# Research and Application of the Sequential Control Logic of Micro Oil Ignition System for Opposed Firing Supercritical Boiler

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**Abstract.** This paper introduces the application of micro oil ignition technology in Opposed Firing Supercritical Boiler, and the design of the sequential control logic. According to the characteristics and operation mode of micro oil ignition, compared with big oil gun control scheme, the paper study the micro oil ignition control logic to ensure that the unit further improve the reliability, and realize the safety of boiler start-up, stable operation and so on. This technology could effectively reduce the supporting oil loss when boiler is at low load stable combustion, and cost savings.

## Introduction

With the development of our national economy, the total power installed capacity and unit capacity have been increasing sharply. The light diesel oil that used only for boiler start-stop, low-load combustion and stable combustion in the power plant has reached several tens of millions of tons annually. In order to effectively reduce the loss of boiler's start-stop, low load stable combustion to save cost, the technology of micro oil ignition has been widely used[1]. This has proposed new requirements for the protection related to thermal control.

In this paper, we study the successful application of micro oil ignition system in the furnace type, and analyze the design and application of the system. According to the working principle[2], we study the sequence control logic, to ensure that the unit further improve the reliability, and realize the safety of boiler start-up, stable operation and so on.

## Micro Oil Ignition System

### Micro Oil Ignition System Characteristics

Micro oil ignition system is set up pulverized coal concentrating device in a specially designed micro oil burner. The system uses ring concentrate technology to increase the local concentration of pulverized coal, and form dense or dilute pulverized coal. With pulverized coal airflow conveying, dense pulverized coal is heated in the first combustion chamber by micro oil gun (because it use trace amounts of fuel combustion to produce a high temperature flame). The pulverized coal breaks out volatile matter and quickly flame[3]. The burning pulverized coal mix and ignite dense phase pulverized coal in the secondary combustion chamber. In this way, micro oil ignition system could realize that the pulverized coal classification ignites and burning energy enlarge step by step. When the ignition state is normal, the micro oil burner can be used as the main burner, and reserve the performance of the original burner.

The essential difference between micro oil ignition and the original small oil ignition is that: the small oil gun ignition is at primary air nozzles, but micro oil ignition is in primary air pipe. This combustion processes is heat insulation and more fuel-efficient. With film cooling technology, micro oil ignition system could prevent primary air pipe and burner to burn out.

Micro oil ignition system is made up of oil burning chamber, pulverized coal concentration device, the first level pulverized coal combustion chamber, and the second level pulverized coal combustion chamber.

**Micro-oil Ignition System Structure**

Micro-oil ignition system is made up of oil burning chamber, pulverized coal concentration device, the first level pulverized coal combustion chamber, and the second level pulverized coal combustion chamber[4].

Pulverized coal concentrating device: the device separate and concentrate pulverized coal gas flow, and import pulverized coal into 1 level pulverized coal combustion chamber;

the first level pulverized coal combustion chamber: the device lead into high concentration pulverized coal air flow. The high temperature oil flame and pulverized coal take place a strong chemical reaction in here. Pulverized coal split and produce large amount of volatile to be ignited;

the second (third) level pulverized coal combustion chamber: volatile matter which is ignited in the first level pulverized coal combustion chamber and partial pulverized coal continue to burn. When these combustible get into the second (third) level pulverized coal combustion chamber, the follow-up pulverized coal is ignited. By graded combustion and energy level amplification, the rest of pulverized coal is ignited finally and produce high-temperature pulverized coal flame in the burner outlet.

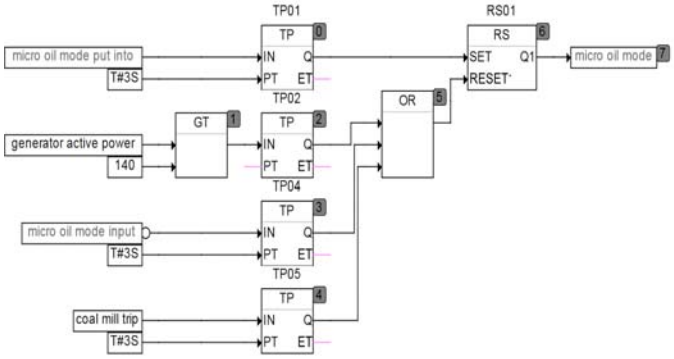
Flame stable ring: the front end of a coal powder nozzle is arranged in a ring shaped ring flame, which can make the particles slow down. It is beneficial to the evaporation of the coal particles. It can be improved by the partial coal separation and concentration.

**Sequence Control Logic**

**General Logic**

In micro oil ignition general logic, we design micro oil ignition mode button. By clicking the button, the unit protection logic is micro oil ignition model protection logic. At the same time, we also design exit logic. When the condition is satisfied, the micro oil mode is exited, and the conventional logic of the unit is to protect the boiler. The specific control logic is shown as fig.1.

Fig.1. Micro oil mode logic




**Micro Oil Gun Control Logic**

1. Micro oil ignition conditions

(1) Total allowable condition

The premise of micro oil ignition system operation is to meet the total start condition[5]. Mainly include: no MFT action, no OFT action, the header of oil valve fully open, oil pressure normal, and so on.

(2) Single oil gun allowable condition

Single gun based on satisfying total allowable conditions, should also meet the respective conditions.

2. A1 angle oil gun control logic

(1) A1 micro oil ignition control cabinet for front wall is at remote control mode;

(2) Oil gun satisfies ignition conditions;

(3) By clicking the start button, the logic sends out 3 seconds pulse and maintain by the RS trigger. A1 angle gun enter the operation;

(4) Under no MFT and OFT conditions, high-energy igniter strike fire for 25 seconds to fire up A1 burner;

(5) The logic opens the corresponding corner of the oil angle valve. If 25 seconds after the oil burner fire, the burner runs.

3. Micro oil ignition trip condition

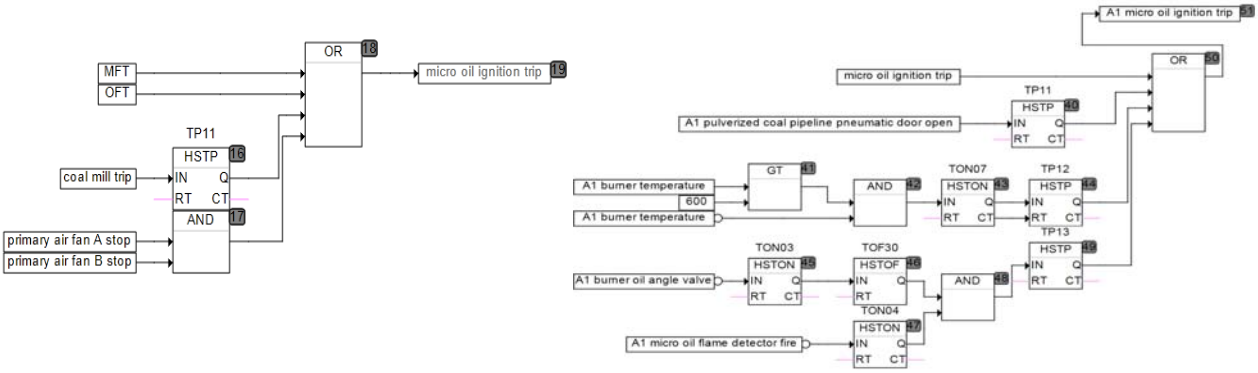
(1) Total trip condition

The micro oil tripping condition is the logic of setting up the safe and stable operation of the equipment and boiler[6]. Total trip condition includes MFT action, OFT action, A grinding coal machine tripping, etc.

(2) Single oil gun trip condition

In addition to meet the total tripping conditions, the micro oil ignition also has the respective tripping conditions.

Fig.2. Micro oil ignition trip condition



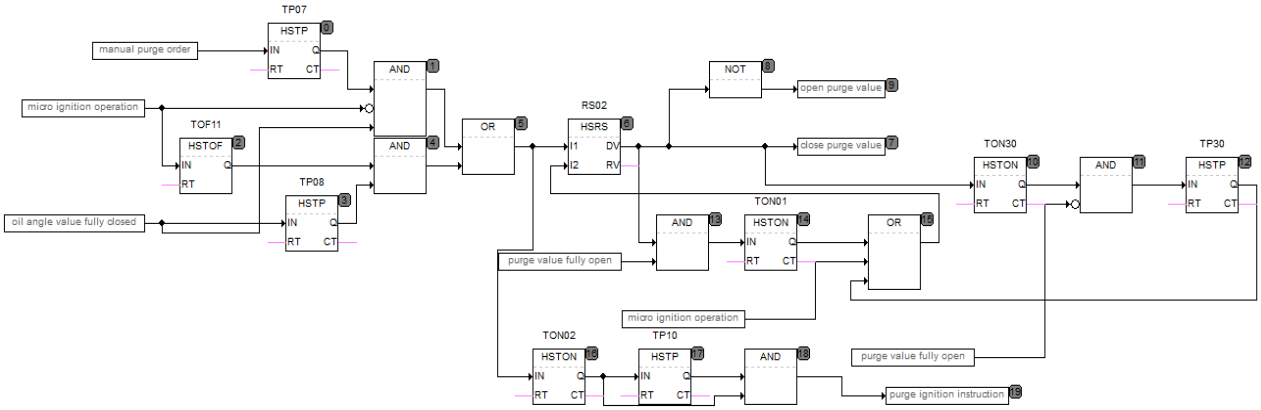

4. Manual purge request

If the boiler MFT or OFT action at micro oil ignition operation process, the system will send out manual purge request.

5. Purge

Purging effects is to remove build-up in the fuel pipe without burning residual fuel and combustible gas to prevent ignition deflagration[7]. The specific control logic is shown as fig.3.

Fig.3. Purging logic




**A Layer Control Logic**

Micro oil ignition system consists of eight guns. In the opposed firing boiler, 4 oil guns distribute from the front wall, 4 oil guns in the back wall. Layer operation is divided into the front wall and the rear wall operation[8].

1. Micro oil ignition system allowable starting conditions in front wall of A layer (The paper explains the front wall as an example)

(1) A1 micro oil ignition allowable starting;

(2) A2 micro oil ignition allowable starting;

(3) A3 micro oil ignition allowable starting;

(4) A4 micro oil ignition allowable starting.

2. Layer start (The paper explains the front wall as an example)

(1) The front wall of A layer is allowed to start. By clicking the start button, the logic sends out 3 seconds pulse and maintains by the RS trigger.

(2) A2 burner starts after 2s; A3 burner starts after 17s; A1 burner starts after 32s; A4 burner starts after 47s.

(3) The reset condition of the RS trigger is that MFT action, OFT action, the front wall of A layer sends out removal order, and the front wall of A layer sends out start order.

3. Layer removal (The paper explains the front wall as an example)

(1) The logic sends out removal order in 3 seconds pulse and maintains by the RS trigger.

(2) A4 burner cuts off; after 2s; A1 burner cuts off after 17s; A3 burner cuts off after 32s; A2 burner cuts off after 47s.

(3) The reset condition of the RS trigger is that boiler MFT action, OFT action and the front wall of A layer sends out removal order.

4. Micro oil ignition failure judgment

(1) A1-A4 micro oil burners in the front wall of the fire no fire two to take four, the front wall of the micro oil fire test 2/4 no fire.

(2) After the wall A5-A8 micro oil fire no fire four to take two, the wall of the micro oil fire seized 2/4 no fire.

(3) Condition (1) and condition (2), for the A layer fire detection no fire, as MFT signal use.

(4) The 8 corners are all non-fire, for the layer and the wall all the fire without fire signal, the use of blowing.

## Conclusion

After the research and optimization, the sequential control logic sufficiently considered the micro oil ignition system characteristics, in order to ensure the normal start-up and operation of the micro oil ignition system. The reliability and safety of the boiler is improved.

## References

[1] B. Lin & W. Y. Sui. Research and Optimization of Micro-oil Ignition System Relates to the Protection Logic for 350MW Opposed Fire Boiler[A]. Computational Intelligence in Industrial Application, 2014: 385-387.

[2] Liu, W.W. & Liang, W.Z. Successful experiences about the application of micro oil ignition technique on super-critical boiler[J]. Shanxi Electric Power 6(183): 56-58.

[3] Xie, W.G. Influence of making use of oil-saving ignition on protective logic and its improvement schemes[J]. Journal of Electric Power 24(4): 331-333.

[4] L. Zeng, et al. The Applied Research on the Small Oil Gun Ignition Technology in Pulverized Coal-fired Boiler[A]. 2010 Asia-Pacific Power and Energy Engineering Conference 2010: 1-4.

[5] Liu, H.L. Practice and thinking of domestic micro oil ignition transformation of 600MW boiler[J]. Energy Conservation Technology 28(159): 87-90.

[6] Wang, L.D. & Yu, G. Control logic implementation of tiny-oil ignition technology applied in opposed firing boiler[J]. Journal of Shanghai University of Electric Power 26(3): 262-265.

[7] Tang, Y.H. & Liu, H.B. Calculating as fired coal quantity for double-inlet and double-outlet mill based on soft sensing[J]. Instrument Technique and Sensor 5: 27-31.

[8] Huang, S.F. Problems of micro oil ignition of boiler in Shajiang C Power Station[J].. Guangdong Electric Power 22(4): 56-58.