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The M-G is a composite device consisting of an engine and a generator mechanically connected through a common shaft. Practically a set of generators is a system in which the engine and generator are connected or rather placed in one chain. It is a device used to convert electricity from one form to another. That is, basically it converts electrical energy into any other type of energy. A set of motor generators is also used to convert voltage, phase and power frequency. They are also used in isolating electrical loads from the supply line. Here's a scenic view of the MG set. Here the engine and generator are connected to each other with a single shaft; they wound around one rotor. A prerequisite for the connection is that the nominal speed of both the engine and the generator should be the same. The engine generator set diagram is shown below, the SetFrom Motor Generator Working Principle above the chart we can see in a typical engine generator set, power is given from outside the engine and as a result the engine shaft rotates the generator rotor. This means that the engine receives electrical energy from the supply line. Its shaft rotates, and since the generator shaft is mechanically connected to it, the generator also receives its mechanical input through the shaft. Thus, the generator also creates electrical power or in other words the generator converts mechanical energy into electrical energy. Thus while the power at the entrance as well as the exit face is electrical in nature, the power flowing between machines in the form of mechanical torque. This provides insulation of the electrical system, as well as some power buffering between the two electrical systems. The conversions can be used to convert electricity into various forms of THE D.C. - This is possible with a AC engine (induction engine or synchronous engine) and a DC generator. DC to air conditioner - This can be achieved with a DC engine and a AC generator. DC at some voltage level to DC at another voltage level. Alternating power at one frequency to alternating power at another frequency Fixed AC voltage to variable or adjustable ac-current phase of AC voltage to phase 3 of AC voltageNow days engine generator sets have been updated in many ways. Previously, they were used in places where speed regulation is required high as elevators, factories, etc. Now the day's semiconductor devices work as a set of motor generators i.e. with the introduction of power semiconductor devices such as thyristor or SCR, GTO, MOSFET, etc. These transformations From one form to another can be triggered very easily. They are small and compact in size, losing less and control is very easy. On the course Students learn basic physics, why compared to how the engine is an engine The generator is running. Four interconnected physics systems that make up the engine or generator are taught: electrical, electromagnetic, mechanical and thermodynamic. Power and a controller are also covered. Actual assembly line examples are discussed about why they are executed and their impact on the success of the product for the customer. Only basic mathematics is used when needed to pass the law of physics into this practical training. About Instructor Norm Kopp is President of Kopp Motor Consultant LLC. He has 50 years of experience in research, development, design, manufacturing and quality assurance of specialized electric motors and feedback devices. He has held senior positions at Honeywell, Sundstrand, Kollmorgen and Windings. Mr. Copp has five patents in traffic management. In the past, he has been a member of the IEEE Review Board and is a recognized author and speaker at various technical associations and colleges. He is currently a member of the board of directors of MCMA EMERF. Mr. Copp holds a Bachelor of Science degree in Mathematics and Physics and a Master's degree in Business Administration. SCHEDULE THIS COURSEClick Is here to request an offer All courses include on-home reference materials! Interested in learning in the home? Let us know about the training you are interested in and we will prepare your offer! Asking questions about the offer? Contact Dana Whalls or call 734-994-6088. As the name implies, the engine generator set uses the electric motor as the main engine to drive the generator. The engine and generator can be mounted on a common shaft or they can be mechanically connected through a connection, a belt drive system or a drive transmission. In all cases, the engine requires a source of three phase power, and it runs on an electric input current while it controls the generator to obtain the required one phase or three stages of electrical power. As the name implies, the motor generator (m-g) set consists of an engine powered by an ac power utility that is mechanically tied to a generator that powers the load. (See Figure 12.1.) Transitions on general-purpose lines will have no impact on the load when using this mechanism. Adding a flywheel to the mine from the engine to the generator will protect against short-term power failures (up to 0.5 s on many models). Figure 12.2 shows the design of a typical M-G set. M-g attributes include: An independent voltage source can be adjusted without interacting with line voltage changes at the power source. Utility line ±20% change line can usually be carried within ±1% at load. The speed of rotation and the inertial pulse of the rotating mass represent a significant stored rotation energy, preventing sudden changes in voltage output when input is momentarily interrupted. Entrance and weekend windings are separated electrically, preventing transitional transition from the missing-gating from the utility company ac line to the load. Stable electrical characteristics for load: (1) voltage and frequency adjustment, (2) ideal sine wave output and (3) the true 120-degree shift phase for three-phase models. Reducing the problems associated with the power factor presented by the utility company power source. The efficiency of a typical m-g ranges from 65 to 89%, depending on the size of the device and the load. Motor generators are widely used to power 415 Hz on mainframe computers that require this frequency. Configuration System There are a number of types of motor-generator sets, each of which has its own features, advantages and disadvantages. The simplified M-g schematic is shown in figure 12.3. The type of engine that drives the set is an important design element. Direct current engine drives can be controlled in speed inde- pendently ac power source frequencies from which dc is derived. The use of the dc engine thus gives the m-g kit the ability to produce power at the desired output frequency, regardless of changes in input frequency. The requirement for straightener conversion equipment, control equipment, and switch maintenance is a disadvantage in this approach that needs to be addressed. The simplest and least expensive approach to rotary power conditioning involves using the induction engine as a mechanical source. Unfortunately, the rotor induction engine is slightly slower than the rotating field produced by the power source. This results in the generator being unable to produce 60 Hz power if the engine is running at 60 Hz and the machines are directly connected at the end of their shafts or circling at a ratio of 1:1. In addition, the shaft speed and the frequency of the generator's output decreases as the load on the generator increases. This potential for varying output rates may be acceptable when the m-g set is used solely as input into the power source, where the air conditioner is corrected and converted to DC. However, some loads cannot tolerate frequency changes over 1 Hz/s and deviations of more than 0.5 Hz from the 60Hz rated. Low-slip induction propulsion generators are available that can produce 59.7 Hz at full load, assuming 60 Hz input. During outages, the exit rate will fall further, depending on the duration of the inter-buy. The ability of the induction engine to restart after a momentary power outage is valuable. Various systems of belts with variable speed have been successfully tested. Magnetically controlled sliding grip pings have been found to be largely unsatisfactory. Other approaches to make induction manage the load at a constant speed gave mixed results. Using a synchronous engine with a direct connection or cogged 1:1 belt drive ratio ensures that The frequency will be equal to the frequency of the engine input. Although the synchronous engine is more expensive, it is more efficient and can be adjusted to ensure the PF's unity load on the ac source. Starting characteristics and mechanical failures after a short interruption of the voltage line depend to a large extent on the design of the engine. Many synchronous engines that are not required to run under load have weak starting torque and can use a pony engine to help in the launch. This approach is shown in figure 12.4. Those engines designed to start with load have starting pole side windings that provide a starting torque comparable to that of an induction engine. Such engines can be synchronized at load with the right engine choice and automatic launch system. A typical utility company ac inter-ruptions is at least six cycles (0.1 s). Depending on the design and size of the flywheel used, the driving period can be up to 0.5 s or more. The generator will continue to produce power output for a longer time, but the frequency and rate of frequency change are likely to fall beyond the acceptable range of most DP loads after 0.5 s. If the input power is interrupted and not returned before the voltage and the exit frequency begin to fall beyond acceptable limits, the output generator controller can be programmed to disable the load. Before this event, a warning signal is sent to the DP control scheme to alert you to an impending outage and initiate an orderly interruption of active computer programs. This makes it easier to restart your computer after a outage. It is important that users accurately estimate the length of time that Mr. Set will continue to deliver acceptable power without input into the engine from the utility company. This data facilitates power outages. It is also important to ensure that the m-g system can handle power returns without ultra-silent protection devices due to the high inrush current that may be required to accelerate and synchronize the engine with the line frequency. Protection from the latest problem requires proper programming of the synchronized engine controller to properly disable and then restore the current of the power field. It may be advisable to postpone the upcoming shutdown by 100ms or so. This will give the computer time to prepare for the event through an orderly interruption. It would also be useful if the computer could resume work non-stop, in the event of a return of electricity during the driving period. Control signals from the m-g controller must be configured to identify these conditions and events in the DP system. Generators commonly used in m-g have a much higher internal intransigence than equivalent transformers with a kVA rating. Because of this situation, Mr. sometimes come with an oversized generator that will be lightly loaded, combined with a smaller engine that is sufficient to drive the actual load. This approach reduces the initial cost of the system, reduces engine losses and provides a lower operating load. Motor generator kits can be configured either for horizontal installation, as shown earlier, or for vertical installation, as shown in figure 12.5. The most common utility feed voltage used to drive the entry of the m-g set is 480 V. The output of the generic tor for systems estimated at approximately 75 kVA or less is usually 208 Y/120 V. For larger DP systems, the most economical output of the generator is usually 480 B. 480 to 208 Y/120 V 3f phase insulation trans-former is usually included to provide 208 Y/120 V power computer equipment. Motor Design Considerations both synchronous and induction engines are successfully used to drive m-g sets, and each has advantages and disadvantages. The main advantage of the synchronized engine is that when it works normally, it synchronizes with the frequency of deliveries. The 1800 rpm engine rotates at 1800 rpm at a supply rate of exactly 60 Hz. The output of the generator, therefore, will be exactly 60 Hz. Utility fre-quencies average 60 Hz; utilities change the frequency slowly to maintain this average in changing load conditions. Studies have shown that utility frequencies typically range from 58.7 to 60.7 Hz. Although frequency tolerances permitted by most computer manufacturers are usually given as ±0.5 Hz on a 60 Hz nominal system, these utility changes are extended over a 24-hour period or longer and usually do not cause load problems. The main drawback of the synchronous engine is that the device is difficult to start. The synchronous engine should be launched and brought to the speed of the auxiliary winding on the rebar known as the armortisseur winding. The speed of retraction is the minimum speed (close to the synchronous speed) at which the engine will stretch in sync if the arousal is applied to the field. The winding armortisseur is usually a protein-cell design, although it may be a rotor-type wound in some cases. This winding allows the synchronous engine to start and come up to speed like an induction engine. When the thrust in speed is reached, automatic sensing equipment applies field arousal, and the engine locks and works like a synchronous machine. As mentioned earlier, some large synchronous engines are brought to speed by the pony auxiliary engine. Armortisseur winding can only produce limited torque, so synchronous engines are usually brought to speed without This requirement does not present any problems for DP systems when initially launched. However, in the event of a short-term power outage, problems may develop. When the ac utility fails, The engine must be disconnected from the input immediately, or it will act as a generic torus and feed the power back into line, thereby quickly depleting its stored (kinetic) rotational energy. During a power failure, the engine speed quickly drops below the retraction rate, and when the ac delivery returns, armortisseur windings must reuse the engine under load until the field can be applied again. This requires a large winding and complex management system. When the m-g set speed is below synchronous, the generator's output rate may be too low for the computer to function properly. The induction engine has no problems with the launch, but it has a slip. To get torque, the rotor must rotate at a slightly lower speed than the stator field. For a nominal engine of 1800 rpm, the actual speed will be about 1750 rpm, slightly changing with the load and input voltage applied. This is about 2.8%. The generator, if controlled directly or on a common shaft, will have a output rate of about 58.3 Hz. This is below the minimum operating rate for most computer hardware. Special high-precision low-slip induction engines are available with a slip of about 0.5% at a nominal engine voltage of 480 WH. When sliding 0.5%, the speed at full load will be about 1791 rpm, and the directly controlled or general shaft generator will have a output rate of 59.7 Hz. This frequency is within acceptable but close to the minimum allowable frequency. The belt and pulley of the adjustable speed drive system is a common solution to this problem. By making a pulley on an engine slightly larger in diameter than the pulley on a generator (with actual adjustable diameters) the generator can be controlled at a synchronous speed. Voltage sagging does not affect the output rate of the synchronized m-g motor set until the voltage is so low that the torque is not reduced to the point at which the machine is pulled out of sync-tion. Then resynchronization becomes a problem. On the induction machine, when the voltage sags, the sliding increases and the machine slows down. The result is a decrease in the output rate of the generator. The adjustable speed drive between the induction engine and the generator solves the problem for individual cars. If a strong voltage sagging is expected at the facility, the system can be installed in such a way that the nominal input volt-age from the utility company produces a frequency of 60.5 Hz, 0.5 Hz on the high side of the nominal fre-quency. Figure 12.6 frequency diagrams vs. motor voltage for three operating conditions: - Slip compensation set high (curve A) - Slip compensation set for 60 Hz (curve B) - No slip compensation (curve C) proper adjustment of sliding compensation, significant input margin voltages can be achieved. Single-decker systems There are two main m-g set of mechanical structures used for DP applications: (1) (1) power generator systems and (2) one mine, single-storey units. Both designs can use either a synchronous or induction engine. In each case, there are pros and cons. The separate design of the machine (discussed previously) uses the engine driving a physically separate generator using a pulp compound or pulley. In order to improve efficiency and reduce costs, manufacturers also produce different types of single-mining systems. The basic concept of one gross system is to combine engine and generator elements into a single whole. The general stator eliminates a number of individual components, making the machine less expensive to manufacture and mechanically more efficient. The overall set of stents significantly reduces the mechanical energy losses associated with traditional m-g designs, as well as increases the reliability of the system. In one design, the stator is built so that alternative wound slots with entry and exit winding. When it is fed with three phases of power, a rotating magnetic field is created, causing the DC-excited rotor to rotate at a synchronous speed. By controlling the electrical characteristics of the rotor, the output of the secondary winding of the stent is controlled. Total time machines provide a lower workload than a comparable two-st hardware system. For example, a typical 400 kVA machine has a frame size of 800 kVA. The larger frame size gives a relatively low-speed power source capable of cleaning sub-circular fuses in the face of malfunction. Exit block can usually deliver up to seven times full load current in the conditions of malfunction. Despite the increase in frame size, the kit is smaller and lighter than comparable systems due to the reduction in the number of mechanical parts. Flywheel Considerations In order to achieve higher energy and power density, Mr. Set designers have devoted considerable attention to the flywheel element itself. New composite materials and power electronics technologies have led to a compact flywheel battery capable of high linear speed within the radius of the outside of the flywheel (tip speed). The speed of the flywheel's rotation is important, as the energy stored in the flywheel is proportional to the square of its speed of rotation. Thus, the obvious method for maximizing energy is to increase the flywheel speed. All practical structures, however, have a limit speed, which is determined by the voltages developed inside the wheel as a result of inertial loads. These loads are also proportional to the speed square. The flywheel, built of composite materials, weighs less and therefore develops lower inertial loads at this rate. In addition, composites are often stronger than conventional engineering metals such as steel. This combination of high strength and low weight allows high tip speeds, compared to conventional wheels. For this geometry, the maximum energy density (energy per unit of mass) flywheel is proportional to the ratio of material force to weight density, otherwise known as specific strength. Table 12.1 illustrates the advantage that composite materials offer in this respect. Recent advances in composite materials technology can allow for almost an order of magnitude advan-tage in the specific strength of composites compared to even the best common engineering metals. The result of this continuous study of composites is a flywheel capable of operating at a speed of more than 100,000 rpm, with a tip speed of over 1000 m/s. These high speeds bring with them new challenges. The ultra-high rotational speeds required to store significant kinetic energy in these systems virtually eliminate the use of conventional mechanical bearings. Instead, most systems work on magnetic bearings. This relatively recent innovation uses mag-nontic forces to levitate the rotor, eliminating frictional losses inherent in the rolling element and liquid film bearings. Unfortunately, aerodynamic drag losses cause most high-speed flywheels to operate in a partial vacuum, making it difficult to dissipate the heat generated by the ochmic losses in the bearings of the electromagnets and the rotor. In addition, active magnetic bearings are inherently unstable and require complex control systems to maintain proper levitation. The integrated generator of these systems is usually the design of a rotating field, with a magnetic field supplied by rare earth permanent magnets. Because the specific strength of these magnets is usually the only fraction that of a composite flywheel, they should rotate at much lower tip speeds; in other words, they should be placed very close to the flywheel node. This jeopardizes the power density of the generator. The alternative is to fasten them closer to the outer radius of the wheel, but contain their inertial loads with the composite wheel itself. Obviously, this forces the designer to either de-stress the speed of the machine, or work closer to the voltage limit of the system. Maintenance issues Because M-g kits require some maintenance that needs to be shut down, most systems provide a bypass, so maintenance work can be done without the need to decommission the computer. If the automatic bypass contactor, solid switch and control equipment are in the same closet as other devices that also need to be deactivated for maintenance, secondary bypass surgery is recommended. Once automatic A detour has been installed, switching gear to a secondary detour can be turned on, taking the m-g set and its automatic bypass system out of the chain completely. Some automatic bypass mechanisms are designed to transfer load load on the bypass route with minimal disruption. This requires synchronizing the output of the generator with the bypass power before closing the switch and opening the power switch of the generator. However, with the load moving off the generator, the bypass power will no longer be synchronized with it. Consequently, relaying the load back to the generator can occur with some irregularities. Adjusting the minimum violation in any direction requires a compromise in the phase or means to move the phase before and after the transfer. The use of rotating field exciters eliminated the need to slip rings in most m-g designs. Therefore, the check and replacement of the brush is no longer necessary. However, as with any rotating equipment, the bearings must be checked and replaced periodically. Motor-Generator UPS Critical DP applications, which can't tolerate even brief interruptions in the air conditioning, can use the m-g set as the basis for continuous power sources by adding a battery-supported dc engine to the drive shaft of the engine on the line. This concept is illustrated in figure 12.7. The Ac engine usually supplies the energy to drive the system from the utility company line. The shafts of the three devices are interconnected, as shown in the picture. When ac power is present, the DC engine serves as a generator to charge the battery of the bank. When the voltage line is interrupted, the dc engine is powered by batteries. Figure 12.8 shows a modified version of this basic M-g UPS, using only the DC engine as a mechanical power source. This configuration eliminates the inefficiency associated with having two engines in the system. Power from the utility source is corrected to provide energy for the DC engine, plus power to charge the batteries. A sophisticated control system for the air conditioning switch and the DC engine in the case of sleep is not required in this design. M-g UPS can also be built around a synchronized ac engine, as shown in figure 12.9. The ac energy utility is corrected and used to drive the inverter, which provides an adjustable frequency source to power the synchronous engine. The exit from the dc-to-ac inverter does not have to be a well-formed sine wave or a well-regulated source. Exiting the generator will provide a well-regulated sinus wave for load. The m-g kit can also work in bypass mode, which eliminates the liquidator, battery and inverter from the current path by operating a synchronous engine directly from the ac line. The M-G UPS set using a general stifier machine is illustrated in figure 12.10. The feedback control scheme adjusts the inverter's firing angle to compensate for changes in input power. This concept is made even further in the system shown in figure 12.11. To enhance a solid-fuel inverter bypass switch is added. During normal operation, a bypass route is included, excluding through diodes-fictions. When the control circuit senses a drop in utility voltage, the inverter turns on and the bypass switch shuts down. The simplified inverter/bypass installation is shown in figure 12.12. Magnetic switches and throttle are included, as shown in the video. An insulating trans-former is inserted between the utility and the cleaning pot. A static inverter is inherently a simple design; mitigation is achieved by windings. Six tyristors are used. Under normal operating conditions, 95% of ac power passes through a static switch; 5% passes through the inverter. This scheme ensures maximum efficiency while keeping the bank's battery charge and straighteners and inverters of thyristors are heated up. Heating extends the life of the components by reducing the degree of heat cycle that occurs when the load suddenly switches to battery backup. The static switch allows you to quickly disable the input when the power utility fails. The kinetic battery storage system As previously indicated, one of the parameters that limits the driving period of the m-g set is the rate of decay of the flywheel/generator combination. As the flywheel slows down, the output rate drops. This limits the useful driving period through 0.5 s or so. Figure 12.13 shows an ingenious modification of the classic power conditioning pattern, which greatly expands the potential ride. As shown, the m-g set is used in the UPS-based system as an element of the DC power grid. The main components of the system include: Steel flywheel for energy storage Small engine drive, size 15 to 20% of the nominal power of the system, to run the flywheel and maintain its normal speed - Variable speed drive (VSD) slow ramp flywheel up to speed and maintain it at the desired rpm - Generator for converting kinetic energy, stored in flywheel in electrical energy - The Diode Bridge rectifier to convert the ac generator output into D.C. to use a WBP bus that continues to draw can use energy substantially regardless of flywheel frequency is no longer a limiting factor that allows DC voltage output to be maintained over a much larger flywheel range in a rpm envelope. In operation, the small drive engine rotates the flywheel while the variable speed drive supports the correct engine speed. As the amount of kinetic energy stored increases on the square of rpm, it is possible to significantly increase the stored energy, and therefore drive, expanding the range of energy use on the fly-wheel. These factors allow a typical driving time of 10 s to several minutes, depending on the loading and operating conditions. Benefits of this approach include reducing the reduction in battery pack and engine generator systems. Incoming search terms:Linked messages: messages: