High-Voltage Monitoring in Electrostatic Separators

Adrian Mihalcioiu, Vasile Neamtu, Anca Stochita, and Lucian Dascalescu, *Senior Member, IEEE*

***Abstract*—High voltage is known to be one of the main control variables in any electrostatic-separation process. From this perspective, the aim of this paper is twofold: to develop an effective high-voltage monitoring system and to demonstrate that it can be a useful tool for controlling the overall operating conditions of an electrostatic-separator system. A custom-designed virtual instrument was employed for processing the experimental data provided by a high-voltage probe, the output of which was connected to an electrometer. In several experiments, the output of the high-voltage probe was also connected to a digital oscilloscope, in order to obtain a better understanding of the variation of the electrode potential after a spark discharge. The laps of time without corona discharge and/or with low electric field intensities could thus be accurately determined, and the impact of the spark discharges on the outcome of the separation process evaluated. The dispersion of high-voltage measured values was found to increase in the presence of the material. The statistical analysis of the data revealed a significant correlation between the standard deviation of the high-voltage and the concentration of metal in the processed material. The results of this paper could be helpful for those seeking the optimization of the operating conditions for the electrostatic separation applications, in which the metal content in the feed materials exhibits substantial fluctuation with time.**

***Index Terms*—Electrostatic separation, high-voltage measurement, virtual instrumentation.**

I. Introduction

ELECTROSTATIC separation is based on the utilization of electrical forces acting on charged or polarized particles in an electric field [1]–[4] generated by an electrode system connected to a high-voltage supply. Applied high voltage (HV) should be adjusted close to the threshold, beyond which spark discharges could occur between the electrodes, in the presence of the processed material [5]. In this way, the highest possible intensity of the electric field is ensured, which implies the best particle-charging conditions and most effective electric-separation forces [6]–[8].

Indeed, electrostatic induction, which is the prevalent charging mechanism of conductive particles in roll-type separators (Fig. 1), depends directly of the electric-field strength at the surface of the electrode carrier [9]. Corona charging, which affects both conductors and insulators, is also proportional to the electric-field strength, and hence, to the voltage applied to the electrode system [10].

Continuous monitoring of the HV drop between the electrodes is necessary in order to avoid spark discharges, which are common in electrostatic precipitators [11], [12]. Whenever a spark discharge occurs, the magnitude of HV between the electrodes is significantly reduced. The duration of the field failure depends of the ability of the HV power supply to restore the potential at which the electrodes were before the spark. Such an event disturbs the separation process, as the aforementioned electric-charging processes cease and no electric forces act on the already charged particles.

From this perspective, the aim of this paper is twofold: to develop an effective HV measuring system for electrostatic separators and to demonstrate that it can be a useful tool for supervising the overall operating conditions of such an installation.

II. Experimental Procedure

A laboratory roll-type corona electrostatic separator EHTP 25-36 (CARPCO Inc., Jacksonville, FL) [13] was employed in the experimental study (Fig. 1).

The separator was provided with two HV electrodes: a wire-type corona electrode and a tubular (nonionizing) electrode. Both electrodes were connected to a same dc HV supply by means of a multipole HV connector; the potential of which was measured by a HV probe (dc—90 MHz, model PVM-5, North Star, Albuquerque, NM, http://www.highvoltageprobes.com/PDF/Vmonad2004.pdf), as shown in Fig. 2.

A. HV Monitoring During Spark-Free Operation

In this first group of experiments, the output of the HV probe was connected to a digital electrometer (model 6514, Keithley Instruments, Cleveland, OH) by means of a calibrated resistor of 1 MΩ, which ensured impedance matching. A general purpose interface bus cable connected the electrometer to a PC, provided with an IEEE488 data-acquisition card. A virtual instrument was developed using the LabVIEW 6.0.i environment

Paper MSDAD-06-05, presented at the 2004 Industry Applications Society Annual Meeting, Seattle, WA, October 3–7, and approved for publication in the IEEE Transactions on Industry Applications by the Electrostatic Processes Committee of the IEEE Industry Applications Society. Manuscript submitted for review October 15, 2004 and released for publication September 5, 2006. The HV equipment employed was partly funded by Fonds Européen de Développement Régional (FEDER) and by the Poitou-Charentes Regional Council.

A. Mihalcioiu was with the Electronics and Electrostatics Research Unit, LAII-ESIP, UPRES-EA 1219, University Institute of Technology, 16021 Angoulême Cedex, France, and also with the Department of Electrical Engineering, Technical University of Cluj-Napoca, 3400 Cluj-Napoca, Romania. He is now with Osaka Prefecture University, Osaka 599-8531, Japan (e-mail: digimed@metecus.ro).

V. Neamtu is with the Department of Electrical Engineering, Technical University of Cluj-Napoca, 3400 Cluj-Napoca, Romania (e-mail: Vasile.Neamtu@et.utcluj.ro).

A. Stochita was with the Electronics and Electrostatics Research Unit, LAII-ESIP, UPRES-EA 1219, University Institute of Technology, 16021 Angoulême Cedex, France. She is now with the Romanian Business Consult, 01395 Bucharest, Romania (e-mail: anca.stochita@rbc.com.ro).

L. Dascalescu is with the Electronics and Electrostatics Research Unit, LAII-ESIP, UPRES-EA 1219, University Institute of Technology, 16021 Angoulême Cedex, France (e-mail: ldascalescu@iutang.univ-poitiers.fr).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TIA.2006.887315

0093-9994/$25.00 © 2007 IEEE

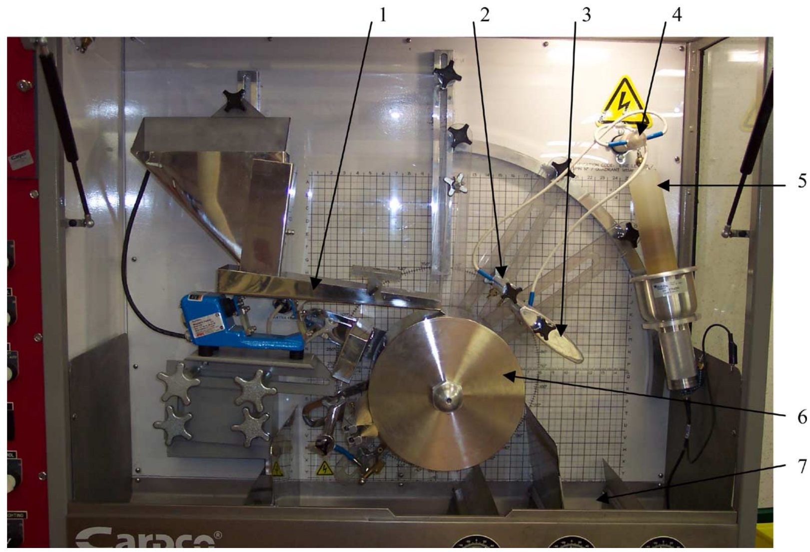


Fig. 1. Roll-type corona electrostatic laboratory separator (CARPCO Inc., Jacksonville, FL) with high-voltage probe. 1: feeder; 2: corona electrode; 3: electrostatic electrode; 4: high-voltage connector; 5: high-voltage probe; 6: grounded roll electrode (carrier); 7: collector.

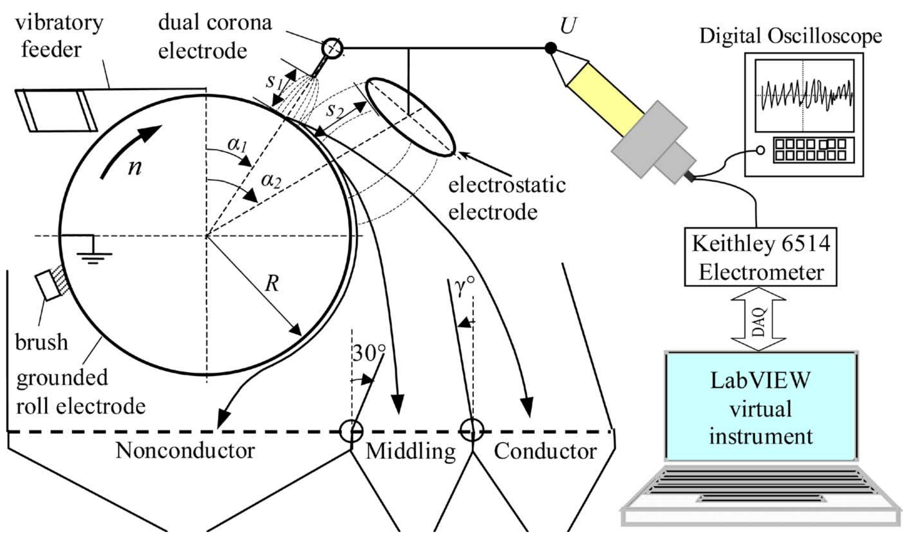


Fig. 2. Experimental setup for HV monitoring using: a high-voltage probe (model PVM-5, NorthStar Research); a digital electrometer (model 6514, Keithley) with a virtual instrument developed in a LabVIEW environment; and a digital oscilloscope (model DL1740, Yokogawa).

[14]. It enabled the remote control of the electrometer, the real-time transfer of the data to the computer, and their processing in accordance with the diagram presented in Fig. 3.

The sampling rate was set to 20 samples/s, as the outcome of the measuring procedure was not sensitive to this parameter. Each time 1000 samples were displayed on the front panel of the virtual instrument, the results were saved in a .txt file for further processing. The average value and the standard deviation (σ_{HV}) were evaluated for each series of measurements.

The granular material employed in the experiments was obtained from genuine chopped electric-wire wastes processed in the recycling industry, with 5%, 25%, or 45% of stranded copper (diameter: 0.25 mm; length > 1 and < 5 mm). In one experiment, the stranded copper was replaced by massive copper wire.

Six sets of experiments were performed in order to evaluate the effects of the factors that might affect the value of the potential measured by the HV probe (Table I).

For the first two experiments, a centered composite design was adopted [15], [16], in order to derive a second-order polynomial model correlating the response σ_{HV} with the variables considered in this paper: metal content c (in percent) of the granular mixture, roll-speed n (in revolutions per minute), and HV level U (in kilovolts). With such a model, the response $y = \sigma_{\mathrm{HV}}$ can be expressed as a function of e factors u_i $(i = 1, \ldots, e)$

$$y = f(u_i) = c_0 + \sum c_i u_i + \sum c_{i,j} u_i u_j + \sum c_{ii} u_i^2. \quad (1)$$

The normalized centered values, marked with $*$, can be defined for each factor as follows:

$$x_i = (u_i - u_{ic})/\Delta u_i = u_i^* \quad (2)$$

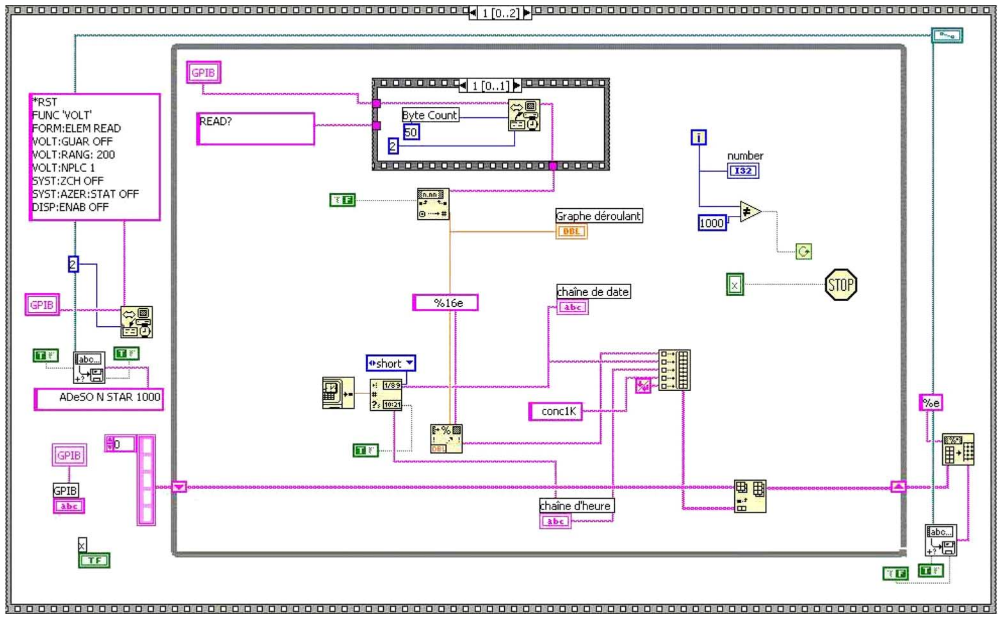


Fig. 3. Diagram of the virtual instrument employed for HV monitoring, using a HV probe and a digital electrometer.

TABLE I
EXPERIMENTAL CONDITIONS

Experiment No/Design	Electrode configuration	Metal content c (%)	Roll-speed *n* (min^{-1})	High-voltage *U* (kV)	Air-gap *s* (mm)
1/CCF*	Corona-electrostatic	Variable 5-25-45	Variable 60-80-100	Constant + 30	Constant 50
2/CCF*	Corona-electrostatic	Variable 5-25-45	Constant 60	Variable +26, + 28, +30	Constant 50
3/OFT**	Corona-electrostatic	Constant 25	Constant 80	Variable -16, -18, -20	Constant 40
4/OFT**	Corona	Constant 25	Constant 80	Variable -16, -18, -20	Constant 40
5/OFT**	Corona-electrostatic	Constant 25†	Constant 80	Variable +26, + 28, +30	Constant 40
6/OFT**	Corona-electrostatic	Constant 25‡	Constant 80	Variable +26, + 28, +30	Constant 40

* : CCF = composite centered face-centered design
** : OFT = one-factor-at-a-time design
† : 100% stranded copper wire
‡ : 0% stranded copper wire

where

$$u_{ic} = (u_{i\max} + u_{i\min})/2; \quad \Delta u_i = (u_{i\max} - u_{i\min})/2. \quad (3)$$

With these notations, the response function becomes

$$y = f(x_i) = a_0 + \sum a_i x_i + \sum a_{i,j} x_i x_j + \sum a_{ii} u_i^2 \quad (4)$$

where x_i can obviously take only the values: -1 (for the minimum input value $u_{i\min}$) and $+1$ (for the maximum input value $u_{i\max}$). For the three factors considered in this paper

$$x_1 = c^* \qquad x_2 = n^* \qquad x_3 = U^*. \quad (5)$$

The analysis of the experimental results was carried out with MODDE 5.0 program (Umetrics, Umea, Sweden) [17].

Experiments #3 and #4 were done at negative polarity, with and without the electrostatic electrode connected to the high-voltage supply. The last two experiments (#5 and #6) were performed again at positive polarity but on different samples of granular materials: one containing 100% and the other 0% of stranded wire.

B. Characterization of HV Supply Response to Sparks

In these experiments, the output of the HV probe was connected to a digital oscilloscope (500 MHz, 1 GS/s, 1 MΩ input impedance, model DL1740, Yokogawa, Tokyo, Japan), and the electrode system of the electrostatic separator was energized from either one or the other of the two tested HV supplies: #1: model M583, GAMMA, Ormond Beach, Florida, and #2: model SL300, SPELLMAN, Hauppauge, NY. All the tests were done at positive polarity. The processed material was

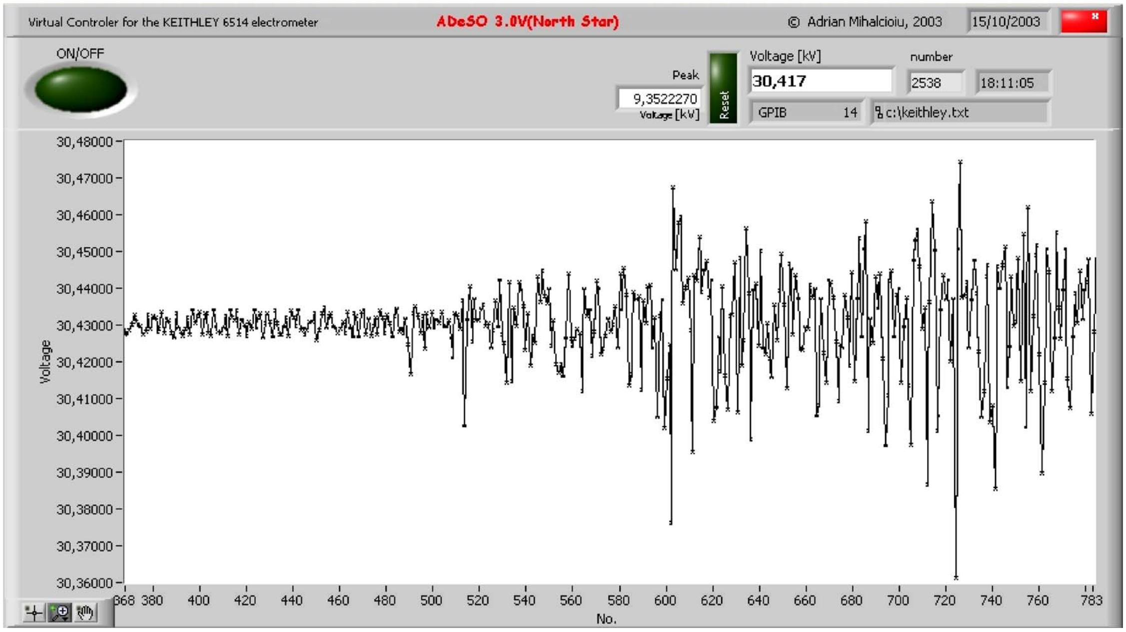


Fig. 4. HV variation before and during granular-material processing, as displayed by the virtual instrument developed in LabVIEW.

a granular mixture of 45% copper stranded wire (diameter: 0.25 mm; length > 1 and < 5 mm), and 55% polyvinyl chloride.

The elongated copper particles initiated spark discharges that caused abrupt variations of the voltage across the interelectrode gap. These variations were displayed on the screen and stored in the memory of the digital oscilloscope. Thus, it was possible to evaluate the time needed by each HV supply to restore the potential of the electrodes to the level it had before the spark discharge.

III. Results and Discussion

A. Spark-Free Operation

Fig. 4 shows the front panel of the virtual instrument displaying the measured values of the HV before and after particle admission in the electric-field zone. The standard deviation $\sigma_{\rm HV}$ increased from less than 1 V to about 5 V.

The results of the experiment #1 are given in Table II. The second-order polynomial model

$$\sigma_{\rm HV} = 6.807 + 2.769c^* + 0.038n^* - 0.540{c^*}^2 + 0.115{n^*}^2 \quad (6)$$

where c^* and n^* are, respectively, the normalized centered values of the metal content c and the roll speed n is characterized by excellent statistics $(R^2 = 0.976, Q^2 = 0.96)$. The model points out a quasi-linear variation of $\sigma_{\rm HV}$ with the metal content c [Fig. 5(a)]. From the curves in Fig. 5(a), it is shown that if $\sigma_{\rm HV} = 6$ V, the metal content c is somewhere between 17.5% and 22% with a probability higher than 95%. The other factor considered in this paper, the roll speed n, has little influence on $\sigma_{\rm HV}$ [Fig. 5(b)], as the respective coefficients are very small when compared with the others.

The experiment #2 (Table III) confirmed the effect of metal content on the standard deviation $\sigma_{\rm HV}$, as shown in Fig. 6(a).

TABLE II
RESULTS OF THE EXPERIMENT #1

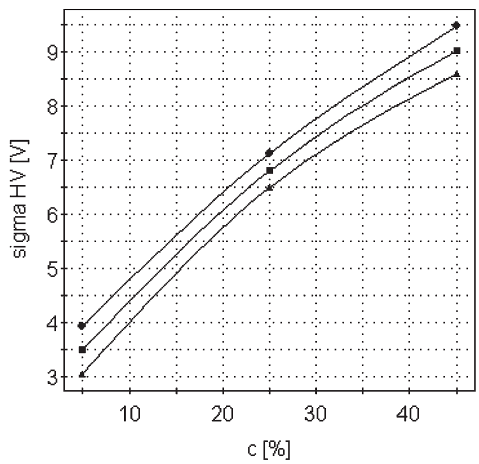
Run No.	Copper content c (%)	Roll speed n (rev/min)	Response $\sigma_{\rm HV}$ (V)
1a 1b	5	60	3.604 3.579
2a 2b	5	100	3.621 3.029
3a 3b	45	60	9.421 8.779
4a 4b	45	100	9.173 9.133
5a 5b	25	60	8.686 9.374
6a 6b	25	100	7.386 7.259
7a 7b	5	80	3.810 3.801
8a 8b	45	80	8.957 9.223
9a 9b	25	80	6.455 6.662
10a 10b	25	80	7.133 7.058
11a 11b	25	80	6.923 5.885

The model fitted with MODDE 5.0 is

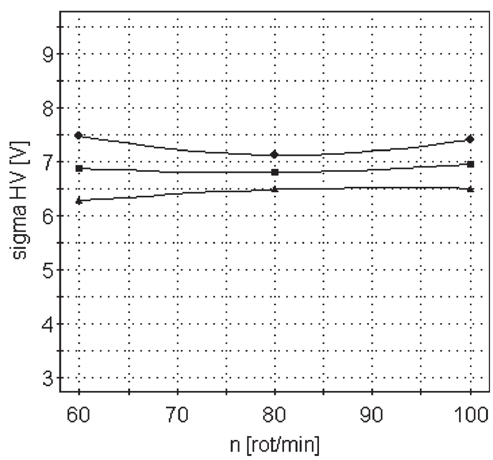
$$\sigma_{\rm HV} = 4601 + 1.849c^* + 1.565U^* + 0.702c^*U^* + 0.738{U^*}^2 \quad (7)$$

where c^* and U^* are, respectively, the normalized centered values of the metal content c and the HV U. The standard deviation $\sigma_{\rm HV}$ increases with the HV [Fig. 6(b)]. For the same composition of the processed material $(c = 25\%)$, it passes from 3.8 (95% confidence interval: 3.3–4.3 V) to 6.9 V (6.4–7.4 V). This implies that it would be easier to predict the correct composition of the material if working at higher voltages.

The high-voltage applied to the electrode system in the experiments #3 and #4 was limited to 20 kV (absolute value). Beyond this limit, the number of spark discharges becomes excessively high (more than one per second).



(a)



(b)

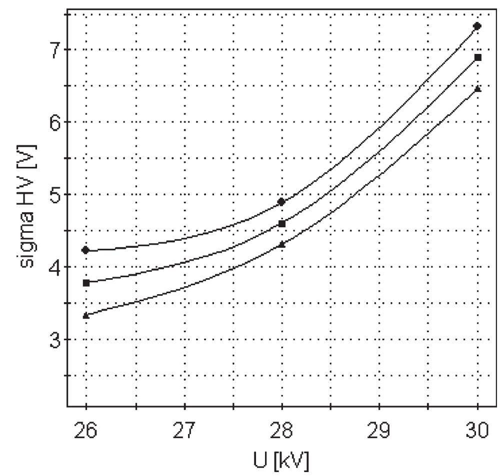
Fig. 5. Plots of the predicted response σ_{HV} and of the respective 95% confidence intervals: (a) as function of metal concentration c (in percent) for $n = 80$ rev/min and $U = 30$ kV and (b) as function of roll speed n (rev/min) for $c = 25\%$ and $U = 30$ kV.

TABLE III
RESULTS OF THE EXPERIMENT #2

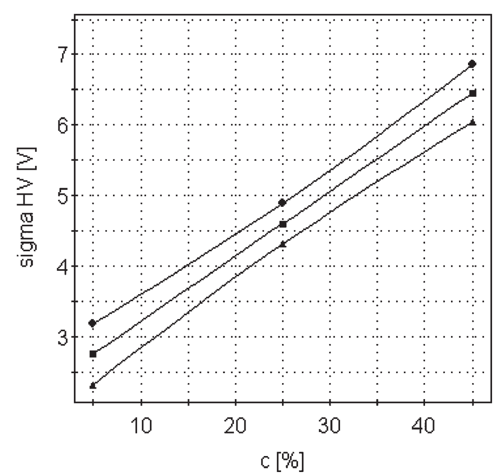
Experiment No.*	Copper content c (%)	High-voltage U (kV)	Response σ_{HV} (V)**
1	5	26	2.678
2	5	30	4.204
3	45	26	5.196
4	45	30	9.866
5	25	26	3.260
6	25	30	6.673
7	5	28	3.957
8	45	28	5.921
9	25	28	4.458
10	25	28	4.936
11	25	28	4.635

* Each experiment consisted of 5 runs
** Average value of the results of 5 runs

Therefore, a straightforward comparison between the results obtained at positive and negative polarities was not possible (the value of σ_{HV} determined in several experiments at $U = +20$ kV with the $c = 25\%$ product did not differ



(a)



(b)

Fig. 6. Plots of the predicted response σ_{HV} and of the respective 95% confidence intervals: (a) as function of metal concentration c (in percent) for $n = 80$ rev/min and $U = 28$ kV and (b) as function of applied voltage U (in kilovolts) for $c = 25\%$ and $n = 80$ rev/min.

TABLE IV
RESULTS OF THE EXPERIMENTS #3 AND #4

High-voltage U (kV)	Response σ_{HV}(V)	
	Experiment #3	Experiment #4
-16	0.248	0.278
-18	0.392	0.318
-20	1.131	1.271

TABLE V
RESULTS OF THE EXPERIMENTS #5 AND #6

High-voltage U (kV)	Response σ_{HV}(V)	
	Experiment #5	Experiment #6
26	2.334	0.450
28	3.247	0.457
30	6.340	1.510

significantly from those obtained at the same applied voltage in the absence of material). No significant difference exists between the results of the experiments #3 and #4 (Table IV), indicating that the presence of the electrostatic electrode in parallel to the corona electrode has little effect, if any, on the value of σ_{HV}.

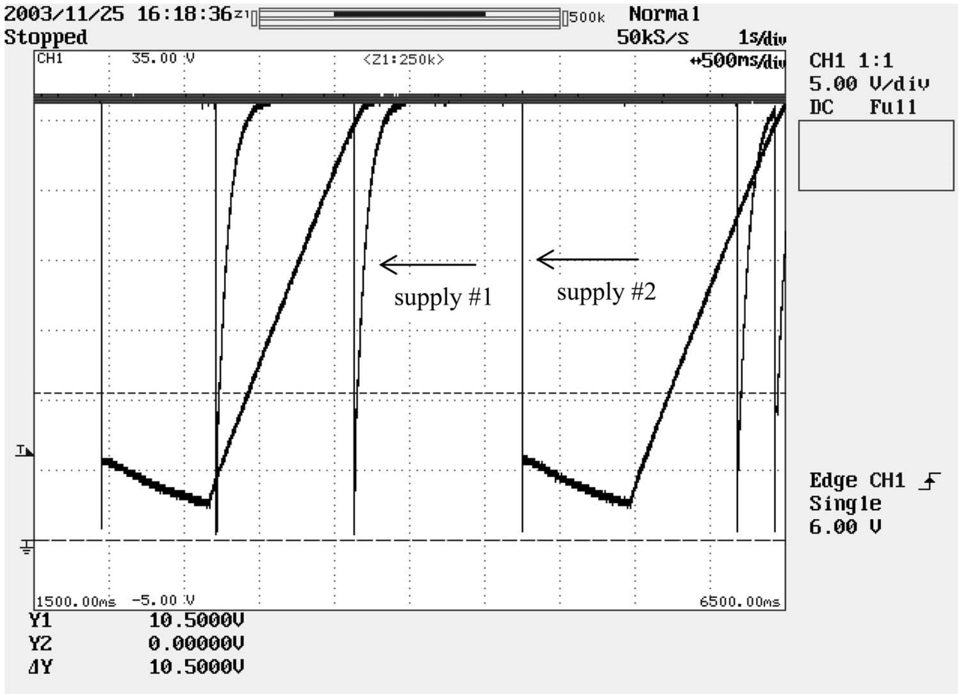


Fig. 7. Voltage restoring curves for the two HV supplies obtained with the digital oscilloscope (5 kV/div, 500 ms/div). The graph resulted from the superposition of the curves recorded for two series of spark discharges, one for each of the HV supplies.

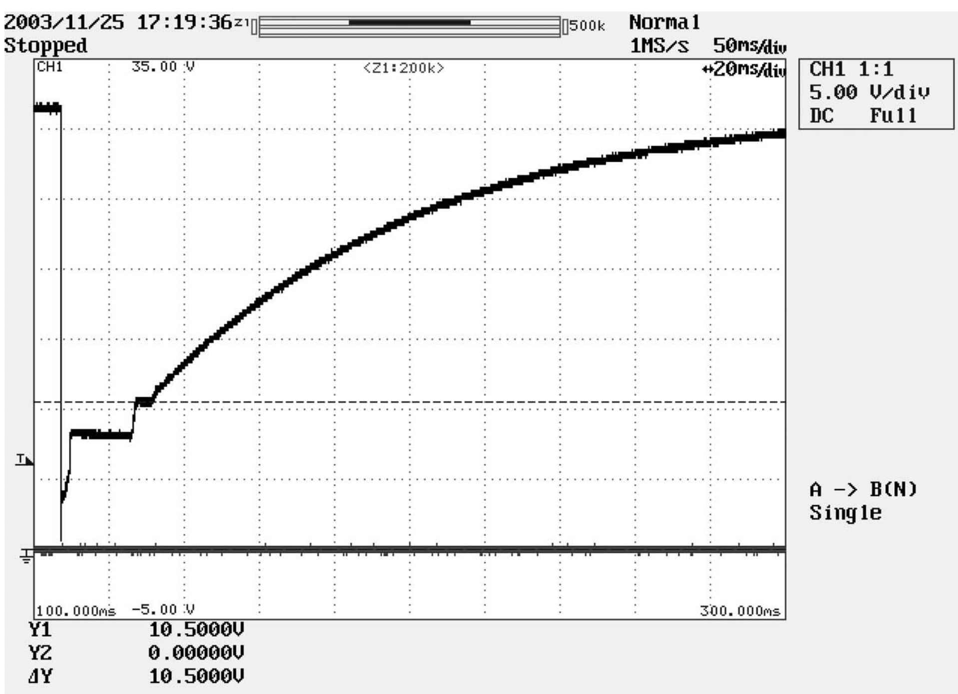


Fig. 8. Voltage restoring curve for the HV supply #1, as displayed by the oscilloscope, at 5 kV/div and 20 ms/div.

The fact that σ_{HV} is quasi-proportional with the concentration of metallic particles suggests that the variation of the measured voltage is related to the back corona that can occur from such particles in an electric field characterized by relatively high local magnitude. The experiments #5 and #6 (Table V), carried out with different materials, containing, respectively, 100% and 0% of stranded copper, confirmed this hypothesis.

B. HV Supply Response to Spark Discharges

As discussed further on, various sampling rates were tested accordingly to Nyquist sampling theorem. The curves in Fig. 7 were obtained using the HV probe (1000 V/ 1 V), the same sampling rate (50 000 samples/s), time scale (500 ms/div), and voltage scale (5 kV/div), for the two supplies. This representation clearly shows that the HV supply #1 needs a significantly shorter time (0.25 s) than the HV supply #2 (1.35 s) to restore their output voltage at the level they had before the spark discharge.

In the case of HV supply #2, the various phases of HV restoring can be easily seen on the curves in Fig. 7. A 20-time higher sample rate (1 000 000 samples/s) and a 10-time shorter time scale (50 ms/div) were necessary for obtaining an exploitable curve (Fig. 8) to characterize the HV supply #1. The presence of different phases on the voltage-restoring curve can be explained by the peculiarities of the internal electronic schemes of the two HV supplies. Thus, the linear response of supply #2 is most probably due to the internal current-limiting protection circuit.

IV. Conclusion

HV monitoring can provide useful information for electrostatic-separation process control. By comparing the measured value of the high-voltage to the preselected optimum level, deviations from the preselected level can be readily detected and used to control the system. In case that spark discharges are too frequent, the applied voltage should be reduced, in order to avoid these events that affect the outcome of the separation process.

In spite of the fact that the electronic HV supplies employed with modern separators are provided with protections against flashover, not all of them are adequate for applications characterized by frequent sparks between the electrodes in the presence of the processed material. The restoration of the high-voltage at the level it had before flashover may require a relatively long time (up to 1 s); imposed by the electronic scheme of the supply. The shorter, this time, the more appropriate the high-voltage supply is for energizing the electrodes of an insulator/metal separator, where spark discharges between the electrodes cannot be completely avoided.

The most interesting result of this paper is the correlation that was evidenced between the standard deviation of the measured high-voltage (σ_{HV}) and the composition of the material passing through the active zone of the separator. A change in the measured σ_{HV} could point out an alteration in the composition of the processed material and indicate that appropriate corrections should be made for optimal operation of the overall system.

Acknowledgment

The authors would like to thank A. Iuga, A. Samuila, and I. Suarasan for pertinent comments on the factors that should be taken into account when choosing an HV supply for electrostatic-separation application. M. Huzau provided experimental assistance to part of the experiments.

References

[1] O. C. Ralston, *Electrostatic Separation of Mixed Granular Solids*. Amsterdam, The Netherlands: Elsevier, 1961.
[2] I. I. Inculet, *Electrostatic Mineral Separation*. New York: Wiley, 1986.
[3] K. Haga, "Applications of the electrostatic separation technique," in *Handbook of Electrostatic Processes*, J. S. Chang, A. J. Kelly, and J. M. Crowley, Eds. New York: Marcel Dekker, 1995, pp. 365–386.
[4] Y. Higashiyama and K. Asano, "Recent progress in electrostatic separation technology," *Part. Sci. Technol.*, vol. 16, no. 1, pp. 77–90, 1998.
[5] A. Iuga, V. Neamtu, I. Suarasan, R. Morar, and L. Dascalescu, "Optimal high-voltage energization of corona-electrostatic separators," *IEEE Trans. Ind. Appl.*, vol. 34, no. 2, pp. 286–293, Mar./Apr. 1998.
[6] L. Dascalescu, A. Mizuno, R. Tobazéon, A. Iuga, R. Morar, M. Mihailescu, and A. Samuila, "Charges and forces on conductive particles in roll-type corona-electrostatic separators," *IEEE Trans. Ind. Appl.*, vol. 31, no. 5, pp. 947–956, Sep./Oct. 1995.
[7] L. Dascalescu, R. Morar, A. Iuga, A. Samuila, and V. Neamtu, "Electrostatic separation of insulating and conductive particles from granular mixes," *Part. Sci. Technol.*, vol. 16, no. 1, pp. 25–42, 1998.
[8] A. Iuga, R. Morar, A. Samuila, and L. Dascalescu, "Electrostatic separation of metals and plastics from granular industrial wastes," *Proc. Inst. Electr. Eng.—Sci. Meas. Technol.*, vol. 148, no. 2, pp. 47–54, Mar. 2001.
[9] J. E. Lawver and W. P. Dyrenforth, "Electrostatic separation," in *Electrostatics and its Applications*, A. D. Moore, Ed. New York: Wiley, 1973, pp. 221–249.
[10] L. Dascalescu, R. Morar, A. Iuga, A. Samuila, V. Neamtu, and I. Suarasan, "Charging of particulates in the corona field of roll-type electroseparators," *J. Phys. D, Appl. Phys.*, vol. 27, no. 6, pp. 1242–1251, 1994.
[11] J. Bohm, *Electrostatic Precipitators*. Amsterdam, The Netherlands: Elsevier, 1982.
[12] N. Grass, W. Hartmann, and M. Klöckner, "Application of different types of high-voltage supplies on industrial electrostatic precipitators," in *Proc. IEEE IAS Annu. Meeting*, Pittsburgh, PA, 2002, pp. 270–276.
[13] "The solution to separation," CARPCO, Jacksonville, FL, Bull. 904, 1990.
[14] *LabView. Measurements Manual*, Nat. Instruments, Austin, TX, 2000.
[15] N. L. Frigon and D. Mathews, *Practical Guide to Experimental Design*. New York: Wiley, 1996.
[16] C. R. Hicks and K. V. Turner, Jr., *Fundamental Concepts in the Design of Experiments*. Oxford, U.K.: Oxford Univ. Press, 1999.
[17] L. Eriksson, E. Johansson, N. Kettaneh-Wold, C. Wikstöm, and S. Wold, *Design of Experiments. Principles and Applications*. Umeaa, Sweden: Umetrics, 2000.

Adrian Mihalcioiu received the M.S. degree in electrical engineering from the Technical University of Cluj-Napoca, Romania, in 2002. His graduate research work was carried out at the Electronics and Electrostatics Research Unit, University Institute of Technology, Angoulême, France, within the framework of the ERASMUS student mobility program, financed by the European Community. Then, he enrolled in a Ph.D. program jointly sponsored by the University of Poitiers, France, and the Technical University of Cluj-Napoca, Romania. His dissertation research involved the developing of measurement techniques and virtual instrumentation for the study and control of electrostatic processes. He received the Ph.D. degree (*magna cum laude*) in December 2005.

He is currently with Osaka Prefecture University, Osaka, Japan, as a Postdoctoral Fellow.

Vasile Neamtu received the M.S. degree in electrical engineering and the Dr.Eng. degree in electrical technologies from the Technical University of Cluj-Napoca, Cluj-Napoca, Romania, in 1975 and 2000, respectively.

After six years spent in industry, as a Research and Development Engineer, he moved to the Technical University of Cluj-Napoca, as Teaching Assistant, Lecturer, and since 2001, Associate Professor in the Electrical Engineering Department. He has coauthored more than 20 papers, most of them related to the design of the electrodes and the high-voltage supplies of electrostatic separators of granular mixtures, with applications in the field of mineral processing and the recycling industry.

Anca Stochita received the B.S. and M.S degrees in electrical engineering from the Politehnica University, Bucharest, Romania, in 2004 and 2006, respectively.

In 2004, she spent four months as an ERASMUS student with the Electronics and Electrostatics Research Unit, University Institute of Technology, Angoulême, France, where she contributed to the development of various measurement techniques applied to the study of electrostatic-separation processes. She is currently with the Romanian Business Consult, Bucharest.

Lucian Dascalescu (M'93–SM'95) graduated (with first class honors) from the Faculty of Electrical Engineering, Technical University of Cluj-Napoca, Cluj-Napoca, Romania, in 1978, and received the Dr.Eng. degree in electrotechnical materials from the Polytechnic Institute of Bucharest, Bucharest, Romania. He received the Dr.Sci. degree and the "Habilitation à Diriger de Recherches" diploma in physics from the University "Joseph Fourier," Grenoble, France.

His professional carrier began at CUG (Heavy Equipment Works), Cluj-Napoca. In 1983, he moved to the Technical University of Cluj-Napoca, as an Assistant Professor, later becoming an Associate Professor of electrical engineering. From October 1991 to June 1992, he received a Research Fellowship at the Laboratory of Electrostatics and Dielectric Materials, Grenoble, where he returned in January 1994 after one year as an Invited Research Associate and Lecturer at Toyohashi University of Technology, Japan, and three months as a Visiting Scientist at the University of Poitiers, France. For four years, he taught a course in electromechanical conversion of energy at the University Institute of Technology, Grenoble. In September 1997, he was appointed Professor of electrical engineering and automated systems and Head of the Electronics and Electrostatics Research Unit at the University Institute of Technology, Angoulême, France. Since 1999, he has also been Head of the Department of Management and Engineering of Manufacturing Systems. He is the author of several textbooks in the field of electrical engineering and ionized gases. He is the holder of 14 patents, has written more than 70 papers, and was invited to lecture on the electrostatics of granular materials at various universities and international conferences in China (1988), Poland (1990), the U.S. (1990, 1997, and 1999), Japan (1993), France (1993), the U.K. (1998), Romania (1999, 2004, and 2006), Canada (2001), Belgium (2002), and Algeria (2005 and 2006).

Prof. Dascalescu is a Senior Member of the IEEE Industry Applications Society and Chair of its Electrostatics Processes Committee. He is a member of the Electrostatics Society of America, Electrostatics Society of Romania, Société des Electriciens et Electroniciens, and Club Electrotechnique, Electronique, Automatique, France.