Resistive Capacitor Switching Transient Limiter

Kadam C. M.[1], Girme K. K.[2] ,Kulkarni P. P.[3] ,Hake A. S.[4] ,Kunure B. S [5]
Department of Electrical engineering
[1,2,3,4,5] Zeal College of Engineering and Research

Abstract- *we presents a new resistive capacitor switching transient limiter (RCSTL) for limiting power capacitor switching transients. The RCSTL consist of a limiting resistors, a full bridge diode rectifier, a thyristor and a coupling transformer.*

In this operation the limiting resistor is connected with capacitor bank and thyristor across the dc bridge rectifier. During the capacitor charging process thyristor remains off so the secondary of coupling transformer works as open circuit.so limiting resistor comes in series with capacitor bank, which limits the capacitor switching transient.

In normal operation the thyristor gets operated and lcoupling transformer act as short circuit. so, the limiting resistors are bypassed by the coupling transformer. In this process, capacitor of 1KVAR is used.

Keywords- RCSTL, KVAR etc.

I. INTRODUCTION

Power factor correction brings in many advantages such as decreasing the power loss in feeders and transformers, reducing system voltage drops, increasing capacity stem, reducing customer's electricity bills, etc. Shunt capacitors are generally used to increase power factor of the power systems . Since the system loads and the voltage profile are not constant, the capacitor banks may be switched in and out several times during a day to adjust the system power factor. When a capacitor bank is switched on, an unwanted, high frequency inrush current and transient overvoltage may appear during the energising process.

The set Transients lower the lifetime of the capacitor banks and can damage the electromagnetic witches such as circuit breakers . Customer's electrical apparatus might be damaged during such phenomenon as well. In addition, operation of the control equipment might also be affected by these transients. Several techniques have been implemented to mitigate the capacitor bank switching transients . The application of surge arresters for reducing the capacitor switching transients is discussed in .Since the surge current needs to be effectively discharged, system rounding issues must be taken into account in this method.

Many approaches are based on the zero-voltage closing control in which the capacitor banks are energised when the voltages across the switching contactors are almost zero . These methods utilize power electronics components and comprise additional control systems, which increase the complexity and the cost of the system and thus, they have less economic justification. In , the capacitor transients are limited by inserting a fixed limiting reactor in the line at the instants of the capacitor bank energising. Although this technique seems to be simple and less expensive, it might result in series resonance occurrence. Pre-insertion of Resistor/Reactor is proposed in . One great disadvantage of this method is that it is basically designed only for high voltage applications. Moreover, bypassing the resistor/reactor could bring about a second transient. A symmetrical structure transient limiter is proposed in . This single-phase limiter effectively suppresses the switching transients and eliminates the series resonance problem. However, in contrast to other similar structures, it requires twice the number of limiting reactors, which increases the overall system cost. In the recently developed approaches , a DC-reactor has been utilised to mitigate the capacitor switching transients. In , single-phase DC-reactor type capacitor transient limiters are studied. These single-phase devices must be separately installed in different phases, which in turn lead to increase in the number of the electric components and lower reliability of the system. Besides, when a single-device failure occurs, the voltage imbalance across the capacitor bank terminals has negative impacts on the operation of the system. A three-phase single-DC reactor-type limiter is proposed in . In this method, a DC-reactor provides high-impedance through a three-phase coupling transformer at the energising instants, through which the transients are suppressed. This paper presents a three-phase resistive power capacitor switching transient limiter (RCSTL) with a simple and reliable

The advantage of RCSTL are :

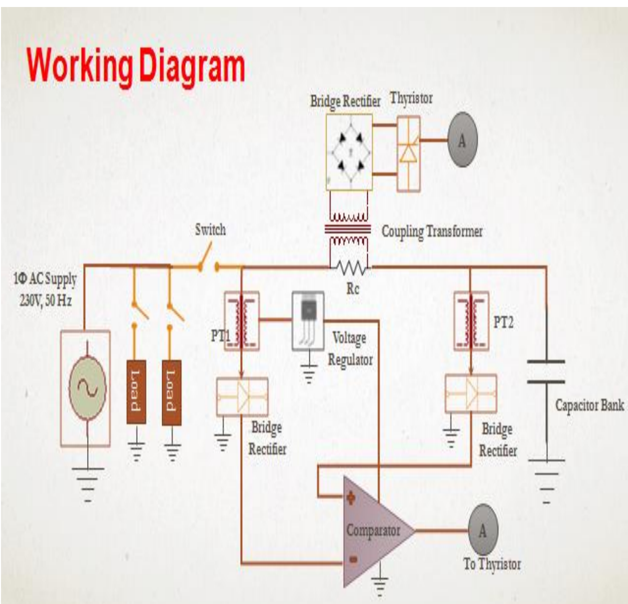
1. The cost of RCSTL is much less than single DC type limiter.
2. The limiting capacity and reliability of system is good.
3. As per the turn ratio of coupling transformer the rating of bridge rectifier and thyristor is adjusted.
4. Due to use of limiting resistor the resonance effect is neglected.

So, in the rest of the paper we discuss the operation of limiting resistor by the coupling transformer. The coupling transformer are operated through bridge rectifier and the bridge is operated with help of comparison circuit. In comparison circuit two potential transformer are used which output is compared with help of comparator.

In next section 2 we discuss the idea about compoenent used and its ratings.section 3 gives the idea about basic layout.

In which we discuss the idea about sequential use of the component. Further section gives simulation and its simulated result.

II. BASIC STRUCTURE OF RCSTL



As shown in fig. the basic structure of RCSTL working on single phase 230 V ac supply. It can be work on three phase supply. It consist of two potential transformer. The Potential transformers are also known as voltage transformers and they are basically step down transformers with extremely accurate turn's ratio. Potential transformers can be used as step down transformer. These transformer consist more primary turns than the secondary turns. The potential transformer are convert 220 V to 6 V, 110mA.

The voltage regulator are used to supply the operational Amplifier. The LM341 and LM78MXX series of three-terminal positive voltage regulators employ built-in current limiting, thermal shutdown, and safe-operating area protection which makes them virtually immune to damage from output overloads.

With adequate heatsinking, they can deliver in excess of 0.5A output current. Typical application of voltage regulator is to reduce noise.

The feature of voltage regulator are :

- Output current in excess of 0.5A
- No external components
- Internal thermal overload protection
- Internal short circuit current-limiting
- Output transistor safe-area compensation
- Available in TO-220, TO-39, and TO-252 D-PAK packages
- Output voltages of 5V, 12V, and 15V.

The voltage regulator used is 7805 series. So, the output voltage is 5 V.

A thyristorconsisting of anode, cathode and gate. The thyristor is in on state whenever it is in forword biased. Some sources define silicon-controlled rectifier (SCR) and thyristor as synonymous The first thyristor devices were released commercially in 1956. As small device thyristor can control large power. Thyristor are used in light dimmer and electric motor speed control. Thyristors may be used in p, relay-replacement circuits, inverter circuits, oscillator circuits, power switching circuit, level-detector circuits, logic circuit, chopper circuits, light-dimming circuits, low-cost timer circuits, speed-control circuits, phase-control circuits, etc.

The thyristor consist of four layer and three terminal may be P-N-P-N. the anode and cathode are the terminals of thyristor. The control terminal, called the gate, is attached to p-type material near the cathode.

The feature of thyristor TYN16 – 600CT are:

- Type number: TYN16-600CT
- Package version: SOT78
- Package name: TO-220AB
- VDRM [max] (V): 600
- VRRM [max] (V): 600
- IT(RMS) [max] (A): 16
- IGT [max] (mA): 15
- ITSM [max] 50 Hz (A): 180
- Tj [max] (Â°C): 150

The another most important compoenent used is bridge rectifier. There are many different kinds of bridge rectifiers most common types categorized by maximum average rectified current, maximum reverse current, forward voltage, packaging type and maximum peak current, maximum revese voltage.

The most common sizes for maximum average rectified current are 1A, 1.5 A, 4 A, 25 A and 35 A. Forward voltage can range from 450 mV to 1.1 kV, with the most common bridge rectifier semiconductor chips having a forward voltage of 1.1 V or 1 V.

The capacitor bank used in this project is responsible for the transient generation. The capacitor bank is generally used to improve the power factor. In this circuit we use capacitor bank of 25 KVAR. The transient generated due to the capacitor are should minimized to reduce its effect on load equipment.

III. PROPOSED OPERATION OF RCSTL

There are two modes operation on basis of capacitor energizing is as follows :

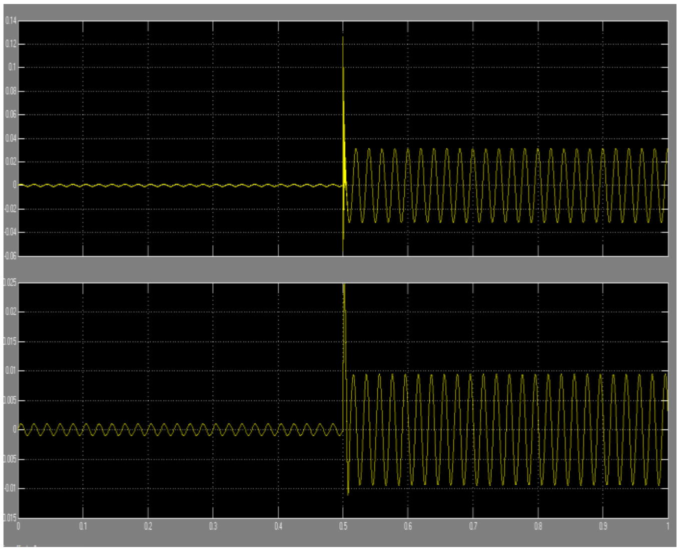
Energising mode : In this mode of operation, as capacitor is in charging operation the initial voltage across it is nearly zero. thus the voltage across PT 1 is more than voltage across PT 2. So the negative terminal of comparator is more than positive terminal so, the output of comparator is -VCC. The output of comparator is directly given to the thyristor so, the secondary winding is open circuited. So the transient current can flow through two path, one is through the winding of the transformer and other is through the limiting resistor. As the secondary of the transformer is open circuited it provides the high impendance path to the current. So, the current flows through the limiting resistor. So the switching transient are suppressed by the limiting resistor.

De-energising mode : now, in this mode of operation the capacitor bank is fully charged. So, output of the PT 1 is much lesser than the PT 2. Hence the positive terminal of comparator is much high than the negative terminal and the output of comparator is positive and equal to +VCC. It send a pulse to the gate terminal of the thyristor so thyristor conducts. Because of the thyristor the bridge rectifier or secondary of the transformer is become short circuit. So, it offer a low impedance path to the flow of the current. Because of that the crrent choose to flow through this path instead of flowing through the limiting resistor.

IV. SIMULATION AND ITS RESULT

The circuit dia. Of RCSTL is shown above. The result of operation can be seen on the oscilloscope. The other method is by using the software available. There are number of software available in market from which we used MATLAB software.

The figure 1 shows the simulation result of RCSTL. In this result the circuit is operated in enegising mode of operation. The result shows the switching transients presents in the circuit. The switching transient present for very short duration of time interval



Where as fig 2 shows the result after the operation of RCSTL. As shown in figure the spikes present the waveform i.e, the switching transient present are gets minimized. Due to the operation limiting resistor used the transient can be neglected.

As shown in figure, the fig 1 shows the result of steady state when the secondary of coupling transformer is short circuited. While the second figure shows the result of energizing mode of operation, in which the coupling transformer secondary is open circuited and switching transient are limited through limiting resistor.

V. CONCLUSION

To suppress the switching transient produced in circuit we can use the RCSTL.during the charging process of capacitor the limiting resistor used mitigates the switching transient. While when the capacitor is fully charged the comparator provides the ON state pulse to the thyristor, which turns on thyristor and makes secondary of coupling transformer short circuit.

So it can be concluded that the proposed RCSTL can be used for suppressing the switching transient. The resistor capacitor switching transient limiter is can be used because of simple, reliable and fast control.

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