FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 25 OF 1961.

REPORT ON BOILER TRIALS CARRIED OUT TO INVESTIGATE THE POSSIBILITIES OF USING CHARRED SOUTH WITBANK COAL AS FUEL.

By:

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REPORT ON BOILER TRIALS CARRIED OUT TO INVESTIGATE THE POSSIBILITIES OF USING CHARRED SOUTH WITBANK COAL AS FUEL.

OBJECT OF THE TESTS:

A number of trials were carried out on the Institute's boiler installation with the object to investigate the possibilities of using washed charred coal* from South Witbank Colliery as fuel. The charred coal was obtained from African Explosives & Chemical Industries and had been washed at a specific gravity of 1.7. The proximate analysis of the "char" was as follows:

Cal.val.	=	10.61 lb./lb.
Moisture	=	4.3%
Ash	=	23.0%
Vol.mat.	=	3.0%
Fix.carb.	=	69.7%

DESCRIPTION OF TESTS AND TEST RESULTS:

The char was fired on a "Bennis" chain grate stoker fitted to a Treble Pass Economic Boiler. Altogether eight trials were carried out as follows:

1st TRIAL:

The boiler was started at 9 a.m. on a fuel bed thickness of 6". The stoker speed was gradually increased to a maximum value of about 13.6 f./hr. At 12 o' clock the average CO content of the flue gases was 0.05%, while the CO_2 content was about 5.5%. The temperature in the fire box had gone up to 420°C.

The fire needed constant attention. It was found that the amount of air needed was much smaller than with ordinary coal due to the small volatile matter content of the fuel (3.0%). Furthermore it was found that a positive pressure of about 4mm. w.g. had to be maintained above the fire bed to prevent the ignition from running away.

During this trial the pressure in the boiler remained zero.

2nd TRIAL/....

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* Gasifier rejects.

2nd TRIAL:

The boiler was again started at 8.30 a.m. on a 6" fuel bed, but the stoker speed was gradually increased to 15.5 ft/hr.

The positive pressure above the bed was again kept at 4 mm. w.g.

At 10.15 a.m. the CO content of the flue gases was 0.05%, the CO_2 content was 5.5%, while the temperature in the fire box was 480°C.

The fuel ignited properly.

At 10.30 a.m. the ash pit had to be cleaned and during this operation the fire bed cooled down to such an extent that the front portion of the bed almost extinguished. All efforts to revive the fire and to bring the ignition point foreward towards the coal gate failed and at 11.45 it was decided to discontinue this test.

The pressure in the boiler went up to 20 p.s.i.

As trials on a 6" bed were unsuccessful it was decided to try a thinner bed. This means that the stoker speed had to be increased in order to push in the same amount of fuel.

3rd TRIAL:

The boiler was started at 8.30 a.m. on a 4" fuel bed. The stoker speed was initially set on 15.5 ft/hr. while a positive pressure of 2½ mm. w.g. was maintained above the bed.

At 9.50 a.m. the bed thickness was increased to 4½" while the positive pressure above the bed was decreased to 2mm. w.g. At 10.05 a.m. the stoker speed was increased to 16.4 ft/hr.

By that time the CO_2 content of the flue gases was 5%, the CO content 0.05% while the fire box temperature went up to 410°C. At 10.15 a.m. the ash pit was cleaned.

The boiler pressure was then 18 p.s.i.

At 10.23 the stoker speed had to be reduced to 15.5 ft/hr as the ignition tended to run away after ash pit cleaning.

The CO_2 content of the flue gases was then 6.5% and the fire box temperature 445°C.

At 10.27 a.m. the stoker speed was put back on 16.4 ft/hr.

At 10.33/....

At 10.33 a.m. the CO_2 content of the flue gases was 7.4% and the fire box temperature 502°C.

At 10.35 a.m. the ignition started running away on the R.H. - side of the grate. The stoker speed was reduced to 15.5 ft/hr. and the positive pressure above the bed was increased to 2½ mm. w.g. in an effort to blow the fire backwards towards the coal gate.

When this gave no result the stoker speed was reduced to 0 and more primary air was admitted to the R.H. - side of the grate.

At 10.58 a.m. the ignition was back just in front of the coal gate and the stoker speed was put back on 15.5 ft/hr.

However, at 11.03 a.m. the ignition ran away again and the stoker speed was reduced to 12.5 ft/hr. The ignition still moved away from the coal gate, and the positive pressure above the bed was increased to 3.6 mm. w.g.

At 11.08 a.m. the stoker speed had to be decreased still further, to 10.0 ft/hr.

This brought the ignition back again so that at 11.13 a.m. the stoker speed could be increased to 13.6 ft/hr.

At 11.15 a.m. the ash pit had to be cleaned.

After this operation the positive pressure above the bed had to be increased to 4.5 mm. w.g. in order to blow the flames back towards the gate and to push back the ignition.

At 11.20 a.m. the positive pressure was decreased to 3.5 mm. w.g. and the stoker speed was increased to 15.5 ft/hr. The CO_2 content of the flue gases was then 7.0% and the fire box temperature 460°C, while the boiler pressure had increased to 65 p.s.i.

However the ignition started running away again and at 11.26 a.m. the stoker speed was reduced to 11.0 ft/hr. followed by an increase to 12,5 ft/hr. at 11.32 a.m. and a further increase to 15.5 ft/hr. at 11.45 a.m.

The positive pressure above the bed was maintained at 3mm. w.g.

At 11.59 a.m. the stoker speed was on 16.4 ft/hr.

The CO_2 content of the flue gases was 7% and the fire box temperature 520°C, while the boiler pressure increased to 68 p.s.i.

At 12.30 p.m./....

At 12.30 p.m. the trial was stopped with the boiler on 80 p.s.i. pressure, ready for an efficiency test on the next day.

4th TRIAL:

The boiler was again started at 8.30 a.m. on a bed thickness of 4½".

The boiler pressure was 10 p.s.i.

At 9.15 the stoker speed was on 13.6 ft/hr. and the positive pressure was maintained at 3 mm. w.g. Fire box temperature was then 260°C.

As the boiler pressure would not increase, it was decided to fire more fuel by increasing the bed thickness to 5" at 9.23 a.m. and to increase it futher to 5½" at 9.50 a.m. The stoker speed was kept on 13.6 ft/hr. to prevent the ignition from running away. The positive pressure above the bed had to be kept at 2½ - 3 mm. w.g.

However, at 10 a.m. the ignition started to run away again on the R.H. - side of the grate. Efforts to push the ignition back only resulted in an advance of the ignition on the L.H. - side of the grate till right inside the coal hopper. As it was feared that damage would be done to the coal gate and the hopper, the test had to be stopped at 11.10 a.m.

The admission of more primary air to the R.H. - side of the grate was unsuccessful while it had been proved again that the thicker fuel bed was not the answer to the problems.

It was therefore decided to operate the boiler on a thinner bed and to increase the grate speed.

5th TRIAL:

The boiler was started at 8.20 a.m. on a 3¾" fuel bed, while a positive pressure of 3 mm. w.g. was maintained above the bed. This positive pressure was decreased to 1½ mm. w.g. at 9.15 a.m. The CO_2 content of the flue gases was then 6.2% while the fire box temperature was 370°C. The stoker was then put on a speed of 17.7 ft/hr. in order to get an adequate amount of fuel on the grate. However this proved to be the wrong speed as the ignition started to move away from the coal gate.

Therefore the stoker speed was reduced to 17.2 ft/hr. and the positive pressure above the bed was increased to

2½ mm. w.g./...

2½ mm. w.g. This only pushed the ignition back on the L.H. - side of the grate, the R.H. - side remained black. At 9.30 a.m. the coal gate was lifted and burning fuel was removed manually from the L.H. - side of the grate and pushed on to the R.H.-side. The stoker was stopped and the amount of primary air decreased to prevent the fire bed from being cooled down. The positive pressure above the bed was kept at 2½ mm. w.g.

All efforts to revive the fire failed and at 11.20 a.m. it was decided to stop the test.

As all previous trials indicated that this fuel could not be burnt on our chain grate stoker it was decided to carry on with a few more trials on a mixture of "char" and coal from Koornfontein Colliery.

6th TRIAL:

The boiler was again started at 8.30 a.m. on a 4¼" fuel bed and a mixture of 80% char and 20% Koornfontein coal.

At 10.30 a.m. the CO_2 content of the flue gases was 6.2% and the fire box temperature 400°C. The stoker speed was then 13.6 ft/hr. A positive pressure of 1mm. w.g. was maintained above the bed.

As the fire again ran away on the R.H. - side of the grate it was decided to stop the test and to inspect the primary air damper. This damper appeared to be of a bad design so that the amount of air admitted to the R.H. - side of the grate was very much greater than the amount admitted to the L.H.-side, so that the R.H. side of the fuel bed was blown cold and proper ignition was prevented. The damper was modified and a draught gauge was installed so that it would be possible to set the damper in such a position that both sides of the grate received equal amounts of air.

7th TRIAL:

Boiler started at 8.30 a.m. on a 4½" bed and a mixture of 80% char and 20% Koornfontein coal.

At 9.56 a.m. the stoker speed was on 11.0 ft/hr. and a positive pressure of 1mm. w.g. was maintained above the bed.

At 10.20 a.m. the stoker speed was increased to 13.6 ft/hr. The CO_2 content of the flue gases was 5.3% and the fire box temperature was 430°C.

At 10.24 a.m./...

At 10.24 a.m. the stoker speed increased to 15.5 ft/hr. and further increased to 16.4 ft/hr at 10.28 a.m. The positive pressure above the bed was decreased to ½ mm. w.g.

At 11.00 a.m. the fire bed was increased to 5" and the stoker speed was set on 16.0 ft/hr.

At 11.13 a.m. the ignition started running away. The positive pressure above the bed was increased to 2mm. w.g. and the stoker speed was decreased to 13.6 ft/hr.

At 11.25 a.m. the ignition was back in front of the coal gate and the positive pressure above the bed was decreased to 1 mm. w.g.

At 11.50 a.m. the ignition ran away again and all efforts to push it back were unsuccessful. The boiler pressure was then 60 p.s.i.

At 12.35 p.m. the test was stopped.

8th TRIAL:

Boiler started at 8.20 a.m. on a 4½" bed and 80% char + 20% Koornfontein coal.

The bed thickness was increasedto 5" at 9.55 a.m.

Positive pressure above the bed was then maintained on ½ mm. w.g. The boiler pressure was 20 p.s.i. The stoker speed was on 12.5 ft/hr.

At 10.10 a.m. the stoker speed was increased to 13.6 ft/hr. The fire box temperature was then 3.85°C and the boiler pressure had increased to 25 p.s.i.

At 10.20 a.m. the ignition started running away. The positive pressure was increased to 4½ mm. w.g.,which pushed the ignition back towards the coal gate.

At 10.23 a.m. the positive pressure was decreased to 1 mm. w.g. and futher decreased to 0.5 mm. w.g. at 10.28 a.m.

The fire box temperature was then 465°C and the boiler pressure was on 35 p.s.i.

At 10.32 a.m. the ignition started to run away. All efforts to push the ignition back failed and at 10.40 a.m. the ignition had moved half way down the grate so it was decided to stop this trial.

As it had/.....

As it had been sufficiently proved that even the firing of a mixture of 80% char and 20% bituminous coal was unsuccessful all trials on this fuel were stopped.

CONCLUSION:

The firing of charred coal from South Witbank Colliery on a mechanical stoker is not possible due to lack of volatile matter (only 3%) and due to the bad ignition properties.

Hand firing might be a possibility if forced draught is available. As the Calorific Value of the char is only about 10,300 B.T.U. the amount of fuel to be fired will be fairly high for a boiler with a reasonable steaming capacity, while about 25% of the fuel fired has to be extracted again as ash. Therefore the whole operation requires a considerable amount of manual labour.

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