**The Experiment and Simulation Analysis of the Effect Of CO2 and Steam On Syngas Composition of Natural Gas Non-Catalyst Partial Oxidation.**

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**Highlights**

* The syngas composition of non-catalyst partial oxidation should be adjusted to satisfy the request of different chemical synthesis.
* CO2 has bigger adjustment range of H2/CO ratio than that of steam.
* The multi-reforming by CO2 or Steam addition is feasible.

**1. Introduction**

Non-catalyst partial oxidation technology has been widely used to produce syngas by reforming of hydrocarbon, including gas (natural gas, shale gas, refinery gas, coalbed gas, coke oven gas, pyrolysis gas, etc.) and liquid (residual oil, asphalt, deoiled asphalt, biomass oil, etc.). For natural gas non-catalyst partial oxidation, the H2/CO of syngas is about 1.8, which is agreed well with the request of FT synthesis. But for other process, such as carbonylation and glycol, the H2/CO should be close to 1 and 2 respectively. So the syngas composition of non-catalyst partial oxidation should be adjusted to satisfy the request of different chemical synthesis. That means a multi-reforming method by CO2 or Steam addition.

**2. Methods**

The experimental platform for the non-catalyst partial oxidation of natural gas is shown in Fig.1.

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**Fig. 1 Diagram of natural gas non-catalyst partial oxidation hot-model experiment platform**

The reactor network model of the reformer is shown in Fig. 2.The reactions in the reformer are described by GRI-3.0.



**Fig.2 Schematic diagram of reactor network (PSR: 12.758m3; PFR: Length=7.08m, Diameter=1.8m)**

**3. Results and discussion**

 

**(a) CO2 (b) Steam**

**Fig. 3 Effects of CO2 and Steam addition on the syngas compositions**

The experiment results of the Effects of CO2 and Steam addition on the syngas compositions are shown in Fig.3. For the case of the O2/CH4=0.95, the H2/CO is decreased from 1.5 to 1.24 when the CO2/CH4 is increased from 0 to 0.16; However, the H2/CO ratio is increased slightly from 1.62 to 1.65 When the H2O/CH4 ratio is increased from 0 to 0.24.

Table 1 shows the feasibility analysis results of multi-reforming. The greater of required adjustment of H2/CO ratio, the addition amount of Steam or CO2 into the reformer is greater. Correspondingly, the oxygen and natural gas consumption per unit effective gas is slightly increased.

**Table1 The multi-reforming analysis**

|  | 1  | 2  | 3  | 4  | 5  |
| --- | --- | --- | --- | --- | --- |
| O2/NG(v/v) | 0.775  | 0.690  | 0.657  | 0.675  | 0.720  |
| Steam(CO2)/NG (v/v) | 1.80(H2O)  | 0.48(H2O)  | 0.107(H2O)  | 0.15(CO2)  | 0.52(CO2)  |
| H2(v%) | 63.02  | 63.16 | 62.83  | 57.45 | 45.13 |
| CO(v%) | 25.15  | 31.65 | 33.87  | 38.35 | 44.60 |
| CH(v%) | 0.62  | 0.60 | 0.76  | 0.61 | 0.64 |
| H2/CO | 2.51 | 2.00 | 1.86  | 1.50 | 1.01 |
| T，K | 1522 | 1562 | 1578  | 1570 | 1533 |
| Oxygen Nm3/kNm3(CO+H2) | 317 | 262 | 247  | 255 | 283 |
| Natural gas Nm3/kNm3(CO+H2) | 409 | 379 | 376  | 378 | 392 |

**4. Conclusions**

CO2 has bigger adjustment range of H2/CO than that of steam. This paper presents the feasibility of multi-reforming on the natural gas non-catalyst partial oxidation by CO2 or H2O addition.