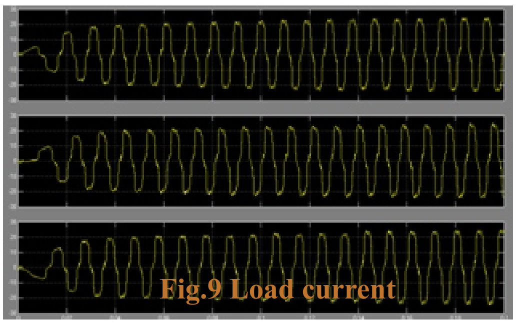

Fig.9 Load current

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V.CONCLUSION:

Three-phase four-wire distribution power systems have beenwidely applied to low-voltage applications; however, theyencounter serious problems of harmonic current pollution and large neutral-line current. In this paper, a new hybrid power conditioner, composed of a hybrid power filter and a neutral-line current attenuator, is proposed. In the proposed hybrid power conditioner, the power capacity of power converters in the hybrid power filter and neutral-line current attenuator can be effectively reduced, thus increasing its use in high-power applications and enhancing the operation efficiency.we consider with wind .it has been design in simulation.

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