CONF-8611103--4

CHARGING AND CORONA MODIFICATIONS TO THE ORNL 25URC ACCELERATOR*

CONF-8611103--4

DE87 004396

N. F. Ziegler and R. L. McPherson

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

INTRODUCTION

A chain-charge monitoring system[1,2] was first installed in the 25URC accelerator in October, 1982, and has provided valuable information about the charging system. Additions to the system during the past year have significantly increased the amount of information provided by the monitor. Cables connecting pickoff wheels and inductors in the terminal were improved to provide higher reliability of the charging system.

The tube corona points supplied with the 25URC accelerator had a point-to-plane spacing of 0.175 inches. Our operating experience indicated that the corona currents for the normal gas pressure and voltage range of the accelerator were lower than optimum. Current-voltage characteristics of a three-needle point set were measured at several spacings and gas pressures to provide criteria for ordering new points.

* Research sponsored by the Division of Basic Energy Sciences, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

MASTER

"The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-84OR21400. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes."

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

CHARGING SYSTEM

The chain charge pickups for the 25URC accelerator consist of ring electrodes encircling each chain course. The ring ID is 1 15/16 inches with a thickness of 1/2 inch. Each ring is connected via coaxial cable to a spark protection circuit and tank feed-through. Outside the tank each pickup is connected to a tap on each of two selector switches with the wipers going to the monitor circuit. Originally, the monitor consisted of a dual-trace oscilloscope, with which the signals from any two pickups could be compared. A signal from an inductive proximity pickup coupled to the toothed chain drive pulley was also brought out to trigger the oscilloscope, thus providing an absolute indication of chain slip-page. This monitoring circuit proved useful in diagnosing charging system problems, but it was located a considerable distance from the control rooms requiring a special effort to observe it. During the past year the monitor has been improved by adding a remote read-out facility for each channel as shown in the block diagram of Figure 1. Six channels are required to monitor the three chains, but only three frequency-to-voltage converters (FVC) are necessary. The nine analog signals are transmitted to the control consoles via the CAMAC system and will be displayed on the CRT monitor providing the accel-erator operator with convenient access to chain charging infor-mation. In Figure 1, the signal from the pick-up electrode is, nominally, in the 0.1 to 0.25 volt, peak, range. With a preamp gain of 25, the input to the FVC and precision rectifier is then about 2.5 to 6.25 volt, peak. The pellet frequency is about 400 Hertz.

It has been assumed that the signal from a chain charge monitor should be of the form, $V=f(t)\sin \omega_c t$, which is an amplitude modulated signal where f(t) is a function of the chain charge and $\omega_c=2\pi *$ pellet frequency. In practice, however, the signal often appears as in Figure 2A where the bottom trace could be better approximated by $V=g(t)+A \sin \omega_c t$. Consider a charge distribution as shown in Figure 3 where the packets of charge are moving through a hole

(radius=a) in a plate of large extent. The voltage induced on the plate at a particular instant should be expressible in the following general form:

$$V_i = \sum_{n=-\infty}^{\infty} \frac{A_n\, q_n}{\pm\sqrt{a^2+x_n^2}} \quad \text{,where } x_n = nb + v_c t.$$

Of course, it is immediately obvious that the induced voltage is a function of the charge approaching, or leaving, the plate as well as the charge passing through the hole. If all charges are equal, only those passing through the hole (x=0) contribute to the induced signal since the charge approaching the plate is exactly equal to the charge leaving. The charges passing through the hole will induce a signal having a period b/v_c and an amplitude proportional to charge, q. This is the expected amplitude modulated signal. If a group of packets approaching the plate are more highly charged than their neighbors, then the plate potential will be driven positive in addition to the signal induced by the packets passing through the hole. Of course, on leaving the plate, the group induces a negative-going signal. One method of eliminating the additive signal would be shielding of the chain as it approaches the pickup electrode.

One rather interesting example of information from the chain charge monitor is provided by Figure 2. Here the two photos present signals from two chains at two different times. The upper traces come from a normally functioning chain. In 2B the bottom trace is generated by a malfunctioning up-charge chain. The bottom trace in 2A came from the same chain after oiling.

The charging system in the terminal of the 25URC accelerator employs charge pickoff wheels on either side of the sheave connected to inductors on the opposite side by high-voltage cables. Although the voltage on these cables is normally only a few kilovolts, the insulation is sometimes punctured which results in loss of charging for the affected chain. The punctures usually occur at points where the cables contact sharp corners of the sheave support structure and

are assumed to be initiated by surges during column sparks. The first effort to improve the insulation consisted of replacing the original cables with high-voltage cables (60 kV rating) running inside plastic tubing. The breakdown voltage for the composite should have been very high, but the insulation was again punctured at points near corners. Since breakdown occured at high gradient points on the "ground" side, it was decided to try a shielded cable such as RG-8. A stress cone was formed by sliding a rubber stopper under each end of the shield and turning the braid back over the outer cover. Six of these cables are now in service in the terminal and have caused no problems.

CORONA POINT CHANGES

For a fixed insulating gas pressure, the terminal voltage operating range of the 25URC accelerator is determined by spark gap breakdown or excessive corona currents at the high end and by minimum corona currents at the low end. From experience, it appeared that the low end corona currents could be increased somewhat with a resulting increase in operating range and, perhaps, result in a longer interval between point replacements. The three-needle tube corona point fixtures have used point-to-plane spacings of 0.175 inches. In an effort to determine a more optimum spacing, the current-voltage characteristic of a three-needle fixture was measured at several spacings and SF_6 pressures. These measurements are summarized for new points in Figure 4. In Figure 5, similar data for "used" points are presented. Point radius, estimated from microscopic examination, is 1 to 2 mils for new points and 4 to 6 mils for used points. Based on these measurements, a new set of tube corona points having a spacing of 0.150 inches was purchased and installed in the accelerator in June, 1986. A comparison of total charging current in the accelerator for the two point spacings is shown in Figure 6.

ACKNOWLEDGEMENT

The authors acknowledge the contribution to this work of C. M. Jones who suggested rectifying the chain charge pickup signals and D. L. Haynes who designed the corona point test chamber.

REFERENCES

1. Thieberger, P., 1978 SNEAP Proc., ORNL Rept. CONF-781051, pp. 91-101.
2. Walker, D., 1980 SNEAP Proc., Univ. of Wisc., pp. 184-194.

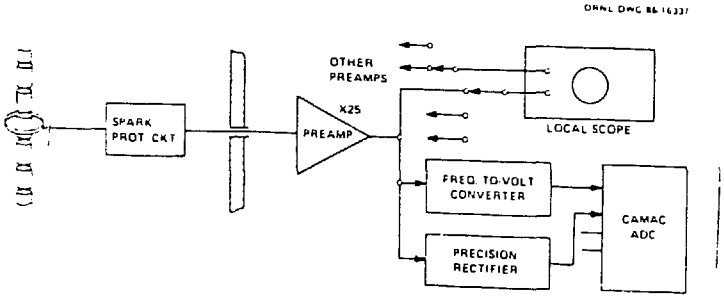
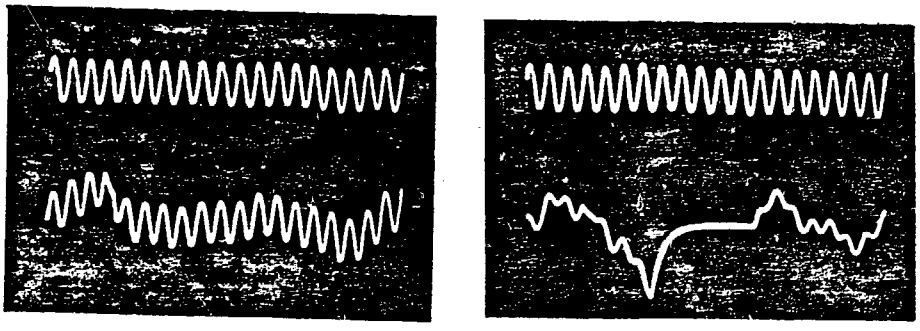


Fig. 1. Chain monitor schematic.



(A) (B)

Fig. 2. Waveforms from chain monitor.

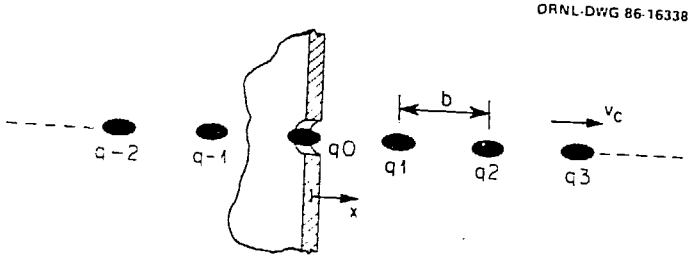
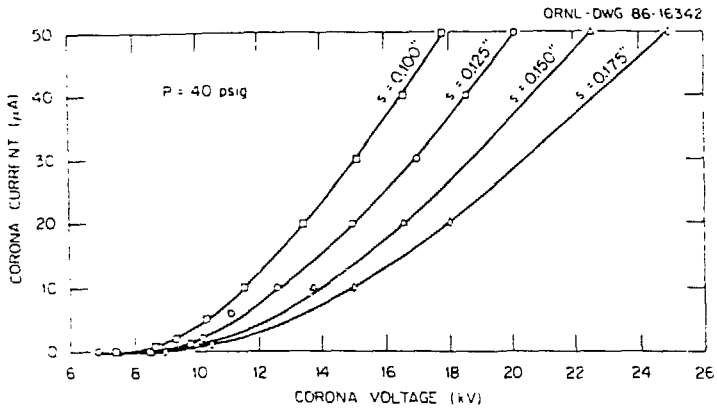
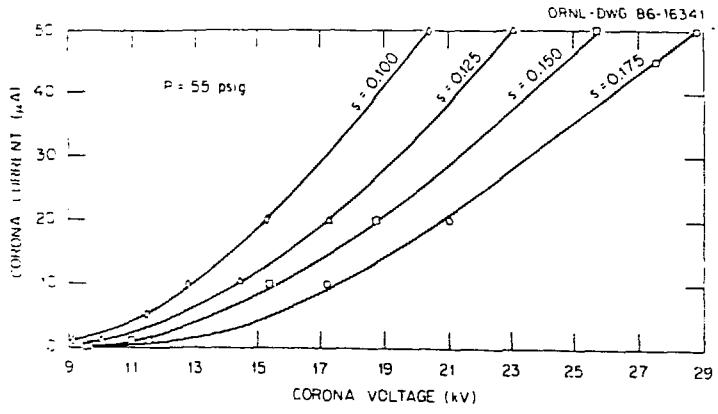


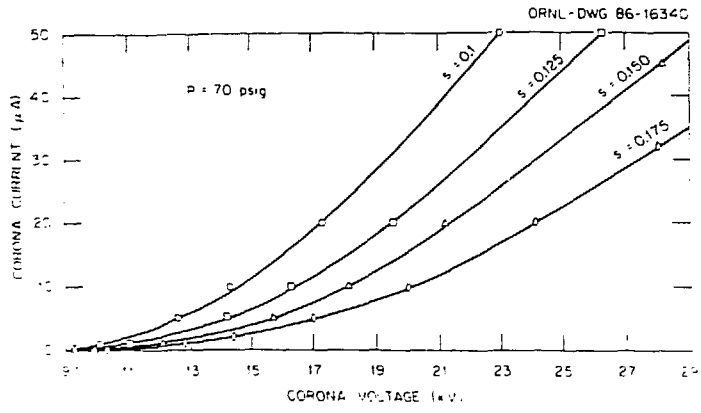
Fig. 3. Charge packets passing through a large plate.



(A)



(B)



(C)

Fig. 4. Corona characteristics of new three-point fixtures.

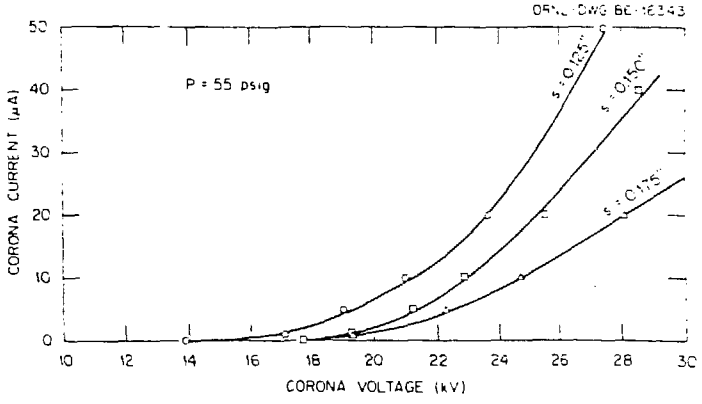


Fig. 5. Corona characteristics of a used fixture.

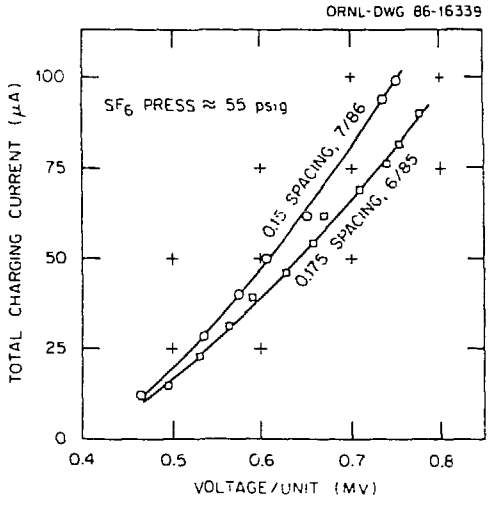


Fig. 6. Effect of point-to-plane spacing on charging current.