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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

MEMORANDUM NO. 17 OF 1954.

CHARACTERISTICS OF SIMCAR DEMAGNETISER AND PROPERTIES OF MAGNETIC MEDIA.

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As explained in previous communications, the Institute has been of the opinion that the difficulties experienced with the Dense Medium Washery at South African Coal Estates could be largely attributed to changes in the properties of the heavy medium and consequently recommended that natural magnetite should be substituted for blast furnace dust. A quantity of natural magnetite, ground mainly to -325 mesh, was accordingly obtained from Frank Martin and the plant was started up on this material. It came as a great surprise when it was found that although operation had somewhat improved, the bath was not completely stable. Tests conducted at that time indicated that the medium was not completely demagnetised and the performance of the demagnetiser was suspected of being faulty.

At this stage a representative of Simon Carves arrived on the scene. He was of the opinion that the fault lay in the size of the medium and not with the demagnetiser. He suggested that the super fines were not included in the milled magnetite supplied to the mine and recommended finer grinding. Investigation showed that the super fines had in fact been excluded from the medium by Frank Martin . This fine material was accordingly obtained and added to the circuit with little effect. Finer grinding was simultaneously tried and there was some improvement but stability was far from satisfactory. Simon Carves' representative finally concluded that the lack of stability was due to the absence of clay in the coal feed and artificially

added..../

added clay to the system. This stabilised the bath, but it was observed that the viscosity of the bath was high and sharp separation of the smaller sizes cannot therefore be expected. In addition, the introduction of clay into the dense medium system also appeared to have an adverse effect on the quality of the slurry from the Baum system.

The Institute was not satisfied with Simon Carves' explanations and persisted with a study of the various magnetic media and industrial demagnetisers.

The present report contains a summary of the investigations carried out to date.

TEST SET UP.

The Simcar demagnetiser originally installed at Blesbok Colliery is generally similar to the one in operation at South African Coal Estates, except that the former is air cooled and the latter oil cooled. The Blesbok demagnetiser together with its condenser were brought to the Institute and installed in the test set up shown in Fig. 1. With the aid of the by-pass on the circulating pump discharge the flow rate through the demagnetiser may be varied from about 85 gallons per minute to 15 gallons per minute. The demagnetiser was designed for 500 volts but the maximum voltage available in the laboratory was 433 and this was applied initially to the demagnetiser.

When carrying out tests a known quantity of suspension was placed in the feed tank and was magnetised by circulating the suspension through the magnetising block with the demagnetiser switched off. A sample of the suspension was then taken and after diluting to a specific gravity of 1.43. (the normal operating specific gravity at South African Coal Estates) the settling rate was determined. This was repeated until the settling rate became constant i.e.

until .../

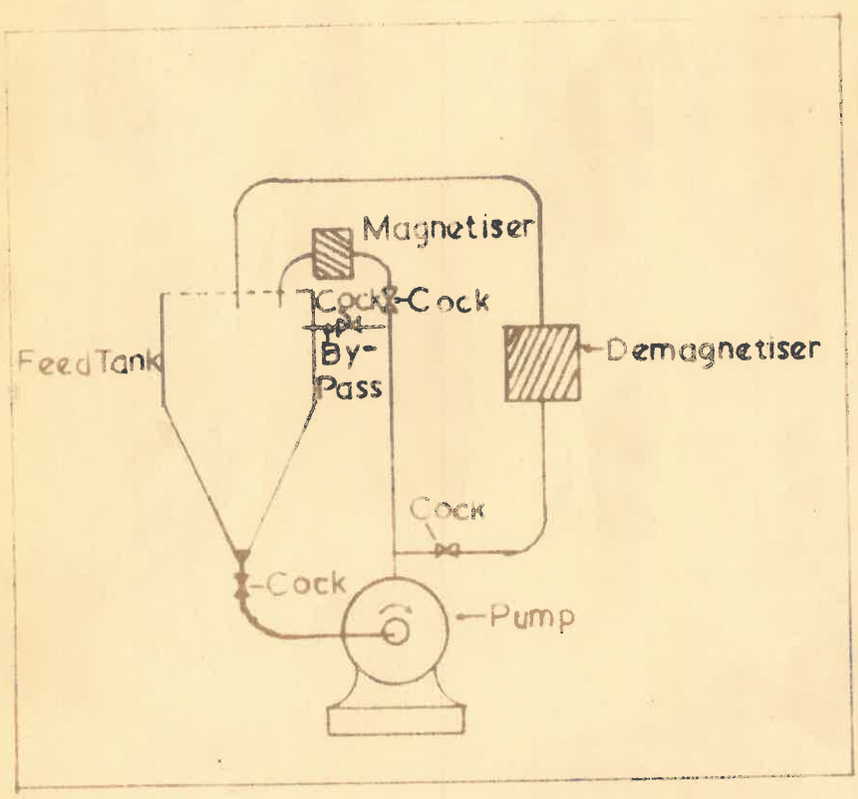
Magnetiser
Cock
Cock
By-
Pass
Feed Tank
Demagnetiser
Cock
Cock
Pump

Figure 1

until the suspension was completely magnetised.

The magnetising block was then switched off and the demagnetiser was switched on. After the appropriate period of circulation at the desired flow rate, a sample of the suspension was again taken, diluted to 1.43 specific gravity and the settling rate determined. The sample was finally passed through a laboratory demagnetiser and the settling rate again determined.

NATURAL MAGNETITE SUPPLIED BY FRANK MARTIN :

A series of tests was carried out using the milled magnetite originally supplied by Frank Martins (i.e. super fines not included). The suspension was circulated through the demagnetiser at various specific gravities, flow rates and periods of circulation. Little difference was observed in the settling rate at 1.43 specific gravity and the settling rate was always substantially higher after passing through the Simcar demagnetiser as compared with the results obtained after demagnetising in the laboratory unit.

Typical results are 0.79 ins./min. after Simcar demagnetiser and 0.31 ins./min after laboratory demagnetiser. According to Simon Carves, the settling rate at the separating specific gravity should not exceed about 0.5 inches/minute for complete stability. In other words it is possible to obtain this value in the laboratory but not with the Simcar demagnetiser when operated at 433 volts.

The voltage was then decreased progressively and it was found that the settling rate of the demagnetised medium decreased accordingly reaching an optimum value at about 180 volts. Below this voltage the settling rate again increased. The results of a typical series of tests is shown in Figure 2. It will be observed that the settling

rate ... /

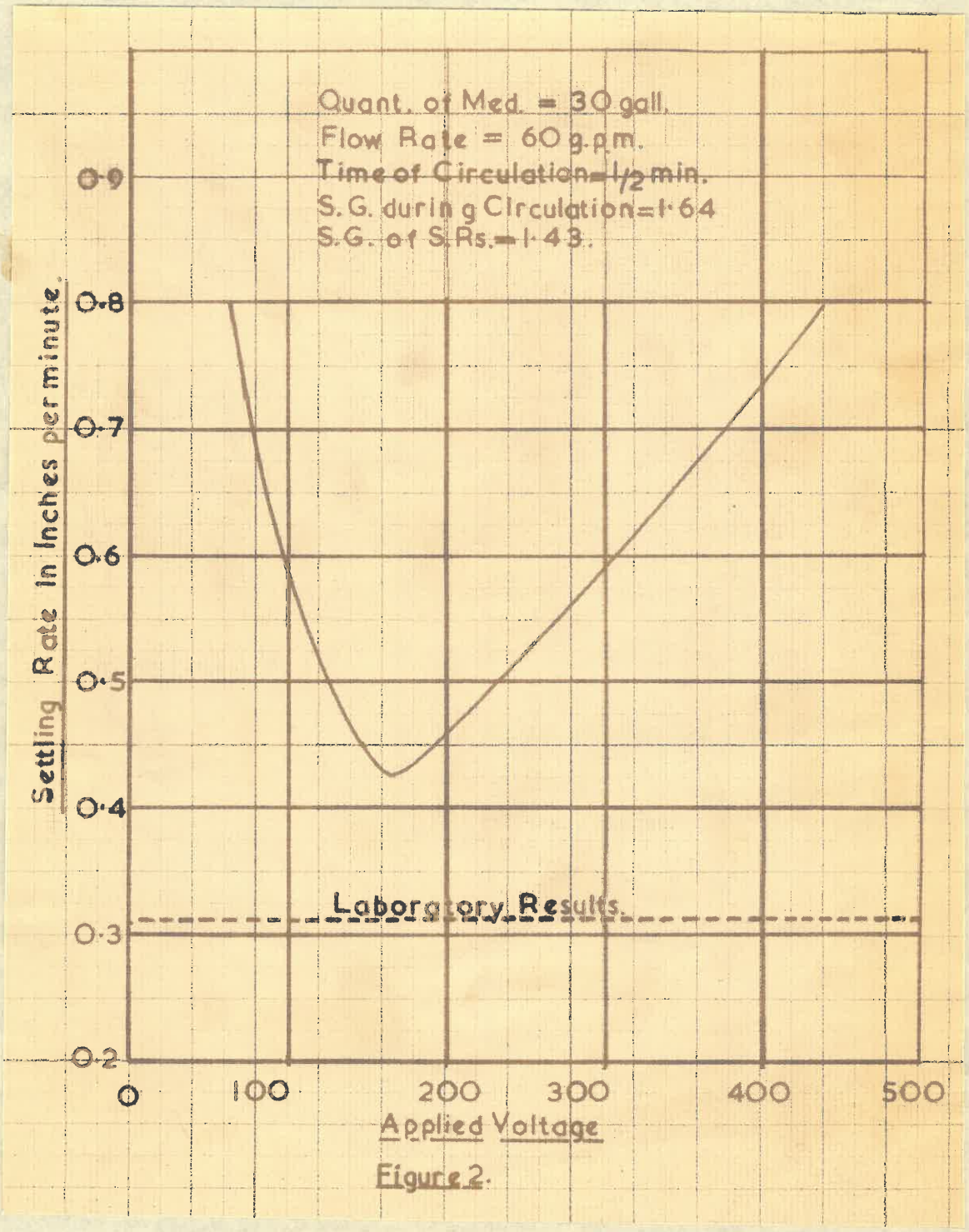
Quant. of Med. = 30 gall.
Flow Rate = 60 g.p.m.
Time of Circulation = 1/2 min.
S.G. during Circulation = 1·64
S.G. of S.Rs. = 1·43.
Settling Rate in Inches per minute.
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
Laboratory Results.
0
100
200
300
400
500
Applied Voltage

Figure 2.

rate of 180 volts applied is about 0.43 inches/minute and should be quite stable in the bath. The settling rate with 433 volts applied on the other hand is 0.79 inches/minute and will definitely be unstable in the bath. If one can extrapolate to 535 volts, the voltage actually applied at the mine, the settling rate will probably be even higher.

It will be observed that there was 30 gallons in the feed tank and that the circulation rate was 60 gallons/minute for half a minute. This, therefore, corresponds to roughly one pass through the demagnetiser at a practical flow rate. The settling rate of the medium, however, improves by continuing the circulation up to 2 minutes

The field strength in the demagnetiser was plotted for various applied voltages with the results shown in Figure 3. It will be observed that the field strength is reduced from some 2,000 oersteds at 433 volts to 900 oersteds at 180 volts, apparently with beneficial results. Further reduction of voltage causes further decreases in field strength and a rise in settling rate indicating that a field strength of about 900 oersteds is the minimum which will completely demagnetise this natural magnetite at a flow rate of 60 gallons per minute.

It appears therefore, that it should be possible to obtain satisfactory operation with the natural magnetite supplied by Frank Martin, without the addition of clay, merely by reducing the voltage applied to the demagnetiser.

This work was repeated using the type of demagnetiser installed at Premier Mine (a very simple type with an axial field instead of a transverse field).

The results of these tests are shown in Figure 4

(settling .../

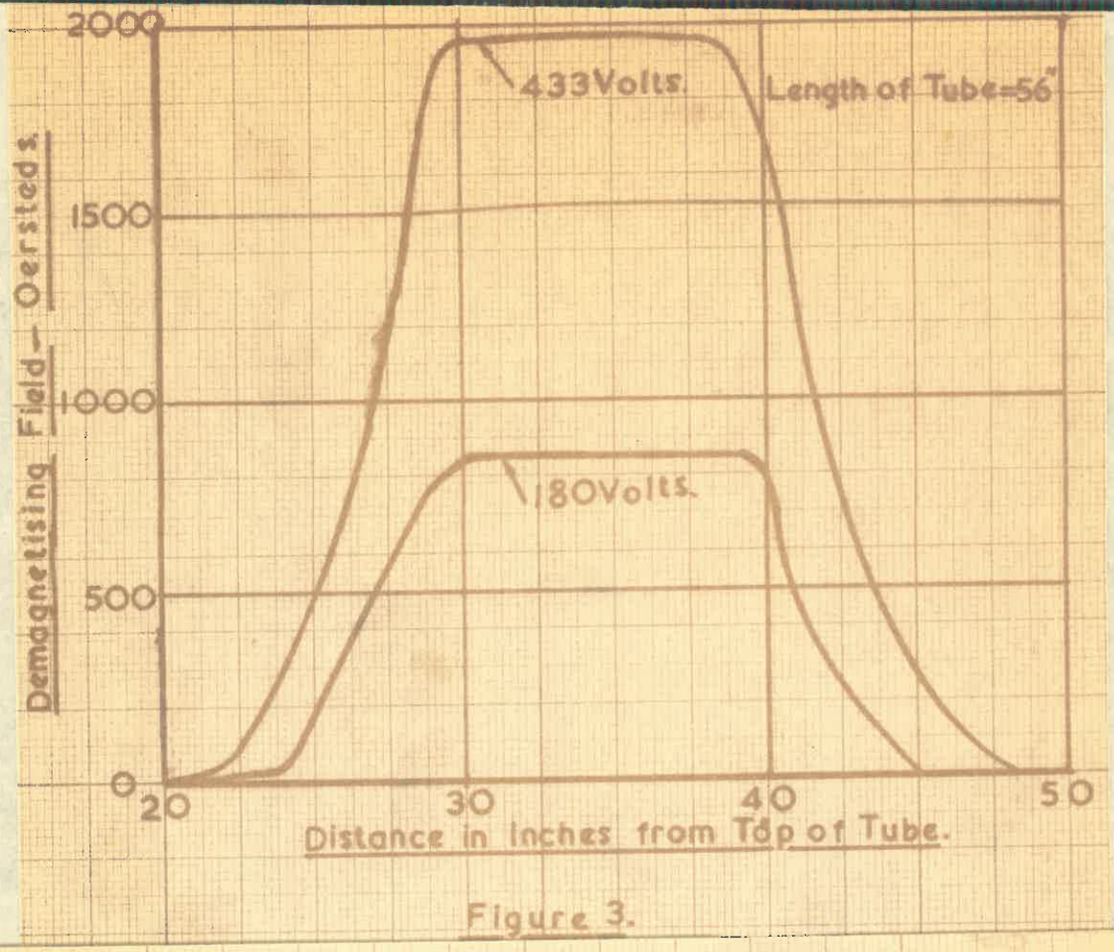

Figure 3.

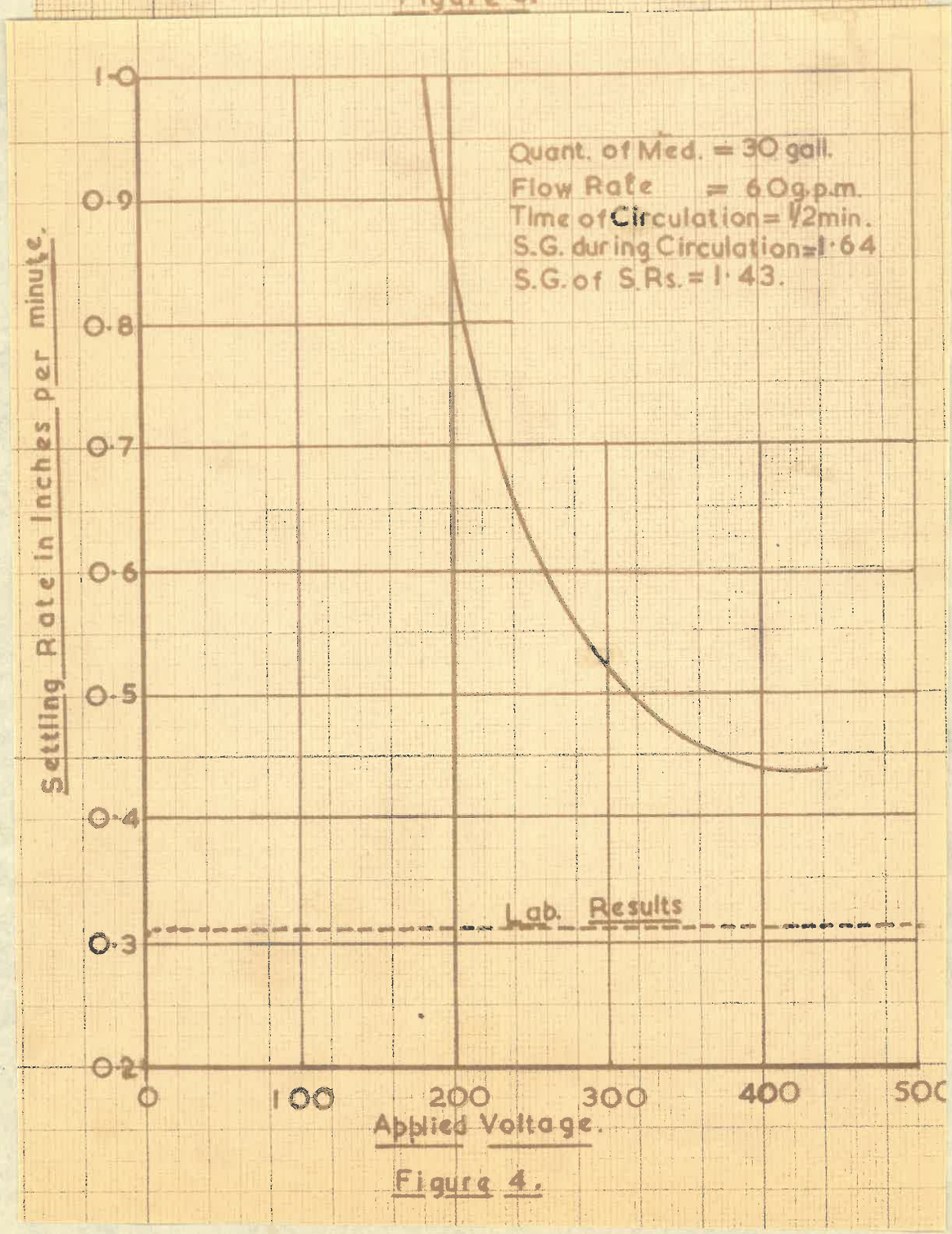

Figure 4.

(settling rate versus voltage) and Figure 5 (Field strength). It will be observed that the settling rate decreases with increasing voltage, and becomes constant at about 390 volts. This voltage corresponds to a field strength of about 900 oersteds when filled with medium. (It was found that the field strength increased from 740 oerstreds when empty to 900 oersteds during circulation of medium which was not the case in the Blesbok demagnetiser). Thus supporting the conclusion that a minimum field strength of the order of 900 oersteds is required to demagnetise this magnetite completely. The optimum settling rate obtained with this demagnetiser (viz. 0.39 inches/minute) agrees closely with that obtained with the Simcar demagnetiser operated at 180 volts.

When operating with magnetite, therefore, another solution would be to install the less expensive Premier Mine type of demagnetiser. This demagnetiser was in fact installed at South African Coal Estates, as pointed out in a previous letter, and during the short period it was in operation the stability of the bath improved materially.

BLAST FURNACE DUST:

A study of this medium is proceeding. The indications to date are that fresh medium from Iscor is liable to be unstable unless clay is added to the system. If the medium is allowed to weather or is artificially oxidised by roasting it should be quite stable in the bath without the addition of clay.

These laboratory indications are substantiated by the fact that the plant operated quite satisfactorily without the addition of clay when using blast furnace dust which had been roasted and thereafter when using medium which had been exposed to the weather for 3 to 4 months and is now red in appearance, indicating oxidation. This same batch of medium was quite unsuitable when freshly delivered.

As.../

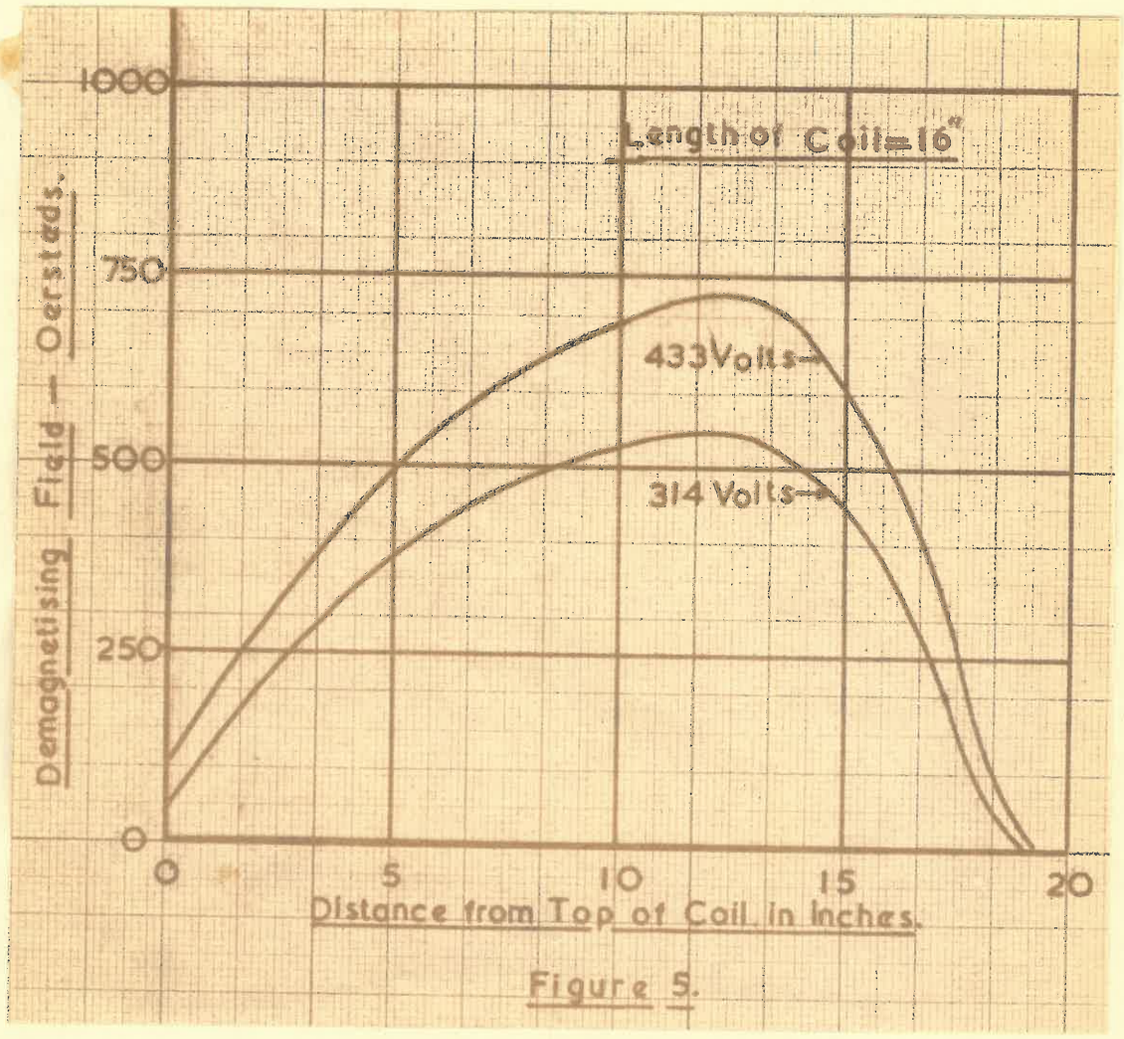
1000
750
500
250
0
Length of Coil = 16"
433 Volts
314 Volts
Demagnetising Field — Oersteds.
0
5
10
15
20
Distance from Top of Coil in Inches.

Figure 5.

As soon as the addition of clay was discontinued the ash content of the slurry decreased substantially. Tests are soon to be conducted to determine the influence of clay on separating efficiency of the bath.

(SIGNED) P. C. Minnaar.
Assistant Technical Officer.

G.A.W. van Doornum.
Principal Technical Officer.

P. J. v.d. Walt,
Assistant Director

PRETORIA.

21st. December, 1954.