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자기압축회로의 EMTP 시뮬레이션

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Simulation of the Magnetic Pulse Compression Modulator using Electromagnetic Transients Program

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Abstract A pulse generator of one stage magnetic pulse compression modulator was simulated by electromagnetic transients program (EMTP). The pulse generator was expected to generate ~ 80 kV peak voltage, ~ 140 ns pulse width and about 70~75 % energy delivery efficiency from initial charge capacitor (0.2 μF) to dummy load (25 Ω). From this simulation, the scheme of pulse circuit could be estimated as a practically reasonable design.

1. 서 론

Applications of the pulsed corona discharge against air pollution which is generated from coal-burning power plant, iron and steel plant, and the like has been studied[1,2]. The free electrons of the corona discharge originate active radicals, which lead to dissociate harmful gas molecules such as NOx and SO_2. To obtain the free electrons, a power supply for fast-rising narrow high-voltage pulse is necessary. There have been used typical 2 types of pulse generators, MPC (Magnetic Pulse Compression) modulator and rotary spark gap switch, for pollutant gas treatment. Both types can meet the long lifetime and high reliability for the purpose of versatile industry application.

In this work, one stage MPC modulator was tentatively simulated before manufacture using EMTP (Electromagnetic Transients Program). From this simulation: 1) the main scheme of MPC circuit composed of the pulse transformer and magnetic switch; 2) the output pulse peak and width; and 3) the efficiency of the pulse generator were investigated.

2. 본 론

2.1 MPC circuit scheme

The scheme of MPC circuit is shown in Fig. 1. This circuit consists of initial charge capacitor 0.2 μF (20 kV), thyratron switch, pulse transformer (20 kV/160 kV), ceramic capacitor (2.7 nF, 160 kV), magnetic switch (metglas 2605CO) and 25 Ω dummy load (non-inductive carbon resistor). The primary and secondary inductance of the pulse transformer is designed to be 0.2 μH and 13 μH, respectively. The short inductance of magnetic switch was made 1.7 μH. Because the output impedance of pulse transformer is calculated as 25 Ω from the values of 2.7 nF and 1.7 μH, the dummy load puts 25 Ω for the impedance matching between pulse generator and load.

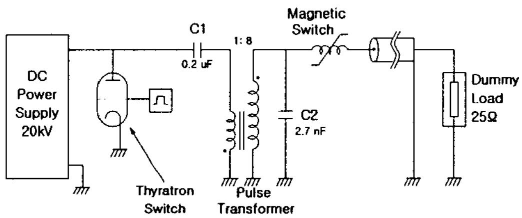

Figure 1. The scheme of MPC circuit for simulation

2.2 Results and discussion

Fig. 2 shows the voltage and current waveforms of the simulated MPC modulator at each part. The peak voltage and current show 82.8 kV and 3.3 kA at the load, respectively. The pulse width (Full Width Half Maximum) and rise time (bottom to top) show 140 ns and 90 ns at the load, respectively. This pulse waveform is suitable for acceleration of free electron. From the principle of impedance matching, the load voltage was divided about half of secondary pulse transformer voltage. This is almost best condition for impedance matching between power source and load. In this work, the dummy load was used for the impedance matching. The problem of impedance matching in real application reactor has relatively various parameters to be considered[3]. Fig. 3 shows the energy of the simulated MPC modulator at each part. While the initial energy of capacitor C1 is 40 J, the energy was decreased 34 J and 30 J at capacitor C2 and magnetic switch, respectively. From this, the total energy loss of this pulse circuit scheme was estimated 10 J. The total energy delivery efficiency can be also calculated 75 %. It is considered that this energy efficiency is relatively high as MPC type pulse generator due to one stage MPC design. The obtained main data in simulation is shown in Table 1. From this table, the efficiency of pulse transformer and magnetic switch can be calculated to be 85 % and 88 %, respectively, which will be practically possible parameters in the case of manufacture. There may have other losses in this pulse circuit such as the switching loss of thyratron and winding resistance of pulse transformer and magnetic switch. Including like these losses, the total efficiency of the designed pulse generator will be expected at least 70 %.

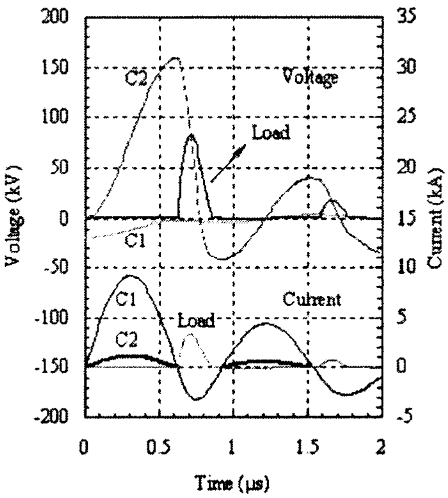

Figure 2. The voltage and current waveforms of simulated MPC modulator.
(C1 : 0.2 μF, C2 : 2.7 nF, Load : 25 Ω)

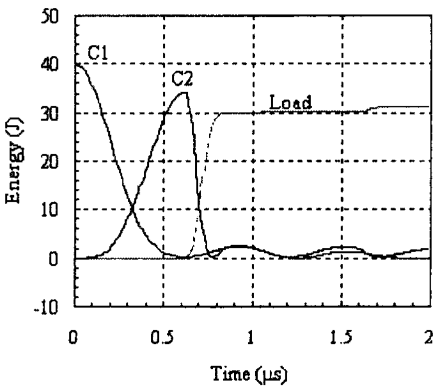

Figure 3. The energy of C1, C2 and load.
(C1 : 0.2 μF, C2 : 2.7 nF, Load : 25 Ω)

Table 1. The obtained main data in simulation

	C1 (0.2 μF)	C2 (2.7 nF)	Load (25 Ω)
Peak Voltage (kV)	20	158.9	82.8
Peak current (kA)	9.18	1.09	3.3
Peak energy (J)	40	34	30

3. 결 론

A scheme of MPC type pulse generator was simulated by EMTP. This simulation can be used to estimate the output waveform, peak and efficiency of the pulse generator. The planed scheme of the pulse generator was reasonably explained. This simulation is a previous stage of the manufacture of the pulse generator.

[참 고 문 헌]

[1] GIORGIO DINELLI, LUIGI CIVITANO and MASSIMO REA, IEEE Industry Application 26, p. 535 (1990)
[2] J. SIDNEY CLEMENTS, AKIRA MIZUNO, WRIGHT C. FINNEY and ROBERT H. DAVIS, IEEE Industry Application 25, p. 62 (1989)
[3] Y. W. Choi, H. S. Lee, G. H. Rim, T. H. Kim, G. H. Jang, W. H. Shin, and Y. H. Song, "Analysis of the pulsed plasma reactor impedance for DeSOx and DeNOx", Jpn. J. Appl. Phys. Vol.40, No. 2B, pp. 1108-1113, (2001)