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REPORT TO MR. ALBERTS ON THE EFFECT OF ADDITION OF OXYGEN DURING THE FINAL PURIFICATION OF GAS (FROM LABORATORY STUDY, NOVEMBER 2 - 18, 1937).

It was necessary to determine whether oxygen exerted a beneficial effect during the final purification of the synthesis gas and to what extent that was true, because no definite information has been previously obtained on that subject.

Operating Conditions

a) Constants:

Temperature behind b and in front of a equal 235/225°C.

Temperature conversion of the gas in the final purification intake about 37°C.

Temperature of the water gas intake to final purification about 26°C.

Amount of synthesis gas 14,000 - 14,800 cbm; subsequently increased to 20,000 cbm.

b) Variables:

$C_2$ - 0.1 to 0.5% by volume.

Organic S prior to coarse purification 6-34 g/100cbm.

Results

1) With no addition of $O_2$ (as was done prior to a continuous $O_2$ addition to the final purification, i.e. before the middle of June 1937). A large amount of $H_2S$ was observed to pass through unabsorbed and a small amount of organic S was present after the first tower. Good final purification in the second tower (3rd series 0.011% $O_2$ by volume).

2) Small addition of $O_2$ (2nd series 0.06 - 0.08% of $O_2$ by volume): better absorption of $H_2S$ in the first tower. In this series the organic S content was exceptionally low before introduction into the system and no judgement could be made on the absorption on the organic S in the first tower.

3) Somewhat increased addition of $O_2$ (4th series, 0.1 to 0.13% by volume of $O_2$): with a high organic S content in the system a good purification in the first tower (absorption of 1/2 to 2/3 of $H_2S$ and of the organic S in the tower).

4) Greater increase of $O_2$ content (1st series 0.21 - 0.3% $O_2$ by volume): an almost complete absorption of $H_2S$ in the first tower; absorption of about 40% of organic sulfur in the first tower; the final purification in the second tower satisfactory in series 3 and 4.

5) The last series of experiments (0.04 — 0.55% $O_2$ by volume) was intended to illustrate the effect of higher oxygen amounts. During the whole experiment 80 cbm $O_2$ (80% pure) were added uniformly to 20,000 cbm of gas, corresponding to 0.32%; oxygen determinations in the gas gave, however, quite

different values, varying between 0.04 and 0.55% by volume, which unquestionably resulted from the imperfect dispersion of the oxygen introduced into the heat exchangers. The method of addition of oxygen must have been in general the cause of the great fluctuation of the results and the poor agreement between the calculated and analytically determined values:

| Series | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Calculated | 0.15 | 0.75 | 0 | 0.16 | 0.32 |
| Determination | 0.21-0.35 | 0.06-0.08 | 0.12 | 0.1-0.13 | 0.04-0.55 |

The good removal of $H_2S$ in the first tower with small original S contents in this series leads to conclusions regarding the effect of the $O_2$ content in the gas. No further judgement of the results of this series can be made because of the great fluctuation of the $O_2$ values.

Moisture Contents in the Gas

The intake temperatures of the converted gas and the water gas in front of the final purification could not be maintained constant because of the great fluctuation in the outside temperature; this should have been necessary for the maintenance of a definite moisture content in the synthesis gas. The values varied between 11.5 and 30.6 g $H_2O$/cbm. We cannot definitely state to what extent the saturation of the gas with steam affected the results. The effect of saturation upon the purification under identical outside conditions will be the subject of subsequent studies.

Oxygen Absorption

| Series | $O_2$ Content in front of the system | Tower 1 | Tower 2 | Total Consumption |
|---|---|---|---|---|
| 1 | 0.21-0.35 | 0.05-0.11 | 0.06-0.17 | 0.22-0.10 |
| 2 | 0.06-0.08 | 0.03-0.055 | 0.003-0.015 | 0.34-0.056 |
| 3 | 0.012 | 0.0008-0.001 | 0.0005-0.003 | 0.001 |
| 4 | 0.1-0.13 | 0.10-0.08 | 0.027 | 0.008-0.127 |
| 5 | 0.04-0.555 | 0.001-0.37 | 0.03-0.16 | 0.03-0.53 |

A higher $O_2$ consumption seems to result from a larger amount of oxygen present, a result which can also be deducted from the $O_2$ values from results obtained during recent operations.

It would be impossible from the above results to express the connection between oxygen and sulfur purification in the form of a chemical equation. Actually the $O_2$ consumption is in all cases greater than could be expected theoretically.

Conclusions

A favorable effect of oxygen on the sulfur removal cannot be conclusively proven from these tests, but an optimum oxygen content of somewhere between 0.08 and 0.13% by volume of the synthesis gas appears favorable.