Study on the Electrostatic Concentration of Low Ash Coal in Corona Discharge Field

By

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In order to recover the coal concentrates of low ash and iron content, the electrostatic separation of coal in the corona discharge field was investigated by a Huff type separator.

From the experiments of the coal separation in the corona discharge field, it is recognized that the coal particles which are extremely low in ash and iron content are attracted to the grounded roller, while the particles of high ash content are repelled from the roller. It is more successful in the corona discharge field to recover the coal concentrates of low ash and low iron content than in the field without corona discharge.

Furthermore, from the measurement of conductivity of coal and the electric charge of coal particles acquired in an electric field, the relation among conductivity, ash content, and iron content of coal was clarified, and then the mechanism of coal separation in the corona discharge field was considered.

1. Introduction

In recent years the demand for high quality coal containing low ash and low iron as raw material for graphite, electrode material, anticorrosive material, coke and other material in the carbon industry, has increased. To fulfil this requirement, a higher grade coal concentrate than that obtained by the old coal washing technique must be produced.

Concerning the coal for steam power generation, its iron content makes toward reducing the melting point of ash and hinders the combustion of coal by the formation of clinkers. Accordingly, the production of low iron coal is necessary to extend the utilization of coal.

Study on the electrostatic separation of coal has been performed for several years in the author's laboratory. From the results of this research, it was considered that the behavior of coal particles in the electrostatic field relate closely to the ash and iron content in coal. Consequently, electrostatic separa-

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tion may be suitable to produce high quality coal.

Now, electrostatic separation can be classified into two types according to the state of the electric discharge of the electrodes. One is the separation in the corona discharge field and the other is in the field without corona discharge. Good results for coal concentration can be obtained even in the field without corona discharge, as previously reported.[1]

In this study, however, the electrostatic characteristics of coal particles and the mechanism of their separation in the corona discharge field were investigated in order to recover the high quality coal concentrate.

2. Principles of Electrostatic Separation in the Corona Discharge Field

On increasing the voltage between the two electrodes, the pointed wire and the plate confront each other, the pointed part of the wire becomes luminiferous and then a local destruction at the pointed part occurs. A slight current passes through between the two electrodes and a spark discharge appears. The state of this local destruction at the pointed part is called the corona discharge.

In the electrostatic field with the corona discharge, the gases are ionized by the collision of electrons. Consequently, a number of electrons and positive ions are generated. These electrons move to the positive electrode and the positive ions to the negative electrode. The positive ions, however, remain in the space of the electrostatic field after the electrons have reached the positive electrode, because the positive ion is heavier than the electron and its mobility is comparatively weak. Accordingly, the ionization of gases is interrupted for a time by the shielding effect of the space charge formed by the residual positive ions. The ionization of gases takes place again after the positive ions have reached the negative electrode and the space charge by the positive ions has vanished. Accordingly, the positive electrode is exposed to the collision of electrons and the negative electrode exposed to the collision of the positive ions intermittently.

If the particles are placed on the grounded plate confronting the pointed wires which are the negative electrode, the particles are polarized by the electrostatic field and at the same time they are exposed to the collision of electrons.

The electric force acting on the particles is expressed as follows:

$$F = QE + 2\pi\rho^3 \frac{\varepsilon - 1}{\varepsilon + 2} \varepsilon_0 \,\mathrm{grad}\, E^2 \qquad (1)$$

where F is the electric force; E, the intensity of the electrostatic field; Q, the electric charge of the particle; ρ, the radius of the particle; ε, the dielectric constant of the particle; and ε_0, the dielectric constant of the vacuum.

The electric charge of the particles placed on the grounded plate, Q, is represented by the total sum of the charge acquired from the grounded plate and the charge obtained by the collision of electrons due to the corona discharge. The second term in equation (1) is the electric force due to polarization of the particle.

If the particle is an insulator, the charge of the particle acquired from the grounded electrode is imperceptible and then Q is the only charge due to the discharge of the electrons. Accordingly, QE acts on the particles as the attractive force to the grounded electrode. The electric force represented as the second term in the equation (1) acts as the attractive force as well as QE. Consequently, the particle is attracted strongly by the grounded electrode.

On the other hand, if the particle is a conductor, the charge of the particle acquired by the collision of the electrons is neutralized immediately by the opposite charge of the grounded electrode. And accordingly Q in the equation (1) is composed only of the charge acquired from the grounded electrode. In this case, QE acts as the repelling force to the particles.

Generally, the electric properties of mineral particles have a wide range of change. According to their electric properties, some mineral particles are attracted to the grounded electrode, while some mineral particles repell and the other particles neither attract nor repell.

3. Preparation of Coal Samples and their X-ray Diffraction Analysis

The coals from the Akabira mine, the Kushiro mine, the Miike mine, and the Oshima mine which are famous coal mines in Japan were used in this study. The ash contents of these coals are shown in Table 1.

Table I. Ash contents of raw coal.

Coal mine	Ash content (%)
Akabira	6.5
Kushiro	10.0
Miike	7.0
Oshima	6.5

(1) X-ray diffraction analysis of the coal samples

The results of the analysis of the coal samples by the Norelco X-ray diffractometer are shown in Fig. 1, Fig. 2, Fig. 3, and Fig. 4. As can be seen

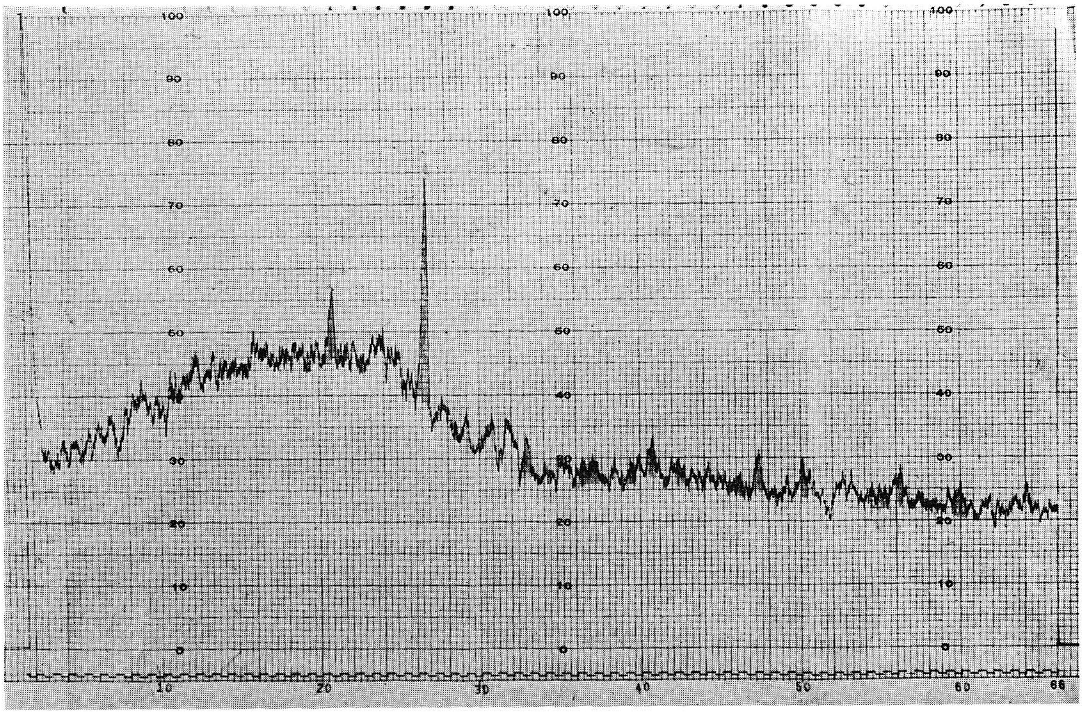


Fig. 1. Diffractogram of the Akabira coal.

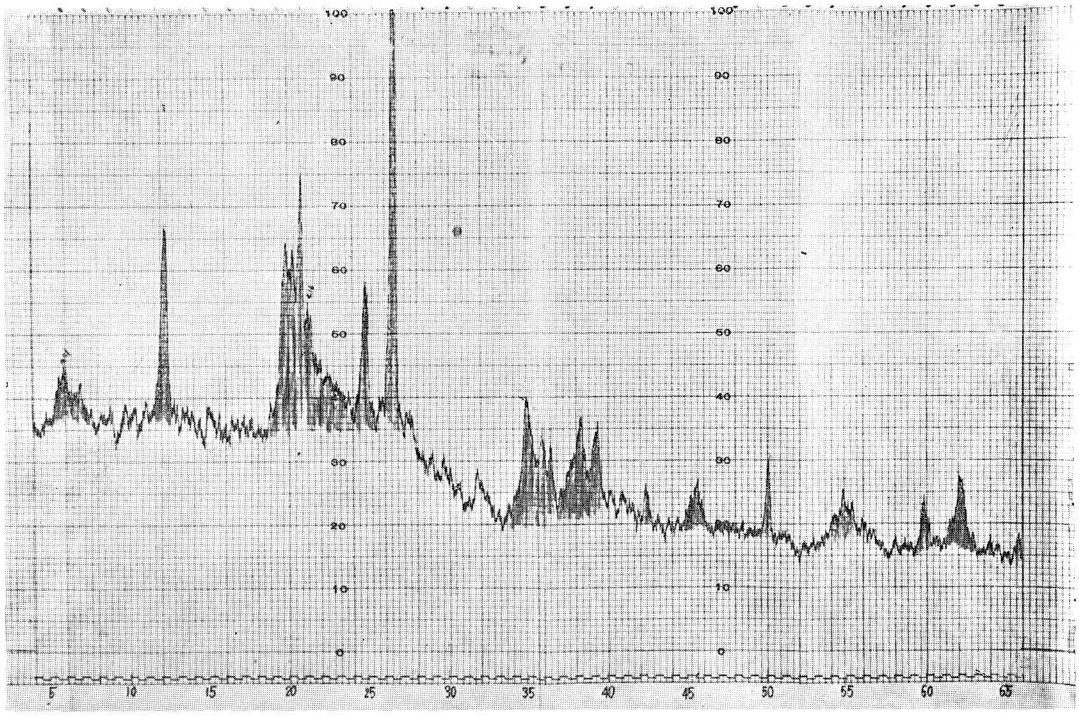


Fig. 2. Diffractogram of the Kushiro coal.

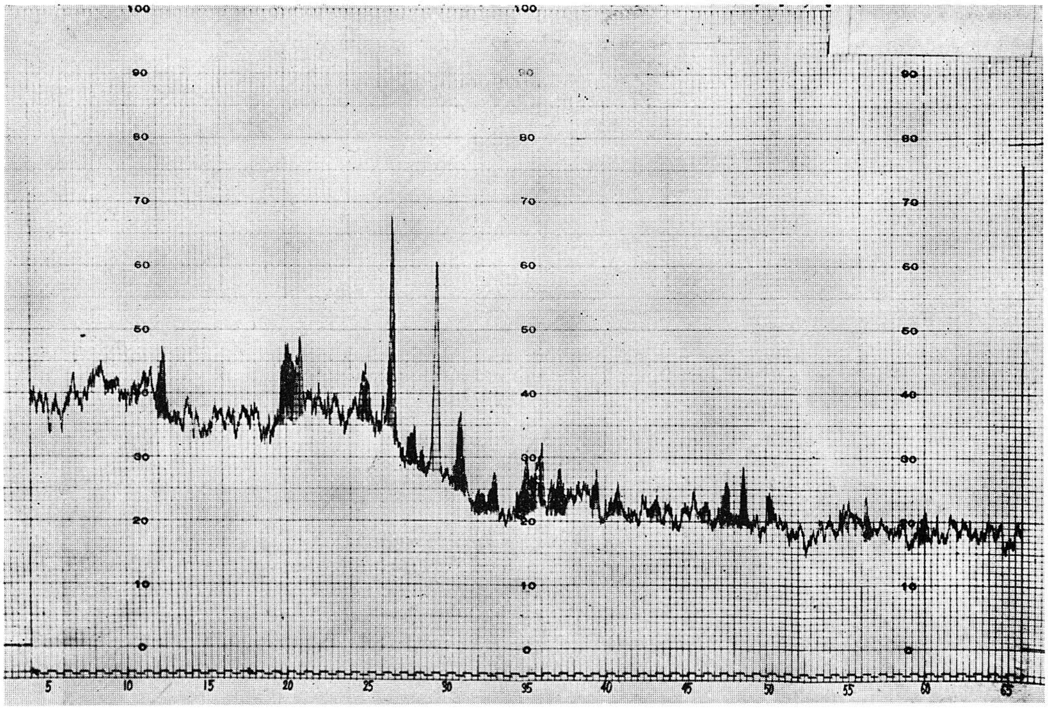


Fig. 3. Diffractogram of the Miike coal.

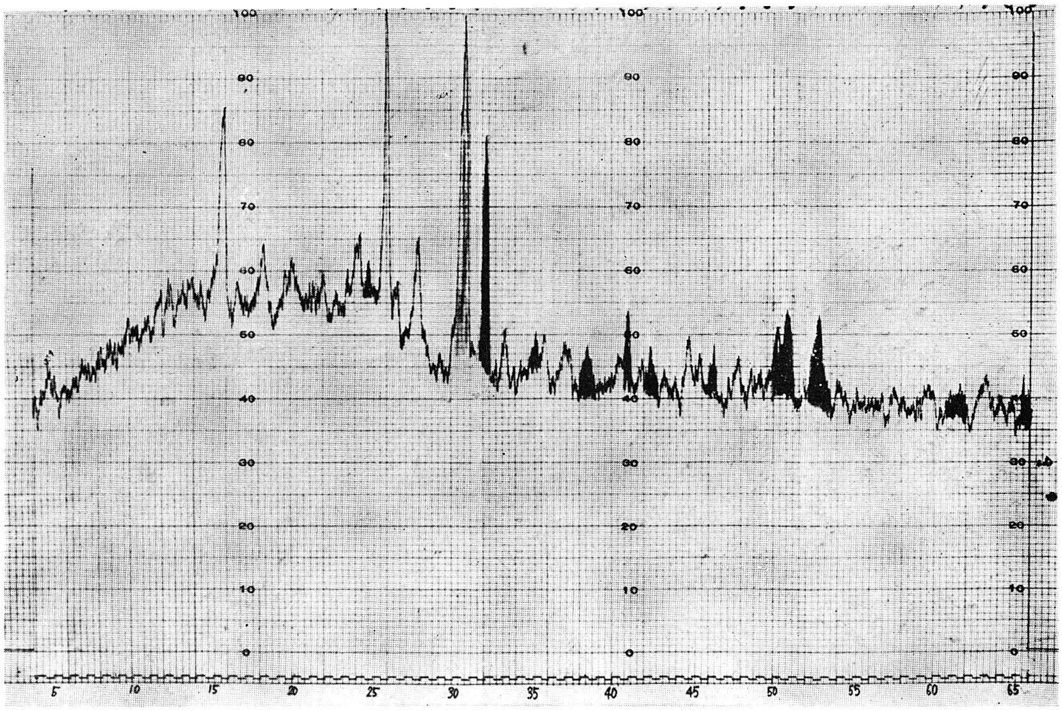


Fig. 4. Diffractogram of the Oshima coal.

from these figures, the kinds of inorganic substances vary with the samples of coal. That is, the Miike coal includes mainly pyrite, quartz, kaoline, calcite and epidote; the Kushiro coal kaoline, quartz, and montmorillonite, and the Oshima coal siderite, dolomite, and other substances.

From the results of the analysis by the X-ray diffraction method, it is recognized that the inorganic substances in coal are mainly quartz and clay minerals, and that the iron compounds such as siderite, pyrite and epidote are contained in coal.

(2) The preparation of testing samples

For the preparation of samples, the coarse pieces of coal were crushed to about 2 mm in diameter and then ground in an agator mortar. The ground products were sieved and fractions of 10~14 mesh, 14~20 mesh, 20~28 mesh, and 28~35 mesh were prepared respectively.

4. Apparatus of Electrostatic Separation

The apparatus of the electrostatic separation used in the experiments was the Huff type separator.

In order to generate the corona discharge field, a needle-shaped electrode combined with a pole electrode is installed as the high tension electrode. The principal part of the apparatus is shown in Fig. 5.

In the case of examining the effects of the particle size on the electrostatic separation of coal, the needle-shaped electrode was combined with a plate electrode instead of the pole electrode as shown in Fig. 6. The pole or the

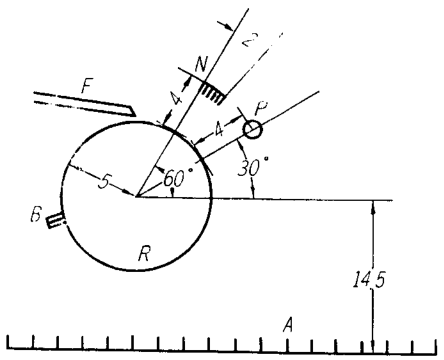


Fig. 5. Separator with corona discharge.
A : Products acceptor B : Brush
F : Feeder N : Needle electrode
P : Pole R : Grounded roller
(Given numerals in cm)

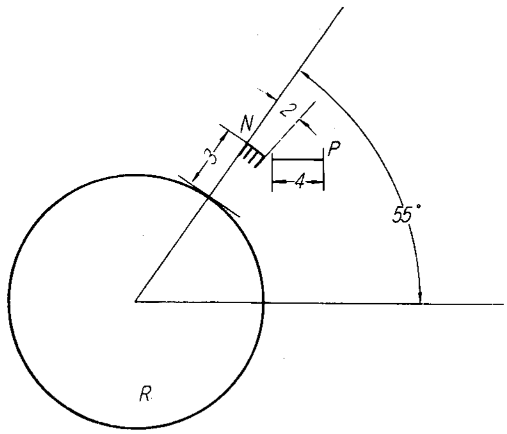


Fig. 6. Setup of electrode for testing the effect of particle size on separation.
N : Needle electrode P : Plate electrode
R : Grounded roller
(Given numerals in cm)

plate electrode was installed to promote the repelling of the charged particles by producing the electrostatic field between this electrode and the grounded roller. It seems to be very useful on the coal separation to install these combined high tension electrodes.

5. Separation of Coal Particles in Corona Discharge Field

(1) Relation between ash content of the coal and its repelling distance

The separation testings on the coal samples in the corona discharge field were performed by the apparatus as shown in Fig. 5. These experiments were carried out under the following conditions, feed size 20~28 mesh, room temperature and normal humidity, and the combined electrodes including the needle-shaped electrode were negatively charged. The results of these testings are shown in Fig. 7, Fig. 8, Fig. 9, and Fig. 10. In these figures, the weight % and the ash contents of the products distributed by the separation are represented as a function of the repelling distance, and the base point of the distributed position is taken directly below the grounded roller surface and the direction repelled from the roller is taken positively.

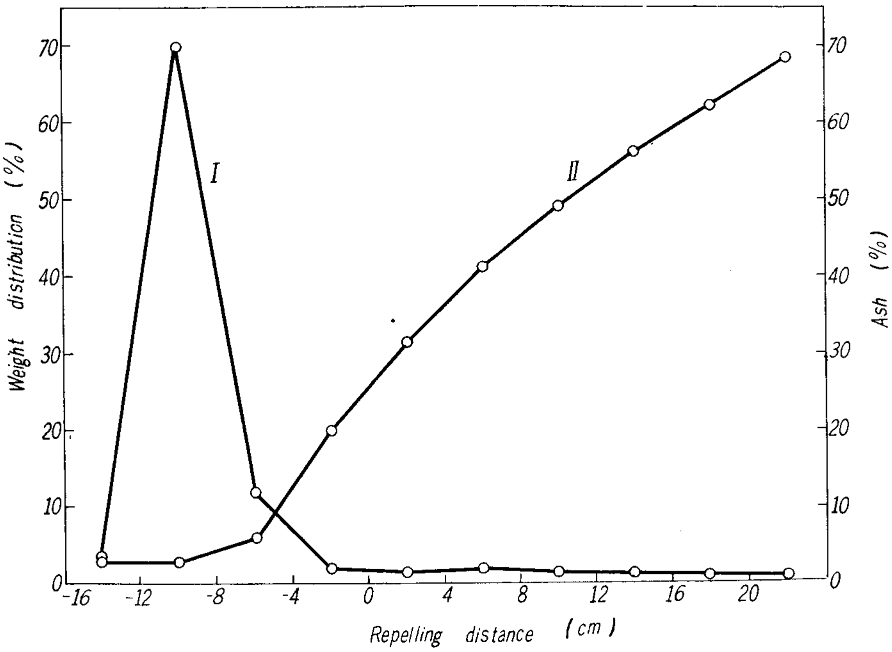


Fig. 7. A results of separation for Akabira coal.
Particle size : 20~28 mesh, Applied voltage--20 KV
(I) The curve of weight distribution (II) The curve of ash content
(At room temperature and humidity)

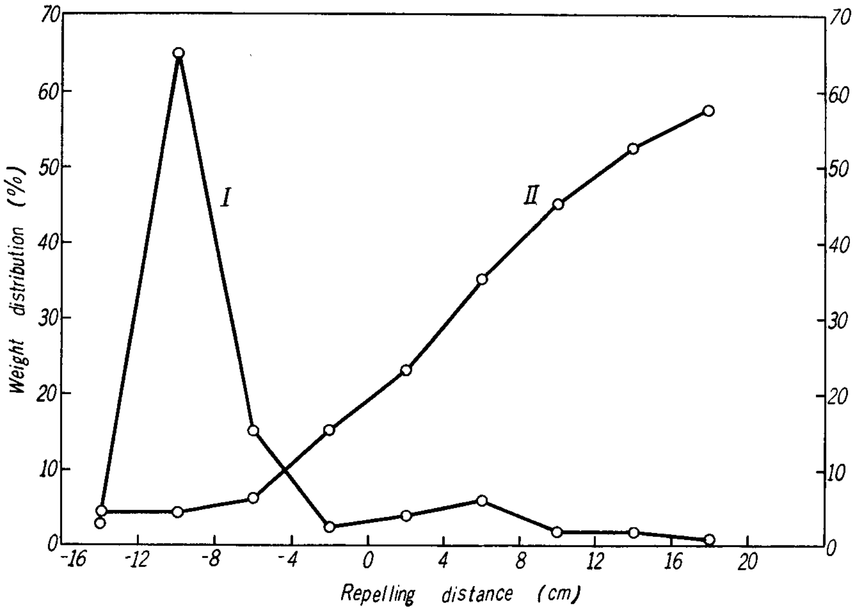


Fig. 8. A results of separation for Kushiro coal.
Particle size : 20~28 mesh, Applied voltage—18 KV
(I) The curve of weight distribution (II) The curve of ash content
(At room temperature and humidity)

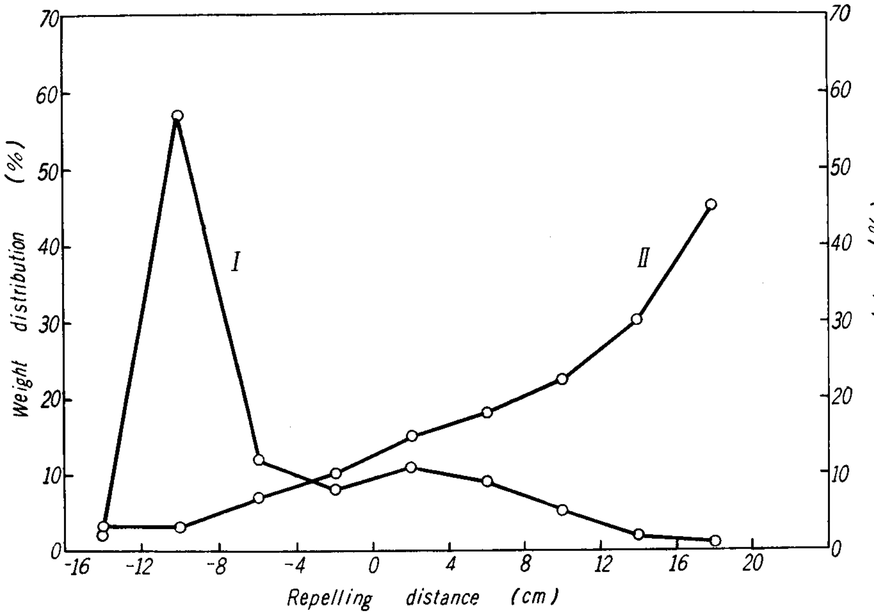


Fig. 9. A result of separation for Miike coal.
Particle : 20~28 mesh, Applied voltage—15 KV
(I) The curve of weight distribution (II) The curve of ash content
(At room temperature and humidity)

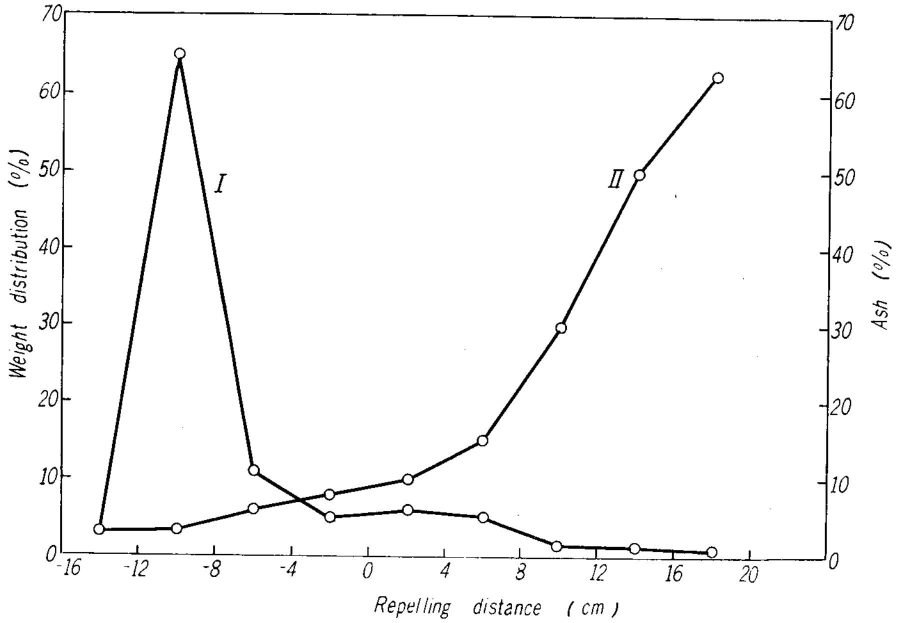


Fig. 10. A result of separation for Oshima coal.
Particle size : 20～28 mesh, Applied voltage—20 KV
(I) The curve of weight distribution (II) The curve of ash content
(At room temperature and humidity)

As can be seen from Fig. 7～Fig. 10, some of the coal particles are attracted to the grounded roller, some of them are repelled from the roller, and the other particles fall freely from the roller. The coal particles attracted to the roller are extremely low in their ash contents. Comparing the ash content of the feed with that of the coal concentrate attracted to the roller, it is found that the ash content of coal reduces from 6.5% to 2.5% for the Akabira coal, from 10% to 4% for the Kushiro coal, from 7% to 3% for the Miike coal, and from 6.5% to 2.8% for the Oshima coal, respectively. The ash content of the products increases with the increase of their repelling distances.

From the above results it may be said that there are close relationships between the ash content of coal products and their repelled distances, and consequently the coal concentrate of low ash content can be recovered by the electrostatic separation in the corona discharge field.

(2) Efficiency of separation

The recovery of the coal concentrate was considered on the basis of the separation in the corona discharge field.

The float-and-sink analysis is used in this investigation since generally the specific gravity of the coal is directly proportional to the ash content. The samples of coal in these experiments are from the Oshima coal mine. The various gravity fractions are weighed and analyzed for ash. And then the washability curves are determined for the feed coal and the concentrate coal attracted to the grounded roller.

The washability curves for the feed coal and the concentrate coal are shown in Fig. 11 and Fig. 12 respectively. From the results of the float-and-sink analysis, the relation between the ash content and weight % was determined for each coal.

As a consequence, it is recognized that coal which has less than 3% ash

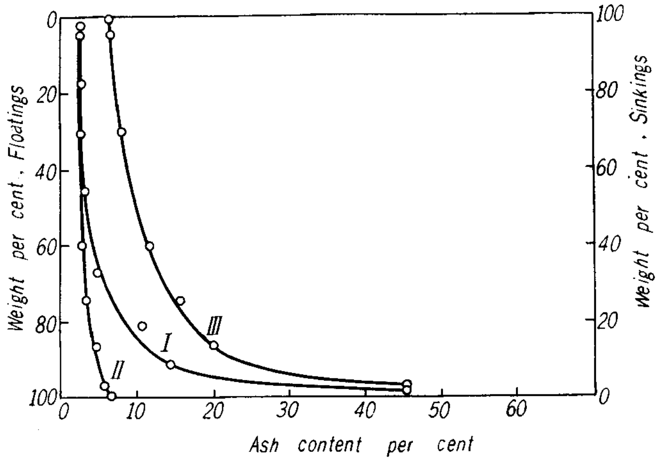


Fig. 11. Washability curve for the feed of Oshima coal.
(I) Observed curve (II) Floatings curve (III) Sinkings curve

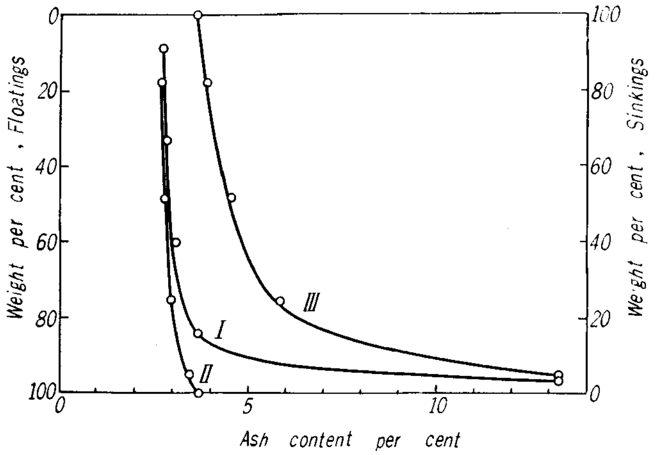


Fig. 12. Washability curve for the concentrate of Oshima coal.
(I) Observed curve (II) Floatings curve (III) Sinkings curve

content has a 96% recovery in the concentrate on the separation in the corona discharge field.

Furthermore, similar investigation was performed on the coal from the Akabira coal mine. The washability curves for the feed coal and the concentrate coal are shown in Fig. 13 and Fig. 14 respectively. From the results of these experiments, it is recognized that the recovery of the coal which has less than 2.5% ash content amounts to 98%.

The separation of coal in the corona discharge field is an excellent way to produce low ash coal with a high recovery %.

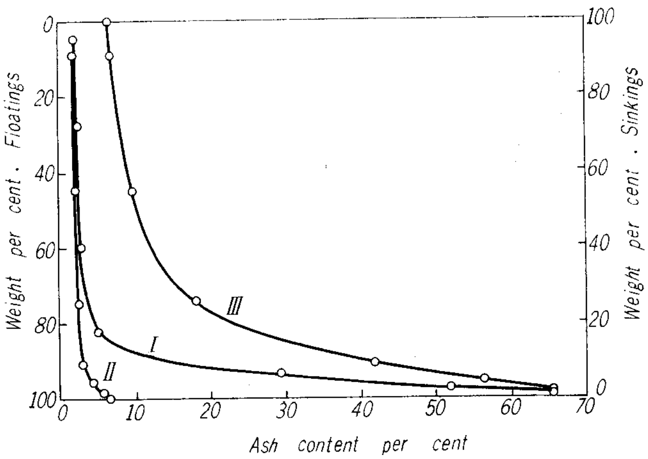


Fig. 13. Washability curve for the feed of Akabira coal.
(I) Observed curve (II) Floatings curve (III) Sinkings curve

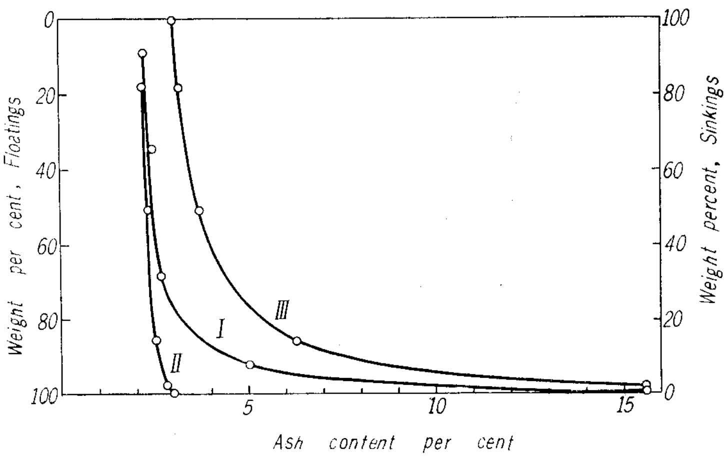


Fig. 14. Washability curve for the concentrate of Akabira coal.
(I) Observed curve (II) Floatings curve (III) Sinkings curve

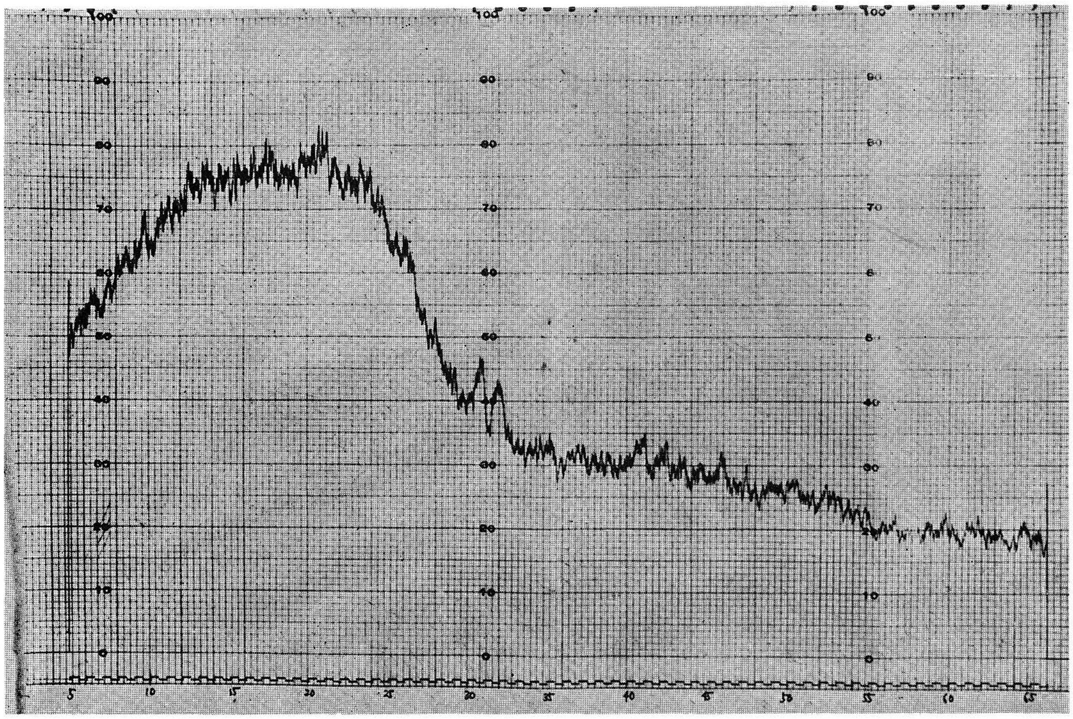


Fig. 15. Diffractogram of the Akabira low ash coal.

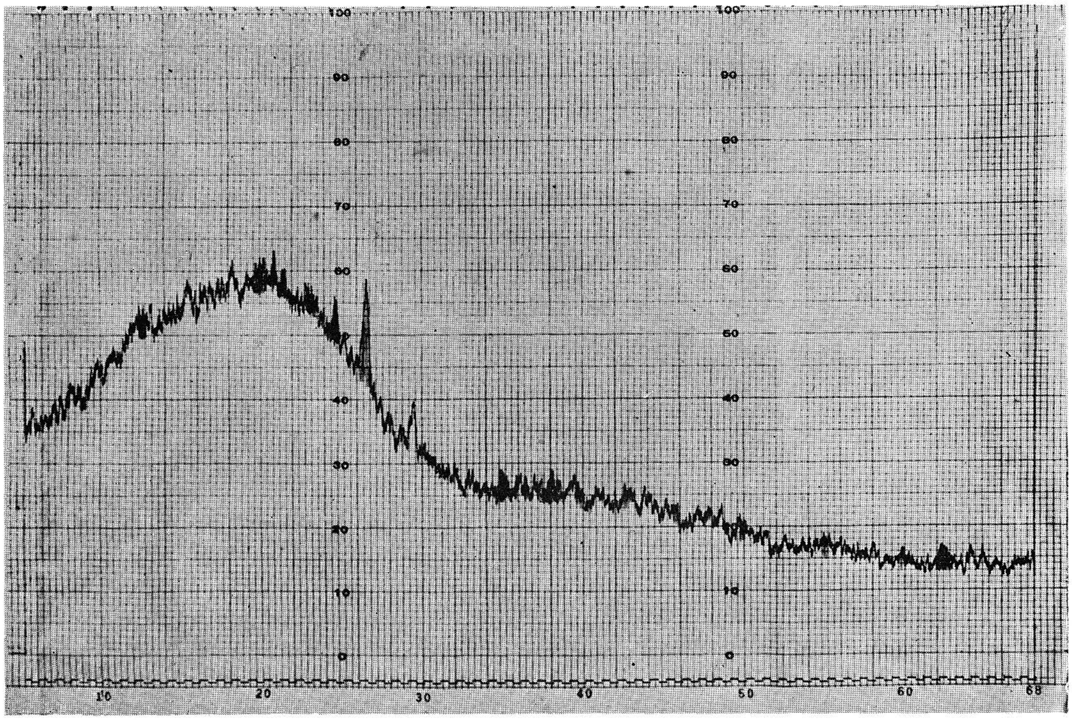


Fig. 16. Diffractogram of the Kushiro low ash coal.

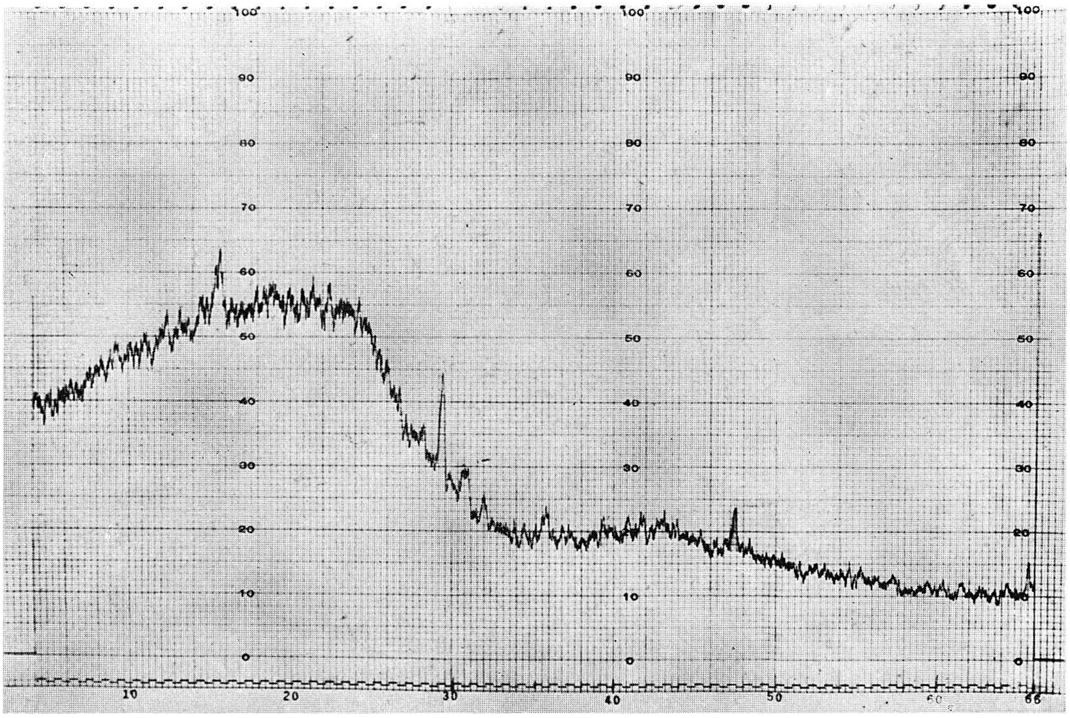


Fig. 17. Diffractogram of the Miike low ash coal.

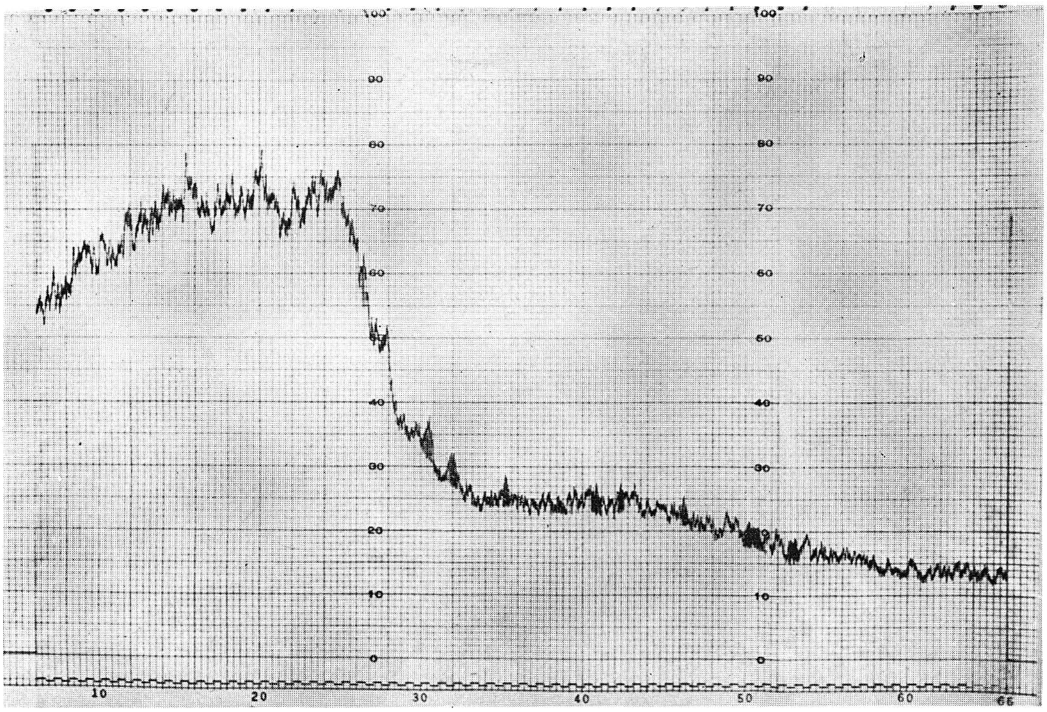


Fig. 18. Diffractogram of the Oshima low ash coal.

(3) X-ray diffraction analysis of the low ash coal

The X-ray diffraction analysis of the low ash coal attracted to the grounded roller was performed. Diffractograms of each concentrate by the Norelco X-ray diffractometer are shown in Fig. 15, Fig. 16, Fig. 17 and Fig. 18. As can be seen in Fig. 15~Fig. 18, the characteristic pattern due to organic substances becomes remarkable in the range of the Bragg angle 30°~10°.

By comparing the results of the low ash concentrate coal shown in Fig. 15~Fig. 18 with those of the raw coal shown in Figs. 1~4, it is recognized that the quantity of inorganic substances contained in the low ash concentrate coal considerably decreases.

Furthermore, the iron compounds such as siderite, pyrite and epidote contained in the concentrate coal are imperceptible although these iron com pounds are notably contained in the raw coal.

(4) Relation between iron content of coal and its repelled distance

In the spectrogram of the fluorescent X-ray analysis, the two peaks of iron appear, one at the Bragg angle 57.45° and the other at 51.74°.

The analysis by the fluorescent X-ray spectrograph was performed for the coal products separated in the corona discharge field.

The coal products collected in the various repelling distances, 8~12 cm, 0~4 cm, and −8~−12 cm respectively were analysed. The results of the analysis are shown in Fig. 19, Fig. 20, Fig. 21, and Fig. 22. In these figures, (A) is the spectrogram for the products collected in the repelling distance

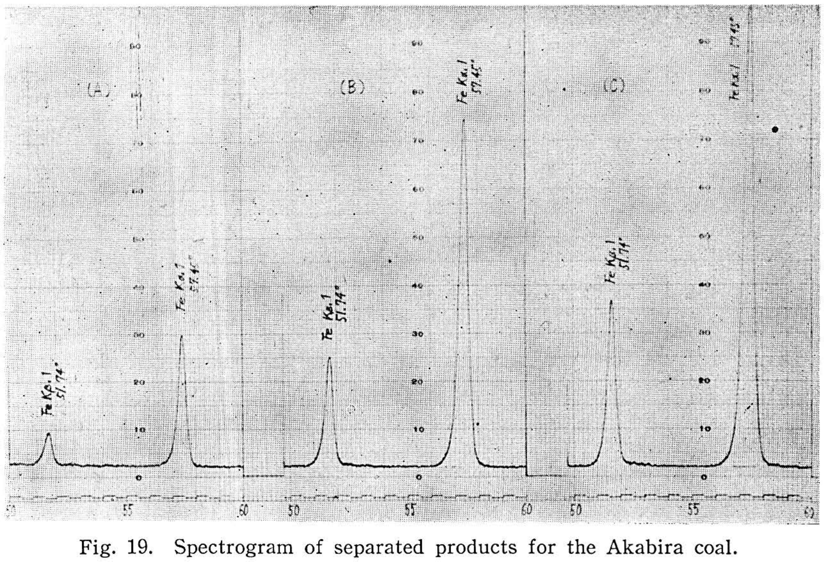


Fig. 19. Spectrogram of separated products for the Akabira coal.

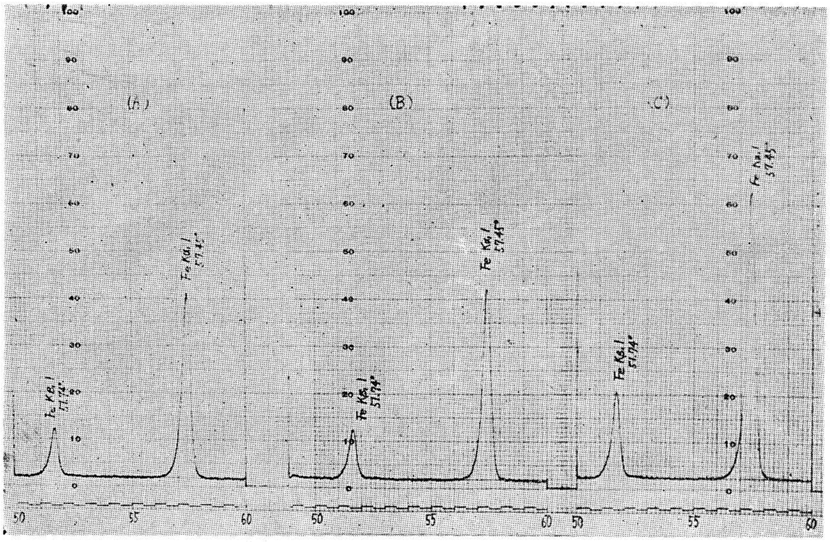


Fig. 20. Spectrogram of separated products for the Kushiro coal.

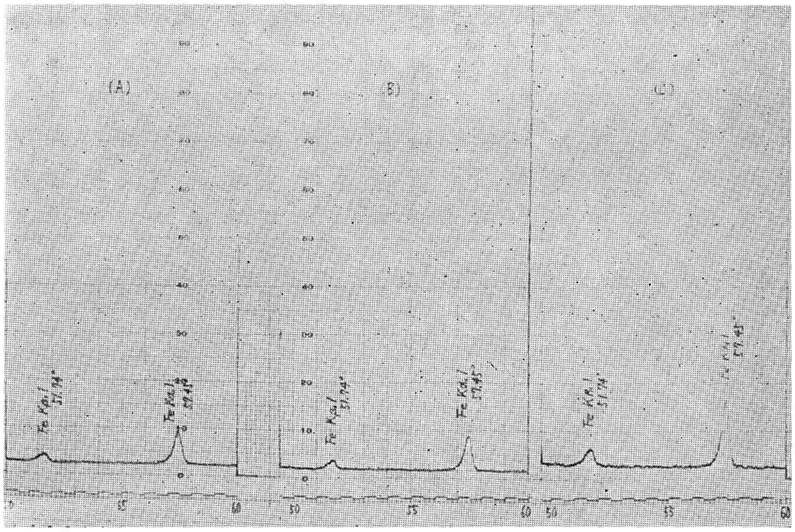


Fig. 21. Spectrogram of separated products for the Miike coal

$-8\sim-12$ cm, (B) in $0\sim4$ cm, and (C) in $12\sim16$ cm. As can be seen in Fig. 19~ Fig. 22, the two peaks of iron, one at the Bragg angle 57.45° and the other at 51.74°, were clearly perceptible.

By comparing the heights of the peak for each coal product, it is recognized that the concentrate coals attracted to the grounded roller are poor in iron content, while the coals repelled from the roller are rich.

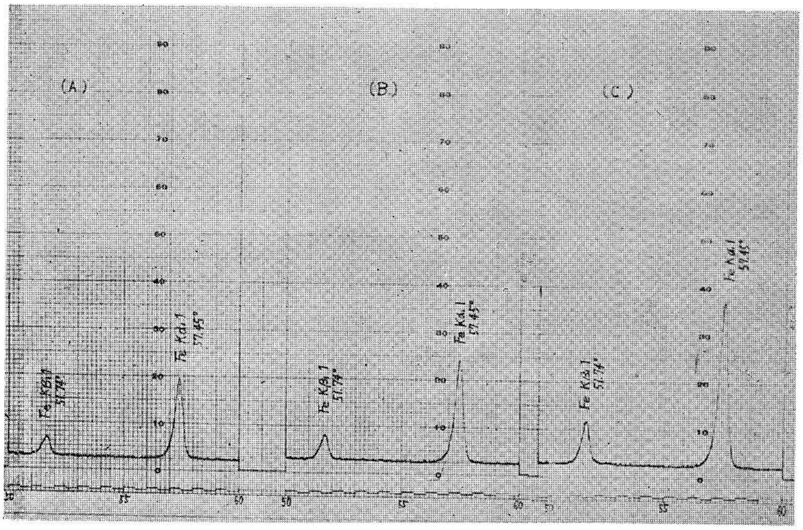


Fig. 22. Spectrogram of separated products for the Oshima coal.

Iron content in the ash and the coal is determined by chemical analysis. The results are shown in Table II.

Table II. Iron contents of coals.

Coal mine	Repelling distance of products	Ash content (%)	Iron content (%)
Akabira	−12∼ −8 cm	2.54	0.36
	−8∼ −4 cm	3.46	0.66
	0∼ 4 cm	31.5	3.56
	16∼ 20 cm	58.8	5.02
Miike	−12∼− 8 cm	3.12	0.08
	0∼ 4 cm	14.8	0.43
	12∼ 16 cm	30.3	1.25
Kushiro	−12∼ −8 cm	4.02	0.14
	0∼ 4 cm	23.1	1.05
	12∼ 16 cm	52.5	2.80
Oshima	−12∼− 8 cm	2.80	0.08
	0∼ 4 cm	10.5	0.50
	12∼ 16 cm	50.1	4.05

From the results of the chemical analysis, it is obviously recognized that the iron content of the concentrate coal attracted to the grounded roller is extremely low, while that of the coal repelled from the roller is relatively high. For example, on Akabira coal, the coal attracted to the grounded roller has 0.36% iron content, while the coal repelled from the grounded roller has 5.02%; and on Oshima coal, the attracted coal has 0.08% iron content, although the repelled coal has 4.05%.

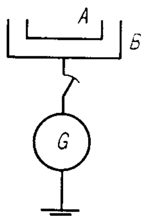
There exists the close relation between the iron content of the coal and its repelled distance. Consequently, coal concentrate of low iron content can be recovered by separation in the corona discharge field.

6. Electric Charge and Conductivity of Coal Particles

It may be considered from the principle of electrostatic separation that the behaviors of coal particles in the electrostatic field are affected by the electric charge and conductivity of the coal particles. Then, for the purpose of considering the mechanism on the separation of the coal particles, the electric charge of the coal particles placed in the electric field and the conductivity of the coal were measured. The Akabira coal was used as the sample in this experiment.

(1) The electric charge of coal particles

The method of charge measurement is shown in Fig. 23. In Fig. 23, A and B are the metal vessels insulated by each other. These two metal vessels form a condenser. B is connected to a ballistic galvanometer. The ballistic galvanometer is earthed. When the charged particles are taken into A, the



A, B : Metal vessels
G : Ballistic Galvanometer

Fig. 23. Diagram of setup for measurement of electric charge.

charge runs to the earth through the ballistic galvanometer and the deflection of the ballistic galvanometer corresponds to the total sum of the charge. The relation between the deflection of the galvanometer and the amounts of the charge was ascertained by using a definite charged condenser which had a constant capacity.

The electric charges of the coal particles distributed by the separation are shown in Fig. 24. As can be seen from Fig. 24, the particles attracted to the grounded roller have the negative charge and the repelling particles have the positive charge.

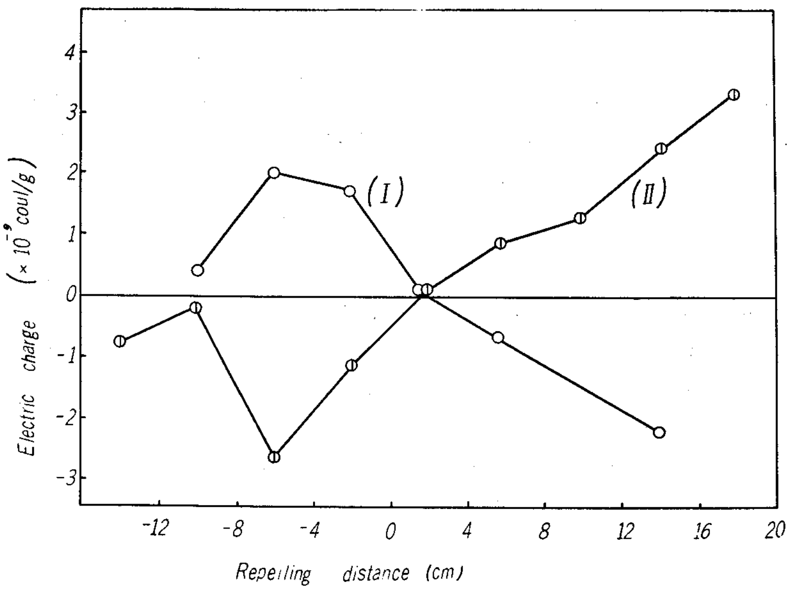


Fig. 24. Relation between the repelling distance of particles and their electric charge in separation with corona discharge.
Particle size : 20～28 mesh, Applied voltage 15 KV
(I) Result of high tension electrode positive
(II) Result of high tension electrode negative

The magnitude of the electric charge of the coal particles becomes larger according to the increase of the repelling or attracting distances. But the charge of the coal particles scraped off by the brush from the grounded roller becomes smaller because an electric discharge occurs when the particles are scraped.

Then, the effects of the particle size on the charge of the coal particles were investigated in both cases of the corona discharge field and the field without corona discharge. The results obtained are shown in Table III.

Table III. Electric charge of coal particles.

Particle size (mesh)	Electric charge (coul/g)	
	Corona field	Non-corona field
28～35	-9.16×10^{-9}	-7.02×10^{-9}
20～28	-8.59×10^{-9}	-4.33×10^{-9}
14～20	-8.60×10^{-9}	-6.14×10^{-10}
10～14	-7.81×10^{-9}	-1.91×10^{-10}

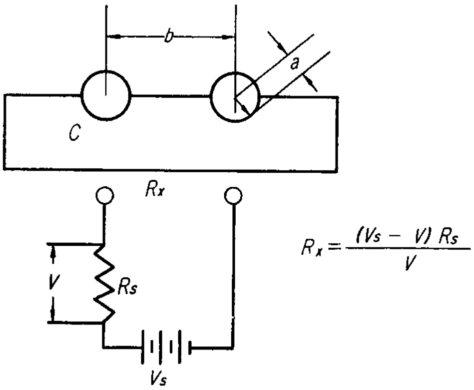
From the above results, it is found that the polarity and the magnitude of the charge of coal particles govern their behavior in the electrostatic field.

The charges of particles do not decrease even in the larger particle in the corona discharge field, but they remarkably decrease with the increase of particle size in the field without corona discharge. Accordingly, in the case of the corona field the range of the feed size in the separation of coal can be enlarged safely, and it is more stable in the corona field for recovering the coal concentrates than in the field without corona discharge.

(2) The conductivity of coal particles

It is also considered that the coal particles attracted to the grounded roller are comparatively insulative and the coal particles repelled from the roller are comparatively conductive. Accordingly, the electric resistance of the coal particles was measured.

Mercury electrodes were prepared on the coal surface and they were set in a circuit as shown in Fig. 25.



a : Radius of mercury electrode
b : Clearance of electrode
c : Specimen of coal
R_x : Unknown resistance
R_s : Standard resistance
V_s : Electromotive force of battery
V : Potential difference between the ends of standard resistance, R_s

Fig. 25. Diagram of setup for conductivity measurement of coal.

The specific resistance of the coal was calculated in the following equation by measuring the voltage drop across the standard resistance using a vacuum potentiometer,

$$\rho = \frac{\pi \cdot R}{\frac{1}{a} - \frac{1}{b-a}} = \frac{\pi}{\frac{1}{a} - \frac{1}{b-a}} \cdot \frac{R_s}{V} (V_s - V) . \qquad (2)$$

The coal samples used in this measurement are the bright coal ones containing low ash and the dull coal ones containing high ash from the Akabira mine. The conductivity measurements were carried out, after the samples were kept in a hermetically sealed glass vessel saturated by a definite vapor pressure for 24 hrs. The results obtained are shown in Table IV.

Table IV. Specific resistance of coals.

Coal \ Relative humidity	100%	75%	15%
Bright Coal (Ω cm)	3.7×10^{11}	4.5×10^{11}	6.7×10^{11}
Dull Coal (Ω cm)	1.5×10^{5}	5.3×10^{5}	15.0×10^{5}

As can be seen in Table IV, the specific resistance of the bright coal shows a much higher value than that of the dull coal. From this result, it is found that the ash content of the coal correlates well with the conductivity of the coal.

As described previously, there is a close relationship between the iron content and the ash content in the coal, and consequently it may be said that the conductivity of the coal correlates closely to the iron content in the coal.

7. Comparison of Separation in the Corona Discharge Field and in the Field without Corona Discharge

(1) The comparison on the effectiveness of the separation

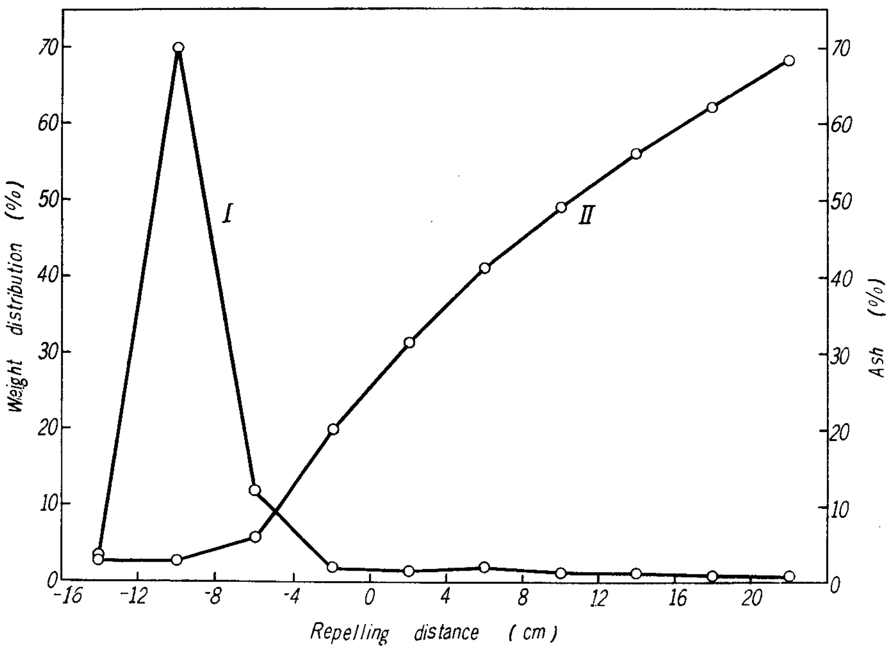


Fig. 26. A result of separation in corona field.
Particle size : 20~28 mesh, Applied voltage—20 KV
(I) Weight distribution curve (II) Ash content curve
(At room temperature)

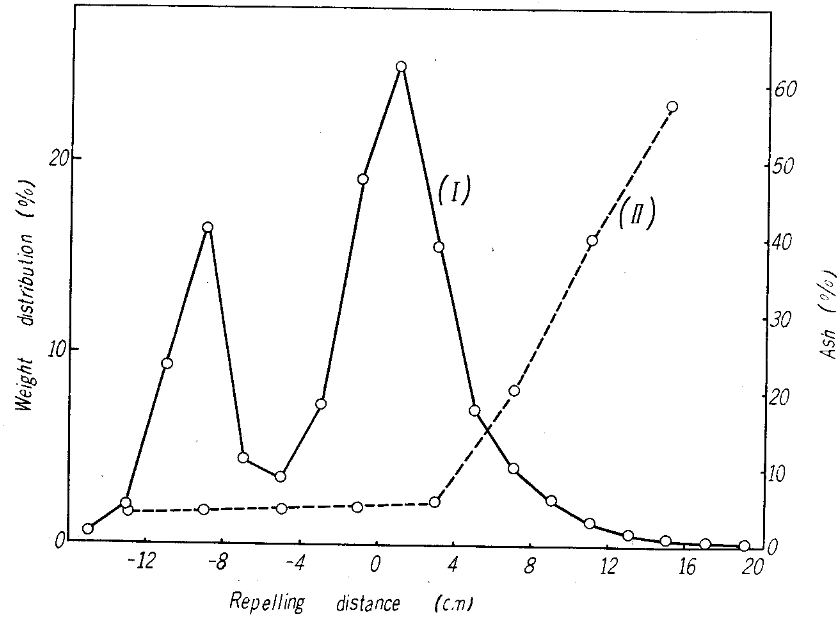


Fig. 27. A results of separation in the field without corona discharge.
Particle size : 20~28 mesh, Applied voltage—2 KV
(I) Weight distribution curve (II) Ash content curve

The separation testing of the Akabira coal in the corona discharge field was performed by the apparatus as shown in Fig. 5. The result obtained is shown in Fig. 26. The result obtained in the field without corona discharge is shown in Fig. 27. As can be seen from these results, even in the non-corona discharge field the coal particles containing low ash are attracted to the roller and the coal particles containing the high ash content are repelled from the roller. However, there are considerable differences in the amounts of the attracted coal concentrates in various cases. The amounts of free falling particles increase considerably in the field without corona comparing with the corona discharge field. That is, the high grade coal particles may be diffused into the low grade coal.

Accordingly, from the point of view of recovery of the high grade coal it may be said that the electrostatic separation of coal in the corona discharge field is more successful than the separation in the field without corona discharge.

(2) The effect of conversion of electrode polarity.

When the needle shaped electrode is negatively charged, at first the dark current and then the brush corona, the spark corona appears between the electrodes when increasing the applied voltage. On the other hand, when the needle shaped electrode is positive, the dark current, the gloom corona, the brush corona, the spark discharge and the streamer corona appear successively. The voltage required to bring about the corona discharge differs with the polarity of the high tension electrode.

The results shown in Fig. 26 are of the separation using the negative high tension electrode. The results of the separation using the positive high tension electrode in the corona discharge field are shown in Fig. 28.

Comparing Fig. 28 with Fig. 26, it is found that the attracted products to the grounded roller decrease by the conversion of the electrode polarity from negative to positive.

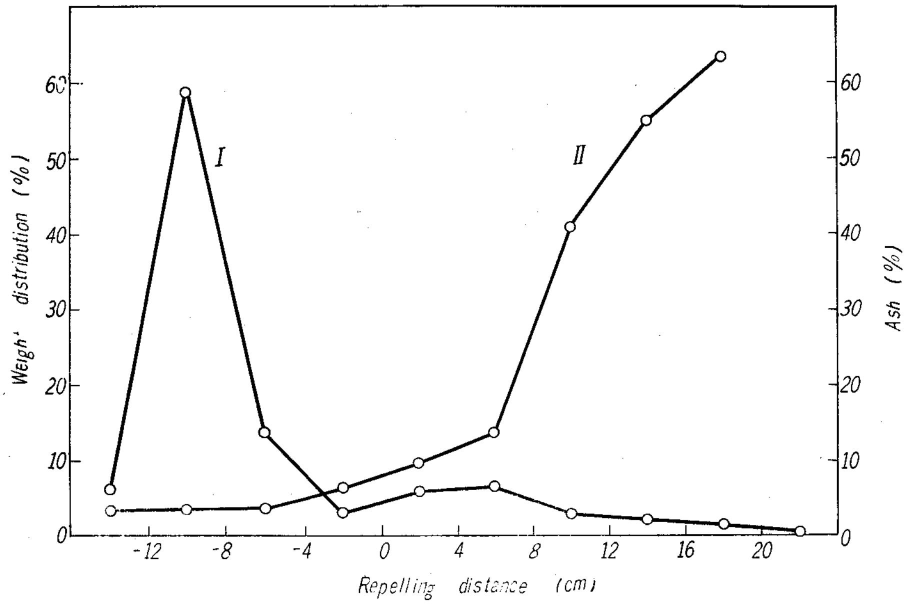


Fig. 28. Separation using high tension electrode polarized positively.
Particle size : 20~28 mesh, Applied voltage 20 KV
(I) Weight distribution curve (II) Ash content curve

The results of the separation using the positive electrode in the non-corona discharge field are shown in Fig. 29. Comparing Fig. 29 with Fig. 27, the attracted products to the grounded roller decrease remarkably by the conversion of the electrode polarity.

It is found from the above results that the effects of the conversion of the electrode polarity on the coal separation are considerable in the non-corona discharge field. However, even in the corona discharge field, the effectiveness of separation is reduced when the high tension electrode is positive. Conse-

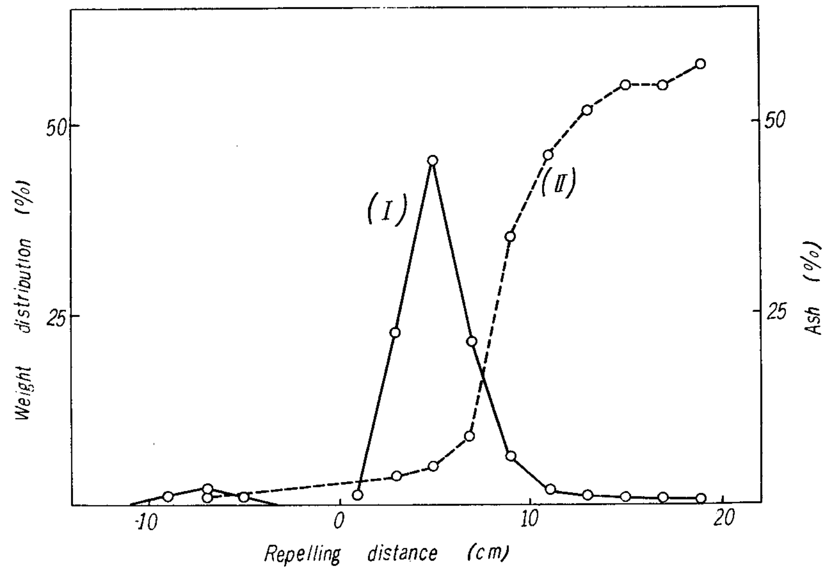


Fig. 29. Separation in non-corona field using high tension electrode polarized positively.
Particle size : 20～28 mesh, Applied voltage 20 KV
(I) Weight distribution curve (II) Ash content curve

quently, better separation of the coal is obtained when the high tension electrode is negative.

(3) Effect of the particle size on the separation of coal

In order to clarify the effect of the feed size on the electrostatic separation of coal, the samples for the range of 10～14 mesh, 14～20 mesh, 20～28 mesh, and 28～35 mesh were tested. The needle shaped electrode combined with the plate electrode was used in the separation with the corona discharge field as shown in Fig. 6.

The results of the testing are shown in Fig. 30. In the separation with the corona discharge field, the particles are forced to charge enough so that the comparatively large particles can be attracted to the grounded roller. However, the result of this experiment shows that the attracted products to the grounded roller slightly decrease with increasing of the particle size from 28～35 mesh to 10～14 mesh.

In the separation without corona discharge field, the particles are not forced to charge by the collision of the electrons. The electric charge of coal particles placed in the field without corona discharge decreases with increasing the particle size as shown in Table III. Accordingly, it may be considered that

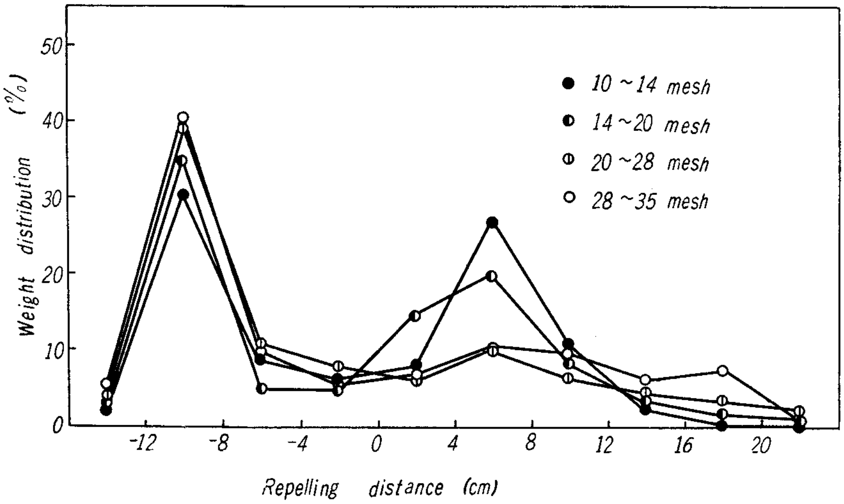


Fig. 30. Relation between weight distribution of coal and its repelling distance with varying feed size.
Applied voltage—15 KV

the effect of the feed size on the separation in the non-corona discharge field is more remarkable than in the corona discharge field.

8. Conclusion

In order to recover coal concentrates of low ash and low iron content separations in the corona discharge field were performed by using a Huff type separator for the coals from the four coal mines in Japan. The ash, iron and other inorganic substances contained in coal, for the feed and separated products, were investigated by means of the X-ray diffraction, the fluorescent X-ray spectrographic analysis and the chemical analysis. Then, the separation characteristics of the coal particles in the corona discharge field were considered.

From these investigations it is recognized that the coal concentrates of low ash and low iron content are attracted to the grounded roller and the coal particles of high ash and iron content are repelled from the roller in the electrostatic separation with corona discharge. Thus, it is ascertained that the separation in the corona discharge field is a suitable procedure for recovering high quality coal of low ash and low iron content.

The electric charge and the conductivity of the coal were measured. From these measurements, it is found that the high quality coal is extremely high in specific resistance, while the coal of high ash and high iron content is relatively conductive. The conductivity of the coal correlates closely to the ash and iron content. The polarity of the electric charge of the coal attracted to the grounded roller is opposite to the grounded roller and its charge is considerably abundant. It is obvious that the behavior of the coal particles in the electric field is governed by the charge and conductivity of the coal particles.

From the comparison of the separation in the corona discharge field with the separation in the non-corona discharge field, it is considered that the separation in the corona field is more applicable to the larger size of feed and is more suitable in performance than the separation without corona discharge.

Reference

1) S. Mukai, T. Wakamatsu, Y. Shida; "Electrostatic Separation of Coal by the Huff Separator", Suiyokaishi, Vol. 14, No. 8, pp. 371～374 (1962)