Stable Operation of Feed Pumps with the Use of Capacitors

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Keywords Electric Double Layer Capacitor (EDLC), Parallel compensation type voltage dip compensators, Waterworks, Distribution pump

Abstract

We shipped an uninterruptible feed pump for water supply to a Japanese water utility. This system is a combination of an Electric Double Layer Capacitor (EDLC) type parallel compensation type voltage dip compensators and an emergency power generation system. The EDLC functions as a storage battery for the parallel compensation type voltage dip compensators. Compared with the secondary battery like a lead battery, the noteworthy feature of the EDLC is a long operational life. No replacement is needed for 15 years and maintenance can be simplified. Since the parallel compensation type voltage dip compensators is of the utility power feeding type, its efficiency is as high as 98%. These features are helpful in a remarkable reduction of running cost. In order to prevent the lowering of water supply pressure in waterworks due to the occurrence of momentary voltage dips or a power outage, we project that there will be a potential strong market to make feed pump for water supply redundant in power supply. As such, going forward, we expect more application cases will arise in the future.

1 Preface

Meiden Electric Double Layer Capacitor (EDLC) type parallel compensation type voltage dip compensators, MEIPOSS MCP, is mostly used as a power supply for production lines in factories and for IT systems. It can maintain stable power supply even in the case of voltage dips so that industrial facilities can continue operation without stopping. Recently, we shipped an uninterruptible feed pump system to a Japanese water utility. This is a combination of the above parallel compensation type voltage dip compensators and an emergency power generation system so that pumping facilities can continue to operate even in the event of dynamic voltage dips or a power outage. If a momentary voltage dip or a service interruption occurs, distribution pumps are stopped, thus causing system malfunction due to the lowering of supply water pressure. Accordingly, the development of uninterruptible feed pump system is a great contribution to the stable supply of tap water. This paper introduces the uninterruptible feed pump system using a parallel compensation type voltage dip compensators as an example of our business activities in the field of waterworks.

2 Features of a Parallel Compensation Type Voltage Dip Compensators

2.1 Application of an EDLC to Batteries

Fig. 1 shows the principle of EDLC, which consists of electrodes made of activated carbon with a comparatively large surface area and organic electrolyte. This type of battery utilizes its specific characteristics for charging in such a manner that elec-

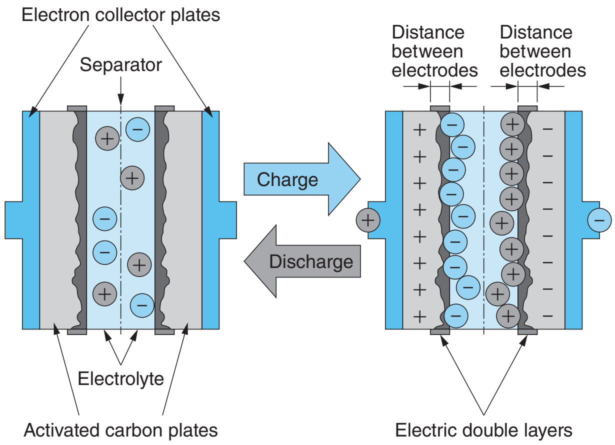


Fig. 1 Principle of EDLC

Layers (electric double layers) are formed, where positive and negative charges are densely distributed on interfaces between electrode and electrolyte.

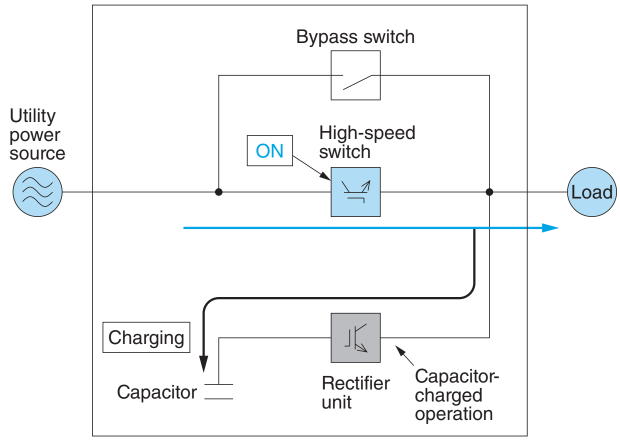


Fig. 2 **Single-Line Diagram of Parallel Compensation Type Voltage Dip Compensators**

A single-line diagram of parallel compensation type voltage dip compensators (standby type emergency power generation system) is shown.

trolytic ions in reversed polarities are made to be absorbed in the positive and negative electric interfaces of anode and cathode at the time of charging (formation of electric double layers), and then desorbed at the time of discharging. As charging and discharging cycle, ions in the EDLC move within the electrolyte and are absorbed and desorbed to and from the positive and negative electric fields. Compared with secondary batteries like lead storage batteries where charging and discharging are repeated with the effect of chemical reactions, the operational life of EDLC is therefore hardly influenced by repeated charging and discharging cycles. Since it is unnecessary to replace capacitors of batteries for 15 years, maintenance can be simplified and running cost can be substantially reduced.

2.2 High-Efficient by Standby Type Emergency Power Generation System Method

Fig. 2 shows a single-line diagram of a parallel compensation type voltage dip compensators. When the system is normal, utility power is fed to the load through a high-speed switch. In this state, the rectifier unit (inverter) is at a stopping state (called the "standby type emergency power generation system method"). Compared with the normal inverter feed system, there is no inverter loss and we realized a high efficiency of 98%.

3 Outline of the System

Table 1 shows the outline specification of the parallel compensation type voltage dip compensators, MEIPOSS MCP, and **Fig. 3** shows an external appearance of MEIPOSS MCP. For an emergency power generating system, a Meiden ZX-type diesel engine generator (rated capacity: 400kVA, quick start type) was adopted. We selected the power generating unit which can feed the power within the permissible fluctuation range of voltage and frequency by the parallel compensation type voltage dip compensators. The rated capacity of each feed pump is 37kW and 2 pump units are used in the system. The Variable Voltage, Variable Frequency (VVVF) inverter performs variable speed operation in accordance with variations of the water distribution rate. The primary side of the VVVF unit for the feed pump is connected with a parallel compensation type voltage dip compensators by which utility power is fed to the feed pump through the parallel compensation type voltage dip compensators while

Table 1 **Outline Specification of MEIPOSS MCP**

This is the low voltage type (210V). The unit capacity is 200kVA and the guaranteed time for operation is 10 seconds.

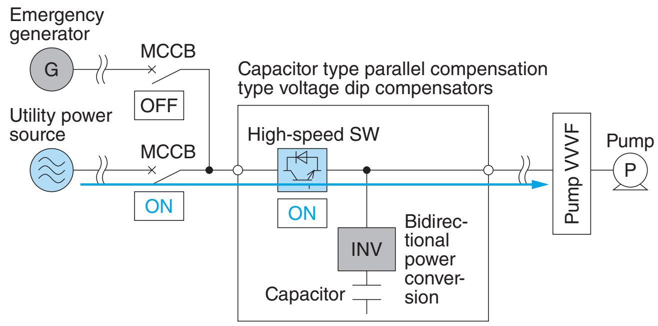
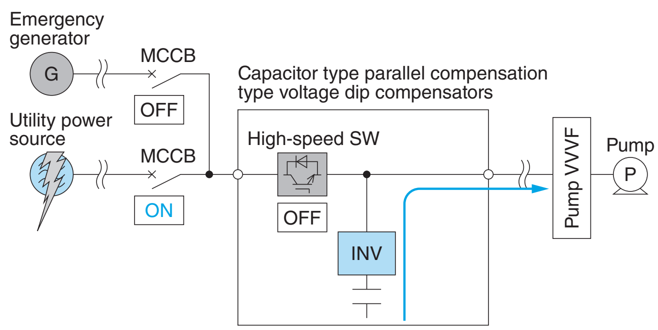
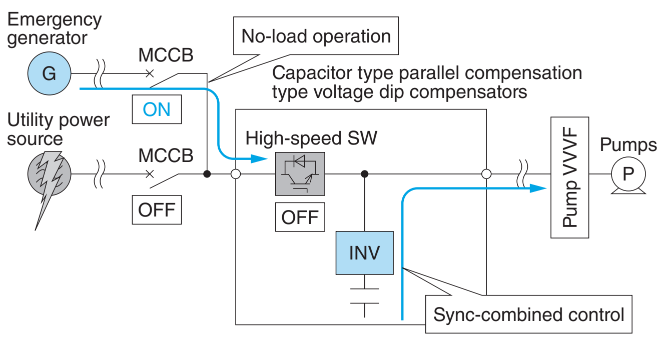
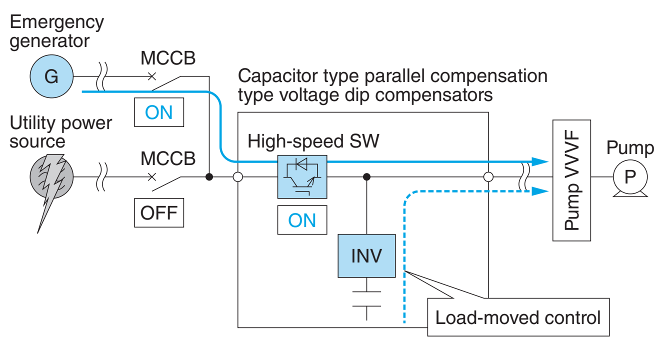
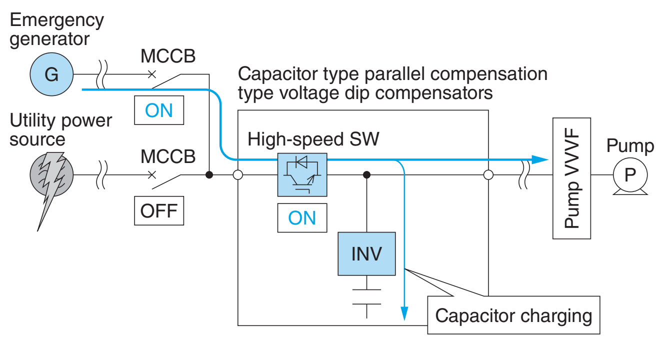
Item	Specification	Remark
Unit system	Utility-momentary dip changeover system	
Rated capacity	200kVA	
Guaranteed time	10 seconds	
Operational efficiency	98% or above	During utility power feeding
Rated voltage	210V	
No. of phases	3-phase 3-wire	
Frequency	50Hz	

Fig. 3 **MEIPOSS MCP**

This is a parallel compensation type voltage dip compensators delivered to a Japanese water utility. It is composed of the input panel, rectifier panel, and the capacitor panel. External dimensions are W3600 × H2300 × D800mm.

Table 2 Flow of Electric Power in the Case of Voltage Dips or a Power Outage

Each diagram shows a flow of electric power in the case of voltage dips or a service interruption to distribution pumps.

	System configuration and flow of power supply	Behavior of equipment and conditions
Operation on utility power		(1) In this state, power is fed from utility power source to the pump load through the high-speed switch (SW). (Parallel compensation type voltage dip compensators at standby state) (2) Rectifier (inverters) is at the stopped state.
Operation on parallel compensation type voltage dip compensators		(1) A voltage drop due to momentary voltage dips or a power outage in the utility power network system is detected and the high-speed switch is turned off (OFF). (2) Simultaneously when the high-speed SW is turned OFF, power is fed from the capacitor to the pump load.
Start of emergency power generating unit		(1) When power is fed from an emergency power generating unit (emergency generator) within about 10 seconds after the occurrence of a power outage, the parallel compensation type voltage dip compensators synchronizes with the voltage of emergency generator (voltage level and phase).
Shortly after interactive operation with emergency generator		(1) After synchronization, the high-speed SW is turned on for interconnection with the emergency generator. At that time, the power supply from capacitors is slowly attenuated so that violent movement of the load is not performed toward the emergency generator side. (Load movement control is carried out with the momentary voltage dip compensator.)
Emergency generator in operation		(1) After the completion of load-moved control, power supply to pumps and capacitor charging are performed with the power source of emergency generator. (2) Shortly after the recovery of the utility power source, operation is manually changed over from the emergency generator side to the utility power side. In the case of a changeover from emergency to utility in order to feed power from capacitors to pumps, such a changeover action can also be taken in uninterruptible mode.

standby type emergency power generation system method is maintained.

4 Method of Power Feeding to Pump Loads in the Case of Voltage Dips or a Power Outage

Table 2 shows the flow of electric power in the case of voltage dips or a power outage. If a power outage continues for more than one second, a quick-start type emergency power generating unit begins to feed power within 10 seconds. During the period of 10 seconds from the occurrence of a power outage to the start of power feeding from the emergency power generating unit, power to the pumps is fed from the parallel compensation type voltage dip compensators.

Since the parallel compensation type voltage dip compensators can compensate the power for 18 seconds, power can be duly fed to the two units of 37kW feed pumps in the specified duration. Therefore, until the power generating unit begins to feed power, operation of the feed pumps can continue. When the system is switched over to power feeding by emergency power generating unit, power is fed to the feed pumps and at the same time to the capacitors. Upon recovery of utility power, the system is switched over from generator power feeding to utility power feeding. Since power source backup is assured by the parallel compensation type voltage dip compensators, operation of the feed pumps is not interrupted.

5 Postscript

This time a Meiden EDLC type parallel compensation type voltage dip compensators was applied for the first time to an emergency power generation system of water distribution pumping facilities of waterworks. After this equipment was installed at the customer's site, it enabled the facility to maintain a stable water supply without the stoppage of feed pumps even in the case of momentary voltage dips or a power outage. This gave a great satisfaction to the customer. We consider that there are many water utilities who wish to have uninterruptible pumping systems for stable water supply. We will continue to make efforts to offer valuable products to respond to these requirements. We express our deepest gratitude to the personnel related to this project for the supply of this system.