CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Catalytic combustion of natural gas is intensively considered over the past decade to achieve ultra low emissions, and improve turbine efficiency. Totally, thirty-nine catalysts from three catalyst libraries were established to study their combustion activity by using high-throughput methodology. The eight tubular flow reactors developed in this study showed an outstanding benefit on testing time since eight catalysts can be simultaneously screened for their activity at the same period time. Moreover, the connection with gas chromatograph also provides both conversion and selectivity of each catalyst, which results in complete activity test.

For the studies of parameters affecting combustion activity with the eight tubular flow reactors, the screening results clearly indicated the appropriate procedure for the further preparing employed catalysts. Primary pre-calcination of washcoated monolith was recommended to perform at 500°C for 3 hrs before impregnation with 5%wt of total loading. Re-calcination was also suggested to perform at 900°C for 3 hrs prior being used. After the preliminary test, a library for studying the effect of using Pd, Pt and La in mo-, bi-, and tri-element system was prepared and screened their activity with the eight tubular flow reactors. Lead formulations were selected for further characterization.

The substitution of Pd by Pt, while maintaining 5% total loading, resulted in the alloy formation between metallic Pd and Pt co-existed with PdO, and improved the combustion activity. The further substitution of Pt by La reduced the amount of metal used, which entailed the slightly decreasing of combustion activity. However, when the amount of Pt was substituted by La until its remaining weight is equal to the amount of Pd (Pd:Pt:La = 1:1:3), the combustion activity seemed to slightly increase since the Pd-Pt alloy became co-exist with PdO, however, supported on La-Al_2O_3 solid solution. Therefore, this formula was suggested to be the best for using these three elements together not only from its high combustion activity, but also from its reduction of noble metal usage.

5.2 Recommendations

Since the screening results illustrated the synergistic effect between Pt, Pd, and La on the combustion activity of catalyst containing Pd and Pt in equivalent amount with 3 times La dilution (Pd:Pt:La = 1:1:3), for the further work, the following recommendations would be suggested:

1) Other time-on-stream properties of leads, e.g. catalytic deactivation, should be investigated in order to observe another synergistic effect due to the using of Pd-Pt-La in tri-element system,
2) The secondary screening of Pd-Pt-La tri-element catalysts should be thoroughly performed around the location of Pd:Pt:La = 1:1:3 in tertiary diagram in order to identify the best formula more accurately,
3) Other catalysts containing Pd and Pt in equivalent weight ratio with different times of La dilution, e.g. Pd:Pt:La = 1:1:4, 1:1:2, 1:1:1, should be created for studying their combustion activities and characteristics related to the amount of La dilution,
4) Other characterization method, e.g. TEM, XPS, should be employed for understanding the leads' characteristics owing to the use of Pd-Pt-La in tri-element system,
5) Other parameters that may affect the combustion activity, e.g. metal-support interaction, particle size, catalyst preparation method, should be investigated using the combinatorial method with the catalytic compositions keeping as same as those of the leads,
6) The number of employed reactors in the multi-tubular flow design would be increased in order to use the employed multi-channel valve in its full capacity (16 channels).