STATUS OF ELECTROSTATIC SEPARATORS AT KEK

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Electrostatic separators with built-in high voltage generators were developed for the secondary beam lines of the 12 GeV proton synchrotron at KEK[1]). They have been operated stably since they had been installed in the beam lines. The maximum field of 1005 KV / 10 cm was achieved in the latest one (Mark II-2) whose aperture of the field of 10 cm_g x 40 cm_w x 6 m_l. The performance of the electrostatic separator is given and the characteristics of vacuum breakdown in the region of 10^{-4} Torr is also discussed.

Performance

All of the separator have been operated in the beam lines at the electric field between 600 kV / 10 cm and 900 kV / 10 cm. The performance of the latest separator which is more compact than that of the initial type of the KEK separator (Mark I) is given in Table 1. The maximum field of theis separator was 1005 kV / 10 cm with the spark rate of 0.3 sparks / min.. The continuous opration has been performed at the field of 900 kV / 10 cm with the spark rate of 1 spark / h in the beam line. The pressure dependence of the breakdown voltage (P-V curve) is shown in Fig. 1. Helium and Neon (35%-65%) gas mixture is flowed to adjust the pressure. The continous operation is performed in the pressure range of a few times of 10^{-4} Torr.

Characteristic of Vacuum Breakdown in This Region

The breakdown voltage in the region of 10^{-5} 10^{-4} Torr depnds on the pressure of the residual gas. This effect has been studied by the authors et al[2]).

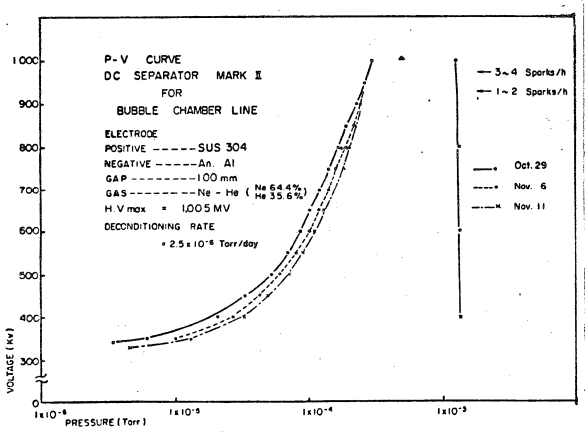

Fig. 1, Pressure depandence of the breakdown voltage at the electrostatic separator (Mark II-2).

Table 1, Performance of the electrostatic separator (Mark II-2).

Electrode gap	10 cm
width	40 cm
length	6 m
Electrode Material	
positive	stainless steel
negative	anodised aluminum
Maximum field	1005 kV / 10 cm
spark rate	0.3 / min
Working field	900 kV / 10 cm
spark rate	1 / h
Conditioning time	a few days
Deconditioning rate and	2 x 10^{-6} Torr /day
Pressure plateau at	1 x 10^{-3} Torr
working field	900 kV / 10 cm
Support insulator	
dimension	10 cm (o.d.) x 20 cm
material	ceramic (Al_2O_3)
H.V. generators	
dimensions (x, y, z)	20 x 72 x 70 cm^3
maximum H.V.	±600 kV
stability	10^{-4}

The following relationship between the maximum voltage (V) and the pressure (p) was found by our experiments,

$$V = V_0 + kp$$

where V_0 is the maximum voltage at the ultra low pressure (10^{-6}) and k is a coefficient. Figure 2 shows the pressure dependence of the maximum voltage for the various gases at the separator Mark III with the gap of 15 cm and the length of 2 m. The k is the function of the gas material. In fig. 3 , the maximum voltages are plotted as the function of the atomic mass number at the pressure of 1 x 10^{-4} Torr. It seems to be understood as the nearly linear function in this mass region for the innert gases.

The useful gas for the electrostatic separator should not be chosen by only the above relationship but by also the the effect of the critical pressure where gaseous discharge is initiated. The effect of the critical pressure is discribed elsewhere.

Neon and helium gas mixture was chosen as the optimised gas for the KEK separators.

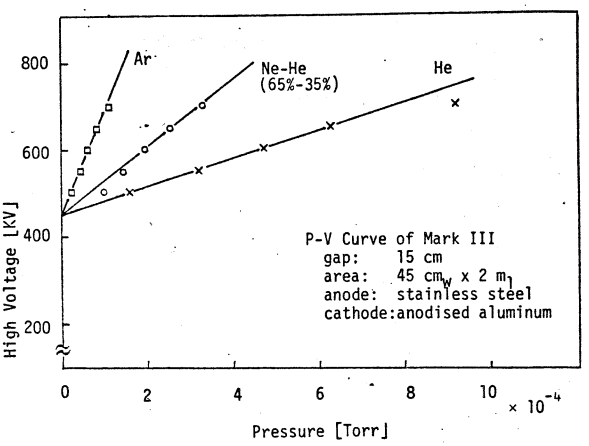

Fig. 2, Pressure dependences of the break-down voltages for the gases of Ar, Ne-He and He at the separator Mk-III.

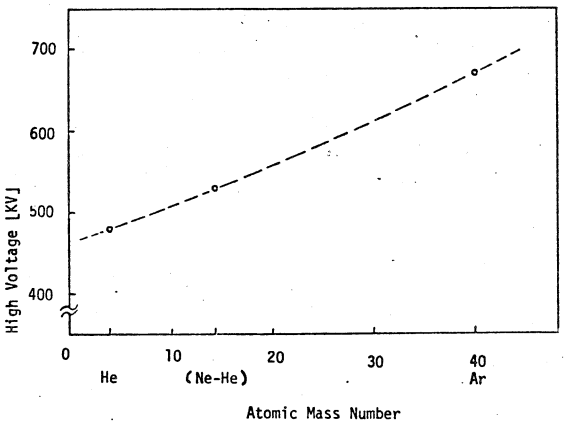

Fig. 3, Mass number dependence of the break-down voltage at the pressure of 1 x 10^{-4}.

Summary

The electrostatic separators with built-in high voltage generators have been operated staby in the beam lines and the no problem have happened during these two years. The working field of 900 kV / 10 cm is a satisfactory result in this development.

References

1) A. Yamamoto, A. Maki and A. Kusumegi, Nucl. Instr. and Methods 148 (1978) p.203.
2) A. Yamamoto, A, Maki, Y. Maniwa and A. Kusumegi, Jap. J. Appl. Physics 16 No. 2 (1977) p.343.